GEOLOGICAL SURVEY OF CANADA.

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

MAPS

TO ACCOMPANY

ANNUAL REPORT

(NEW SERIES)

VOLUME X

1897

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1899.

GEOLOGICAL SURVEY OF CANADA

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OF

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GEOLOGICAL SURVEY OF CANADA

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

ANNUAL REPORT

(NEW SERIES)

VOLUME X

REPORTS A, H, I, J, M, S.

1897

OTTAWA
PRINTED BY S. E. DAWSON, PRINTER TO THE QUEEN'S MOST
EXCELLENT MAJESTY
1899

No. 679.

To the Honourable
CLIFFORD SIFTON, M.P.,
Minister of the Interior.

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

The volume comprises 1,046 pages. It is accompanied by 8 maps and illustrated by 12 plates, besides a number of figures in the text.

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

I have the honour to be, sir,
Your obedient servant,

GEORGE M. DAWSON,
Director.

OTTAWA, October, 1899.

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ERRATA.

Plate I Part H, title, *for* Mattawa *read* Matawin.
Page 12 H, line 14 from top, *for* waters *read* routes.
" 17 H, line 20 from top, *for* Osmaire *read* Osinawe.
" 17 H, line 23 from top, *for* Gabawy *read* Sabawy.
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" 59 H, line 24 from top, *for* Tip-cop *read* Tip-top.

" 17 I, line 8 from bottom, *for* Slater *read* Salter.
" 28 I, line 11 from bottom, *for* from *read* form.
" 46 I, line 1 from top, *for* number *read* member.
" 132 I, line 8 from bottom, *for* affected *read* effected.
" 143 I, line 4 from top, *for* south-west *read* south-east.
" 157 I, line 10 from bottom, *for* Verne *read* Verner.
" 208 I, line 4 from bottom, *for* 876 to 886 *read* 870-7 to 880.
" 209 I, line 19 from bottom, *for* Mackenzie *read* McKenzie.
" 216 I, line 14 from bottom, *for* 642·2 to 649·5 *read* 640·5 to 647·8.
" 252 I, line 21 from top, *for* association *read* associated.
" 261 I, line 17 from bottom, *for* Snake *read* Snare.
" 261 I, line 17 from top, *for* Snake *read* Snare.
" 274 I, line 8 from bottom, *for* distinguished *read* disintegrated.
" 284 I, line 16 from bottom, *read* (Shabosaging Lake).
" 285 I, line 9 from top, *for* Kaotisinimigouang *read* Kaotisiniwaning.
" 287 I, line 5 from bottom, *for* Free *read* Three.

" 19 J, line 20 from bottom, *for* destructive *read* denudational.
" 20 J, line 21 from top, *for* rivershed *read* watershed.
" 59 J, line 21 from top, *for* denudational *read* denudation.
" 70 J, line 10 from top, *for* discriminated *read* disseminated.
" 92 J, line 19 from bottom, *for* mines *read* miners.
" 152 J, line 2 from bottom, *omit* in these.

" 13 M, lines 6, 12, 17 from bottom, *for* Jacksontown *read* Jacksonville.
" 13 M, line 16 from bottom, *for* north-east *read* north-west.
" 14 M, line 11 from top, *for* Jacksontown *read* Jacksonville.
" 15 M, line 16 from top, *for* Jacksontown *read* Jacksonville.
" 17 M, line 12 from bottom, *for* south *read* north.
" 19 M, line 14 from top, *for* Borestown *read* Boiestown.
" 43 M, line 9 from top, *for* Nepisiquit *read* Nepisiguit.
" 55 M, line 5 from top, *for* north-east *read* south-west.
" 115 M, line 12 from top, *for* Tattagouche *read* Tête à Gauche.

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

SUMMARY REPORT

ON THE

OPERATIONS OF THE GEOLOGICAL SURVEY

FOR THE YEAR 1897

BY

THE DIRECTOR

OTTAWA
PRINTED BY S. E. DAWSON, PRINTER TO THE QUEEN'S MOST EXCELLENT MAJESTY
1898

No. 644

SUMMARY REPORT

ON THE

OPERATIONS OF THE GEOLOGICAL SURVEY

FOR THE YEAR 1897.

OTTAWA, 10th January, 1898.

The Honourable CLIFFORD SIFTON, M.P.,
Minister of the Interior.

SIR,—I have the honour to submit herewith the Annual Summary Report of the Geological Survey Department for the year 1897, including, in accordance with the Act relating to the Geological Survey, an account of the proceedings and work accomplished by the Survey during the calendar year which has just closed.

Nature of this report.

This Report affords a brief record of the executive and office work of the Department and of the organization and main results of the field-work. To the latter, a greater amount of space is accorded, and the gentlemen entrusted with the carrying out of field-work are invited to thus place on record, for the early information of the public, all the more important facts observed by them, especially such as appear to possess a definite economic importance, or are likely for any reason to be of immediate value to those engaged in developing the resources of the country.

As explained in previous Summary Reports, the detailed examinations of special districts and the elaboration of reports and maps upon these, as well as other investigations carried out along particular lines, often require several years for their satisfactory completion. It has now for some time been the practice to print and publish the results of such work in separate form whenever completed, thus rendering it at once available to the public, and subsequently to issue such reports of permanent value in a collected form as a volume, properly indexed, which is distributed to Parliament and to such public institutions, libraries and exchanges as are entitled to receive it.

Annual Report, Vol. VIII.

Volume VIII. of the new series of Annual Reports was thus completed for issue in June of last year. In addition to the Summary Report for 1895, it consisted of the following parts :—

Report on the country between Athabasca Lake and Churchill River.

Report on the geology of a portion of the Laurentian Area lying to the north of the Island of Montreal.

Report on explorations in the Labrador Peninsula, along the East Main, Koksoak, Hamilton, Manicuagan and portions of other rivers.

Report of the Section of Chemistry and Mineralogy.

Report of the Section of Mineral Statistics and Mines, 1895.

This volume was accompanied by six maps, geologically coloured, and illustrated by eighteen plates and a number of cuts in the text. The French edition of the volume is now nearing completion.

Of Volume IX. (N.S.) the following parts have already been separately printed :—

Volume IX.

Report on the Doobaunt, Kazan and Ferguson Rivers and the north-west coast of Hudson Bay.

Report on the geology of the French River sheet, Ontario.

Report of the Section of Mineral Statistics and Mines, 1896.

Palæontology.

Other parts of this volume are in various stages of progress. In the palæontological series of publications, Part 3, Volume III., *Palæozoic Fossils,* has been completed by Mr. J. F. Whiteaves and printed.

Sales of publications.

Particular attention may be directed to the fact that 5843 separate publications of the Geological Survey have been sold during the past year—a number nearly twice as great as that for 1896, and very much in excess of that in any previous year. These sales are in addition to the large numbers of reports and maps gratuitously supplied to public institutions and exchanges, and often include publications issued many years ago. The demand thus shown for the reports and maps, serves to illustrate their utility and the necessity of keeping in stock, as far as possible, copies of even the older publications, for which special need may arise, in connection with particular districts, at any time.

The correspondence connected with the sale of publications is very considerable and the prices charged are, as a rule, little more than nominal; but as it may be assumed that, in all cases, the information asked for is actually required, the time and trouble involved are, it is believed, well spent.

Reprints and new editions.

The comparatively small edition printed in former years, is now resulting in the proximate or complete exhaustion of various reports and maps, leading to the necesssity of the production of reprints or new editions. This condition is likely to increase in the future and to add to the amount of work to be carried on in the office and the expenditure in printing. Larger editions are now being printed of all the reports and maps.

Maps issued.

During the year the printing for issue of twenty different maps has been completed. This number would have been larger but for the fact that it has been found necessary to delay the preparation of colour-stones for several of the Nova Scotia map-sheets of which the geographical features are already engraved, pending the further examination in the field of some important geological questions affecting these sheets. It is hoped that the special investigations made last summer with this object in view, may render it possible to complete the information for several of the above sheets, which in that event will be promptly issued.

Preliminary editions of maps.

The production of a new edition of the geological map of the northern part of the Lake of the Woods, Western Ontario, spoken of in the last Summary Report, was pushed forward as rapidly as possible, and a preliminary edition of the corrected map was issued in June last. The complete exhaustion of the first (1885) edition of this map, with the continued and numerous demands for it, consequent on the further development of gold mining in the region, rendered its prompt re-issue desirable. It was impossible, however, at the time, to re-examine a number of new points which had arisen in connection with the prospecting and mining operations. These have now been investigated by Mr. McInnes, and it will be possible at a later date to complete the new edition of this map with further corrections.

Another map of which a preliminary edition was issued during the summer to meet immediate requirements, was that of the important Trail Creek mining district of British Columbia.

Maps supplied to Ontario Bureau of Mines.

At the request of Mr. A. Blue, Director of the Ontario Bureau of Mines, arrangements were made to furnish special editions of the Shebandowan sheet and of the map of the Lake of the Woods above alluded to, printed from the stones already prepared. These have since been issued with the Sixth Annual Report of the Bureau. A large circulation has in this way been given to these maps, covering important parts of the province of Ontario, and the expense of separate reproduction by the Bureau has at the same time been obviated.

General geological map.

A previous general geological map of Canada published in 1884, being now in many respects out of date, the compilation of a new map of the kind was begun in 1896. Work on this map has been continued during 1897, whenever time admitted, and this map is now so far advanced that it is probable it will be ready for issue at an early date.

Reprint of Yukon Report.

The great amount of attention directed to the Yukon district during the past year, has led to the practical exhaustion of the separate copies of the Report on the Yukon District and adjacent northern portion of British Columbia with its accompanying maps, forming part of volume III. (1887-88) of the Annual Report. In view of the continued applications for this report and the map-sheets referred to, it has been decided to reprint the text of the report, together with those parts of the subsequent report by Mr. McConnell, (Vol. IV.) which relate to the Yukon district. This work, together with that of correcting the accompanying map-sheets is now in progress. The reprint will thus include practically all the available geological data for the Yukon district, which, although very far from complete, is likely to be of considerable importance to the prospectors and miners entering that country next spring.

General index.

The general index of the earlier reports of the Geological Survey, which has been in process of compilation by Mr. D. B. Dowling for some time, has now been completed, and the first part of the manuscript is in the hands of the printer. This includes the *Geology of Canada* (1863) and subsequent Reports of Progress up to the first volume of the new series of Annual Reports, dated 1885. The reports from 1843 to 1863 are not included, as the volume for 1863 embraces all the main facts covered by these, in a summarized form. The Annual Reports from 1885 to date are all separately indexed. The general index now completed contains about 31,000 references alphabetically arranged, as well as an analytical key to localities and districts geographically arranged and an enumeration of all analysis, assays and special descriptions of minerals, etc.

Issue of mineral statistics.

The annual preliminary statement of the mineral output of Canada for the preceding year (1896) was completed and sent to the printer on February 13th last. As subsequently revised, this shows a total production in minerals of the value of $22,609,825, exceeding that of 1895 by nearly two millions and being twice the amount of the total output for the year 1886, the first year for which exact and comparable figures are available.

Greatly increasing output.

Many parts of the Dominion have contributed towards this gratifying expansion, but the province of British Columbia is more particularly in evidence in this regard. The rapid and steady increase of metalliferous mining in that province still continues, and what is already known of the output in 1897, goes to show that it will, probably, be about fifty per cent greater than the amount recorded for the previous year. In Ontario, gold mining in the western part of the province has been rapidly increasing in importance, and now that actual returns in bullion are beginning to come in from a number of mines, the future of this industry appears to be assured.

Geological information on Yukon district.

The most noteworthy feature of the past year in this regard is, however, the sudden and world-wide attention which has been directed to the Yukon district by exceedingly rich discoveries of placer gold on the Klondike and its tributary streams. Gold mining was first attempted in the Yukon basin about 1880, and in 1887 the reports from this hitherto almost unknown district were of such a character as to induce the government to despatch an expedition to it for the purpose of ascertaining the facts, and of determining, approximately, the position of the International boundary with regard to the places then more immediately claiming attention. The writer was entrusted with the control of this expedition, Mr. W. Ogilvie being particularly instructed to determine the position of the 141st meridian, while Messrs. McConnell and McEvoy of the Geological Survey were attached as assistants.

The results of this work were given to the public in a report by the writer on the Yukon District and adjacent northern portion of British Columbia, Mr. McConnell's Report on an exploration in the Yukon and Mackenzie Basins, and Mr. Ogilvie's Report entitled Exploratory survey of part of the Lewes, Tatonduc, Porcupine, Bell, Trout, Peel and Mackenzie Rivers, this latter being published in the Annual Report of the Department of the Interior for 1889.

In the first-named of the above reports, the conditions then existing were summarized as follows :—

Forecast based on work of 1887-88.

"Mining can scarcely be said to have begun in the region more than five years ago, and the extent of country over which gold has been found in greater or less quantity is already very great. Most of the prospecting has been confined to the banks and bars of the larger rivers, and it is only when their innumerable tributary streams begin to be closely searched, that 'gulch diggings' like those of Dease, McDame and other streams in the Cassiar district, and possibly even on a par with Williams and Lightning creeks in Cariboo, will be found and worked. The general result so far has been to prove that six large and long rivers, the Lewes, Tes-lin-too, Big Salmon, Pelly, Stewart and White, yield 'fine gold' along hundreds of miles of their lower courses. With the exception of the Lewes, no part of the head-waters of any of these have been prospected or even reached by the miners, and scarcely any of their innumerable tributaries have been examined. The developments made up to this time are sufficient to show that when means of access are improved, important bar-mining will take place along all these main rivers, and there is every reason to anticipate that the result of the examination in detail of the smaller streams will be the discovery of much richer auriferous alluviums. When these have been found and worked, quartz mining will doubtless follow, and the prospects for the utilization of this great mining field in the near future appear to me to be very promising."

The forecast embodied in the above quotation, resulting from a preliminary reconnaissance of the geological features of the district, has been most amply verified by the recent discoveries in the Klondike region. The entire Yukon district is now certain to be explored and prospected, and as a result of this there can be no doubt that it will soon become recognized as a most valuable portion of the Dominion—a permanently productive part of that great mineral belt which, it has been pointed out, extends within the borders of Canada from the forty-ninth parallel on the south, north-westward to the 141st meridian, with a length of some 1200 or 1300 miles.*

Character of the placer deposits.

In regard to these placer deposits, some particularly interesting questions occur, which remain to be solved by geological investigations of a detailed kind. As a result of the exploration of 1887, it was found that the north-westwardly flowing part of the Cordilleran glacier terminated along a line approximately fixed at a considerable distance to the south of both the Klondike and Forty-mile regions, neither of which have been crossed by any such confluent glacier.†

The deposits normally resulting from denudation, under varying conditions of slope and base-level, may, therefore, probably have remained practically undisturbed from a very early period in the Tertiary, beginning possibly not long after the close of the Laramie, when the latest orographic movements proved for the region occurred.

Such a prolonged and uninterrupted wearing down of rocks containing auriferous veins, may in part account for the great quantities of residuary gold now contained in the placers. Some facts already known in regard to the thickness of the pay gravels, appear, however, to suggest that successive levels may possibly have been enriched by concen-

*Annual Report, Geol. Surv. Can., vol. III. (N.S.) p. 14 R.

†Geological Magazine, vol. V., p. 347, (1888). Annual Report, Geol. Surv. Can. 1887-88, p. 40 B, 1888-89, p. 28 D. Trans. Royal Soc. Can., vol. VIII., Sect. 4, (1890).

tration taking place upon underlying frozen gravels, constituting a sort of false "bed rock" and admitting of the successive deposit of a number of superposed and richly auriferous layers. On the other hand, we have the probability, depending upon our general knowledge of the fauna and flora of the Tertiary of the West, that the climate was much less rigorous during the greater part of Tertiary time. This is borne out by observations made in regard to such of the placers of the Cariboo district of British Columbia as are distinctly pre-glacial and underlie the boulder-clay of that region.*

Important questions relating to the placers.

The question thus raised remains to be decided by further geological examination, and by the search for organic remains in association with the placer deposits. Bones of the mammoth and of other contemporary animals are known to be present in some abundance in this region north of the area formerly occupied by the Cordilleran glacier,† but their precise relation to the auriferous gravels has not yet been determined. It is also possible that the more modern gravels may have been enriched by the wearing down of antecedent placers of the Laramie rocks, with which the coals of the district are associated. Such considerations show it to be very important, if possible, that further geological work should at once be undertaken in this new region, as a scientific study of its physical conditions and history promises not only to throw much light on the conditions determining the gold-bearing alluviums, but also to connect these with the parent deposits from which the placer gold has been derived, and to establish the extent and distribution of the rocks in which these original deposits occur.

Collections of minerals prepared.

At the request of the Minister of Agriculture, a good typical collection, composed of large specimens of Canadian minerals of economic value, was prepared for the Stockholm exhibition; but at a later date, it having meanwhile been found that adequate accommodation could not be obtained for Canada at that exhibition, this collection was loaned for display in connection with immigration work in several of the Western States of the American Union, where it attracted considerable attention.

The preparation of small illustrative collections of Canadian minerals for institutions in Canada in which natural science is taught, has been continued, in so far as time and means admitted. Such collections are gratuitously supplied to approved institutions of the kind, and in a number of cases there is reason to know that they have been very highly appreciated and put to really practical use. The number of

*Summary Report, Geol. Surv. Can. 1894, p. 26 A.

† Quart. Journ. Geol. Soc. Feb. 1894.

these collections sent out during the past year has been 60, comprising in all 5164 specimens.

Commercial samples.

Special samples of various kinds likely to bring about results of commercial value, have also been sent to the Imperial Institute in London and elsewhere, and it may here be well to repeat that any such approved samples sent to the Department here, will be transmitted to the Imperial Institute, together with the trade particulars, price-lists, etc., which the producers may care to furnish.

Correspondence.

The general correspondence of the department has again greatly increased during the past year, and has included a large proportion of inquiries relating to almost every known mineral product, as well as numerous general questions of a miscellaneous kind. In reply to these it is usually possible to furnish the information desired, or at least to designate the source from which the facts may be obtained.

Necessity for new museum and offices.

The absolute necessity for additional space for the preservation of specimens accruing to the museum, and for work-rooms for material under examination, has led to the construction of temporary partitions and shelving in the two lower floors of the building on Sussex street, adjoining that belonging to the Government and already occupied by the Survey. At best, however, this provides little more than storage room of an unsatisfactory kind, and that in a building which is even more liable to danger from fire than the one occupied by the museum and offices. The need for new, fireproof and more spacious quarters for the museum, records and offices of the department, becomes more pressing every day and is one which, in the interests of the country, cannot much longer be ignored. It has been pointed out in the reports of the Director of the Survey for a number of years past, and it is not possible to omit a renewed reference to it in this Report without incurring grave responsibility.

Insufficiency of present building.

While it is believed that Parliament and the public generally would approve the expenditure necessary for the construction of a building suited to the adequate display of the mineral resources of the country, it is realized also that the economic and scientific value of the collections and records, now so inadequately housed, and the impossibility of replacing them if destroyed is not fully appreciated. Nor is it possible, in the present cramped quarters, to give any just exposition for the public eye, of the material wealth of Canada. To the numerous local visitors, the museum, even as it at present exists, affords an instructive object-lesson. To those who come, every year in increasing numbers, from other parts of the empire and from abroad, it is inspected as the only national museum maintained by the Canadian Government. Its value is duly recognized, but the inferiority of the accommodation accorded to it in comparison with that given elsewhere to similar collections, presents itself as a subject of criticism and of regret. Quotations from the published remarks of visitors given in previous reports need not here be repeated, and it is to be hoped that in future it may not again be necessary to cite them.

The meeting in Toronto, in August last, of the British Association for the Advancement of Science, the arrangements for which were materially assisted by the Canadian Government, afforded an opportunity for the presentation and discussion by specialists of various topics connected with the geological investigation and economic development of Canada. This meeting was the second occasion on which the Association has been assembled in a city beyond the limits of the British Islands, the first having been in Montreal in 1884, and although the International Geological Congress, held simultaneously in St. Petersburg, attracted many geologists who would otherwise have been present, it was attended by a number of well known geologists, mineralogists, geographers and others, from Great Britain, the United States and other countries. Meeting of the British Association.

Such members of the Geological Survey as were not precluded by the remoteness of the scene of their operations at the time, were enabled to attend the sessions of the Association, and a number of papers were read by them on subjects connected with their work. At the close of the meeting, in addition to other excursions of more local interest, arrangements were made by favour of the Canadian Pacific Railway and with the aid of the Local Committee and the Provincial Governments, for a journey to the Pacific Coast, with special facilities, for the officers of sections and other prominent members. It was arranged that the third, or geological party should stop at various points of interest on the way west, and the result of this particular excursion cannot fail to exercise an important influence in making known, in the most practical way, the important developments now in progress in the country. Geological excursions.

In this connection it may be appropriate to allude particularly to the opening words of Professor Roberts-Austen, Chemist and Assayer to the Mint, in his lecture on Canada's metals at the Massey Hall, in which he conveyed a high tribute to the work already done for Canada by its Geological Survey; and to an article in *Nature* (London), devoted to the trans-continental excursion, in which the following passage occurs: "Then let us set down our admiration for the work of the Canadian Geological Survey. Considering the means at its com- References to work of the Geological Survey.

mand, and the positively inconvenient extent of its territory, it is marvellous how much has already been accomplished, and how clearly the general structure of the country has been brought out. It was pleasant to observe, too, how well its work was appreciated among the people for whom it was primarily intended, and how in the mining districts the geological maps we carried were quite familiar to the prospectors and mining people generally, who were usually furnished with copies."

Meeting of Geological Society of America.

The winter session of the Geological Society of America, held in Montreal on December 28th, 29th and 30th, was also attended by a number of members of the staff of the Geological Survey, several of whom contributed papers on Canadian geology.

Work of the Director.

With the increasing scope of the operations of the Geological Survey, it seems to become every year more necessary that the greater part of the time of the Director should be devoted to administrative work and official detail, rather than to original investigations in the field. A few days were devoted by me in the early summer to examinations bearing on questions which have arisen in connection with the mapping of the rocks of parts of the province of Nova Scotia, relating particularly to the age to be assigned to certain Palæozoic strata in Pictou and Colchester counties, with a view to enable the early publication of several map-sheets, which has been delayed pending the results of such critical inquiry. Further allusion is made to the points in question on a later page, where something is said by Dr. Ami on the result of the determination of the fossils upon which the interpretation of the sections largely depends. Advantage was also taken of my visit to the Maritime Provinces, at this time, to look over, in company with Professor Bailey and Dr. Matthew, the remarkable series of rocks displayed in and near the city of St. John, New Brunswick.

Visits to mining districts.

At the close of the meeting of the British Association above alluded to, I accompanied the geological party to Victoria, B.C., affording such assistance and information as was possible, and gaining in return many useful hints from several of the distinguished investigators who composed the party. Visits were made in going west, to the mining districts centring at Sudbury and Rat Portage, and one day was spent at Banff and another at Glacier; while on the way back, most of the party visited some of the centres of mining operations in West Kootenay. The party was everywhere received by the local authorities with the greatest cordiality, and I have reason to know that our scientific guests were pleased and impressed with the hopeful and important development of the mineral and other resources of the country, now everywhere in progress.

The advances made in regard to mining and the provision of means of communication in the West Kootenay district, which I had not myself seen since the date of my preliminary report of 1889, are most striking and remarkable. Notwithstanding the low price of silver—one of its most important products—this district is steadily and profitably increasing its output of this metal, and is also marketing very important quantities of gold, lead and copper. It is the first-developed of the metalliferous mining districts of British Columbia and as such may be taken as an example of others yet to come. Kootenay.

A short visit was also paid by me to Harrison Lake, but rather with the object of noting its general geological features than with that of inspecting the mineral deposits there being opened up. A day was also spent at Kamloops, for the purpose of gaining some knowledge of the mineral deposits which have been discovered since the date of my report upon that region, and are now being developed. Mr. W. F. Wood here kindly accompanied and guided me to some of the more promising claims. The metalliferous deposits here occur in connection with, and so far as yet opened out, may be said to be confined to, a mass composed chiefly of gabbro, about six miles long by two miles and a half wide, of which the limits are approximately defined upon my published map. Coal Hill is a prominent high part of the mass, which although apparently separated at the surface from that constituting Cherry Bluff and Battle Bluff on Kamloops Lake, is similar in character and no doubt attributable to the same Tertiary period. The Cherry and Battle Bluffs mass has been described as probably representing the central and originally deep-seated eruptive focus of a Miocene volcano, and the offshoot, or partially separate area of Coal Hill, is in all probability of the same character and date. Both have evidently been originally deeply covered by the fragmental volcanic deposits and basaltic flows of which remnants appear as ridges and escarpments in the vicinity. The metalliferous minerals seem to have been deposited by hydrothermal action marking the last stages of volcanic activity, a more or less complete decomposition of the rock itself being affected at the same time. Kamloops.

The ores met with about Coal Hill consist principally of iron- and copper-pyrites, containing more or less gold, but accompanied with but little quartz. They follow fractured and shattered zones which generally run about east-and-west (magnetic) occurring in nests and spots in the substance of the rock itself and in jointage-planes, and sometimes forming masses or sheets of pure sulphides several inches thick. Ores at Kamloops

The sulphides thus appear to have partly replaced the rock-matter and in part to have filled intervening joints and spaces in the more or less brecciated mass; the latter being possibly a subsequent or concluding phase of the impregnation. Small quantities of chalcedonic quartz, resembling that abundant in parts of the ordinary volcanic rocks of the district, were observed in some places. A little native copper is also occasionally seen in small particles and leaves.

The magnetic iron ores of Cherry Bluff * may in all probability be considered as due to similar action taking place in another part of the old volcanic centre, at or about the same time. The general conditions, in fact, show a resemblance in many respects to those found in the case of the Rossland ores, but the amount of gold present appears to be less considerable than in these, and the value of the ores, in so far as yet determined, must depend chiefly upon their content in copper. The amount of development actually accomplished is not very great, but some small shipments of hand-picked ore have been made.

Parties in the field.

The field-work of the Geological Survey has, as a rule, been carried out by parties or individuals who devoted the entire available season to surveying or exploring operations; but of late years it has frequently been found necessary to initiate special investigations or surveys, on which members of the staff or assistants have been occupied for shorter periods, and it is not always easy to draw the line between these and the field-parties, properly so called. Following, however, the practice in former reports, the field-parties of the past season may be said to have been fifteen in number, distributed as follows:—

British Columbia	2
North-west Territories (boring operations)	2
Ontario	4
Quebec	1
New Brunswick	1
Nova Scotia	3
Hudson Strait	2
	15

Special examinations, *etc.*

In addition to the above-mentioned parties, special examinations, collecting and other work in the field has been carried out during the year by other members of the staff. Dr. H. M. Ami spent more than two months in Nova Scotia in palæontological examinations intended to further define the true position of certain series of rocks in that province.

* Annual Report, Geol. Surv. Can., vol. VII. (N. S.) p. 341 B.

He was also sent to western Ontario in September to investigate the reported discovery of mastodon remains in new localities there, with results given on a subsequent page. Mr. L. M. Lambe was occupied for nearly three months in the North-west Territories in collecting, and in inspecting the boring operations on the Saskatchewan. Mr. E. D. Ingall found time to visit a few mineral occurrences of interest and Mr. A. A. Cole spent three weeks in making plans of the graphite deposits opened up in Buckingham township, Que. A visit was made by Mr. W. F. Ferrier to Hastings and Peterborough counties in connection with certain minerals and rocks found there. Mr. J. White devoted nearly three weeks to running some necessary survey lines in parts of Prescott and Frontenac counties, Ont.

Mr. C. W. Willimott was also employed as usual for some time in obtaining specimens of rocks, ores and minerals suitable for school collections.

The main features of the field-work of the year, may, in the first place, be alluded to in order, further details being contained in the reports given on later pages:— Synopsis of field-work.

In British Columbia, attention was given almost entirely to the West Kootenay district, Mr. R. G. McConnell continuing the geological work there, while the necessary topographical data were being obtained by Mr. J. McEvoy. Messrs. R. W. Brock and W. W. Leach acted as assistants. The principal object in view has been to provide a geological map embracing the main mining camps and connecting them, and so much progress has now been made in this that a considerable part of the entire West Kootenay sheet can now be compiled and engraved. The principal rock-formations of the district have been recognized and outlined and much valuable information respecting the occurrence of the various classes of ore-deposits has been obtained. An abstract of such facts, for a part of the region, is given in the explanatory notes on the preliminary edition of the Trail Creek map, already published.

In Manitoba, a short season was spent by Mr. J. B. Tyrrell in further defining and investigating the thickness and relations of the Devonian, Silurian and Cambro-Silurian strata, chiefly between Manitoba and Winnipeg lakes, the results being such as to now admit of the delineation of the several formations with proximate accuracy on that part of the map of Lake Winnipeg and its vicinity.

In the Rainy Lake district of Western Ontario, Mr. W. McInnes continued, and has completed, the surveys and examinations necessary for the area to be covered by the Manitou sheet of the geological map, Synopsis of field-work—*Cont.*

which is now in course of compilation in the office. He reports favourably of the prospects for gold mining in that comparatively new part of the region. A portion of his time was also devoted to the revision of the geology of the northern part of the Lake of the Woods, where mining is now well established, with the object of completing the data for a corrected edition of the map of that lake and its vicinity.

Mr. A. E. Barlow and Dr. F. D. Adams report jointly on their further work in Central Ontario, on the Haliburton sheet. The chief geological problem involved in this region is, it will be remembered, that respecting the relations of the Hastings and Grenville series and the possible connection of these with the Huronian rocks. Mr. Barlow notices at some length the distribution and mode of occurrence of the corundum deposits, which constitute an interesting feature of the district and one probably of economic importance.

On the Perth and Ottawa City sheets, the position of which is indicated by the names applied to them, work was continued by Dr. R. W. Ells. These sheets include large areas both of the crystalline Archæan rocks and of the Cambro-Silurian formations, the distribution and character of which is being systematically worked out. Iron ores occur in a number of places in the crystalline rocks, and prospecting is being carried on for gold and other metallic minerals. The Cambro-Silurian strata are chiefly of value as structural materials, but their position and structure is also of importance in connection with the question of the possible occurrence of natural gas.

By Mr. R. Chalmers, work was continued on the gold-bearing alluviums of the 'Eastern Townships' of Quebec, and it is now intended to complete a report upon these. The investigation of the superficial deposits and ancient shore-lines along the St. Lawrence and Ottawa valleys, both in Quebec and Ontario, was also continued, with interesting results, of which a somewhat full synopsis is given on a later page.

Exploratory work was conducted by Dr. R. Bell and Mr. A. P. Low on the north and south shores, respectively, of Hudson Strait. This was rendered possible, and appeared to be desirable, in connection with the Hudson Bay expedition despatched under Dr. Wakeham of the Department of Marine and Fisheries.

The coast explored by Dr. Bell, extends from Ashe Inlet and Big Island north-westward to Tchorback, a length of about 250 miles, and a journey was also made by him inland from the head of Amadjuak Fiord to the vicinity of Amadjuak Lake, a distance estimated at fifty miles. The length of coast examined is fringed by numerous islands of all sizes, and is described as rugged, and for the most part mountainous. The rocks of this coast are those of the Laurentian, including important beds of crystalline limestone, and in part no doubt referable to the Grenville series rather than to the fundamental gneiss. Graphite and mica are known to occur in association with these rocks here, but have not yet been found in deposits of economic importance. Silurian limestones are believed to occur in the interior of Baffin Land to the north of Amadjuak Lake, and Cambro-Silurian limestones, apparently of Hudson River age, were found to characterize Akpatook Island in Ungava Bay.

Synopsis of field-work—*Cont.*

Mr. Low's exploration began at Douglas Harbour, about 130 miles from the west end of Hudson Strait, and included the southern shore thence eastward for a distance of about 650 miles, or to George River, Ungava Bay. This coast has been mapped with approximate accuracy and a general knowledge of its geological structure has been obtained. The rocks consist chiefly of granites and granite-gneisses, but include areas of schistose rocks which appear to represent the Cambrian of the interior of the Labrador Peninsula in a considerably altered state and have iron ores associated with them.

In New Brunswick, Prof. L. W. Bailey has been employed in visiting and examining, so far as possible, all the mineral occurrences of known or supposed economic importance, and is now engaged in putting his observations in the form of a systematic report.

In Nova Scotia, regular field-work has been continued by Messrs. H. Fletcher and E. R. Faribault, with assistants. Mr. Fletcher's time was chiefly devoted to the mapping of the areas to be covered by the Springhill and Joggins map-sheets, but examinations were also made in other parts of the province, particularly in Cape Breton, where additional data were required in connection with the preparation of revised editions of some of the map-sheets of the Sydney coal-field. Mr. Faribault's work was, as in previous years, in connection chiefly with the gold-bearing rocks of the Atlantic coast belt. He was instructed, however, on this occasion, to devote most of the season to a critical review and examination of the gold mining districts of the already-surveyed eastern part of the province, with a view to the preparation of a general report upon these. In his preliminary report, given on later pages, it has been thought advisable to include such detail respecting the structure and mode of occurrence of the gold-bearing veins as may be of immediate importance to the miners, much attention being at the present moment turned to the gold mines of Nova Scotia.

Experimental Borings in Northern Alberta.

Boring operations in Northern Alberta.

The circumstances under which it became necessary to cease operations on the bore-hole at Athabasca Landing, at a depth of 1770 feet were fully explained in the last Summary Report. The "tar sands" at the base of the Cretaceous, in which the occurrence of petroleum is probable, were not actually reached in this boring, but much general geological information of value was obtained.

Sites chosen for bore-holes.

In view of the facts disclosed and in accordance with the recommendation based on them and given in the last Summary Report, provision was made for work upon two new experimental bore-holes, the sites selected for these being respectively the mouth of Pelican River, ninety miles down the Athabasca below the Landing, and Victoria, on the Saskatchewan. Contracts for the work, which was to proceed as far as possible concurrently at the two places, were entered into with Mr. W. A. Fraser. It was hoped that a depth of 1000 feet would be attained in each place during the season; that depth being likely to afford all the information required at the first-named locality, while a depth of about 2000 feet will eventually be required at the second. Although the expectations in regard to depth have not been fully realized, owing to circumstances detailed in the annexed report of Mr. Fraser, very substantial progress has been made.

Boring at Pelican River.

The most interesting developments have been those in connection with the Pelican boring, where the "tar sands" appear to have been reached (nearly as anticipated) at about 750 feet and penetrated to a depth of about 70 feet. Maltha or heavy, tarry petroleum was here met with, saturating the sands and shales in a manner similar to that found in the same lower Cretaceous beds where they outcrop naturally further down the Athabasca; but at 820 feet an exceedingly heavy flow of natural gas under great pressure was struck, such as to prevent for the time being any further work in the hole.

Information gained as to petroleum and gas.

The actual knowledge thus gained of the continued presence of the maltha at a distance of some sixty miles from the nearest natural outcrop of the "tar sands," is of importance in greatly extending the area of the probably petroleum-bearing field. The great flow of natural gas would also in itself be of economic value if situated where it could be immediately utilized, but this is not at present the case in this locality. It is of particular interest, however, when taken in connection with the considerable quantity of gas met with in the Athabasca Landing boring and that found in borings made for water at Langevin and Cassels on the line of the Canadian Pacific Railway. The gas is not found in these four places at exactly the same horizon in the Cretaceous rocks; but its occurrence goes far to prove that, particularly in the lower strata of the Cretaceous, natural gas in quantities of commercial value may be expected to occur over a vast area of the North-west, the distance between the extreme points at which its existance has now been determined (Langevin and Pelican) being about 350 miles.

The occurrence of maltha or natural tar in the rocks penetrated in the Pelican boring instead of petroleum proper, is, it must be confessed, to some extent disappointing, as it had been hoped that when at a distance from the natural outcrops which have been subjected to prolonged atmospheric influences the tarry matter would be found to be replaced by a lighter oil. It must be remembered, however, that the source of the petroleum which has saturated the lower beds of the Cretaceous is to be looked for in the underlying Devonian rocks, and even in this boring it is quite probable that in the lower layers of the "tar sands," or in the underlying formation, such lighter oil of greater commercial value may yet be found. But should this not prove to be the case here, there is still every reason to believe that these more favourable conditions will be found in other parts of the field.

The strata passed through so far in the boring at the Pelican may thus be summarized and classified :— Section at Pelican River.

Depth from surface.		Thickness of formation.
86 feet.	Sand and gravel (surface deposits)	86 feet.
185 "	Dark bluish-black soft shales, with some sandstone in upper part. *Pelican shales*	99 "
465 "	Grayish sands and sandstones, and brownish and grayish shales. *Grand Rapids sandstones*	280 "
750 "	Grayish and brownish shales, alternating with thin beds of hard sandstone and ironstone. *Clearwater shales*	285 "
820 "	Sands and clays often saturated with heavy oils and tar. *Tar sands*	70 " or more.

The above section may be compared with that given in the Summary Report of 1895 for Athabasca Landing, and with that found and described on the lower river by Mr. R. G. McConnell, Annual Report (New Series), Vol. V., part D.

It is proposed, if the discharge of gas from the bore-hole shall have by that time so far diminished as to render work possible, to continue this boring next summer to a depth of about 1000 feet, which should carry it some distance into the rocks underlying the Cretaceous and make a complete and satisfactory test for this particular locality. Further operations.

In the boring at Victoria, only the dark overlying shales have yet been penetrated, to a total depth of 705 feet. It was known that these would have to be sunk through, and no particular results of Boring at Victoria.

interest are to be looked for until a considerably greater depth has been attained. Very considerable difficulties have been encountered here by reason of the exceptionally soft and incoherent nature of these shales, which can be retained in place only by completely casing the bore-hole as it advances. It will probably be necessary to enlarge a considerable length of the boring already made here and to introduce casing of greater diameter before further progress can be made in depth. It is proposed, however, if possible, to complete this hole to a depth of about 2000 feet next summer.

Report on boring operations.

Mr. Fraser's report on the boring operations carried out during the past season, with particulars of the beds passed through, is as follows:

"I have the honour to submit the following report of operations conducted during the summer of 1897 at Pelican River on the Athabasca, and at Victoria on the Saskatchewan.

"Owing to the late date at which the contracts for these two borings were signed, and the necessity of a complete new outfit for Victoria, which took some time to get together, a late start in the spring was made. I arrived in Edmonton on May 24th, and the car-load of machinery destined for Victoria arrived by the same train. The Hudson's Bay Company's steamer which had been arranged for by telegram, was waiting to take the machinery down to Victoria. When I arrived the captain was inclined to leave without the machinery, as the river was falling rapidly and he was afraid that his steamer would ground, owing to the heavy load he would be carrying. The plant was, however, loaded without delay and left for Victoria on May 26th. No casing had arrived as yet, so none could be taken down with the plant.

"I had brought two gangs of trained men up with me. One of these I sent to Athabasca Landing to load the plant and machinery there upon boats and rafts for Pelican Rapids. The other gang proceeded with me to Victoria by steamer. As the captain had feared, the boat grounded twice going down and did not arrive at Victoria until June 2nd.

"After starting the men at building the rig at Victoria, I hurried back to Edmonton. The five car-loads of casing had meanwhile arrived. As the steamer would not be making another trip for some time I was compelled to send casing enough to do the first part of the work down by teams. The rate by steamer was $5 per ton, while that by team was $15. I also unloaded all of the casing from the cars, Mr. McCauley, of the Cartage Co., transporting to the edge of the river the casing destined for Victoria, and that destined for the Pelican being taken over to the north side of the river by the teamster who had contracted to deliver it at Athabasca Landing. I then proceeded to Athabasca Landing, arriving there on June 8th.

Report on boring operations—*Cont.*

"There it was found that the men had just finished loading the plant, and part of the casing. With three rafts and a large flat-boat loaded with all they could carry, we left on the morning of the 10th to descend the river to the mouth of the Pelican River.

"We experienced great difficulty with the rafts when nearing the mouth of the Pelican, and were forced to leave two of them some four miles above and to proceed down with the boat and one raft. We landed these in a low, horse-shoe like flat where the Waupaska trail strikes the Athabasca, about two miles above Pelican River. There we unloaded the machinery and then brought the other rafts down. No horses or oxen could be procured, and the work had to be done entirely by hand, under great difficulties. We proceeded, however, to build the rig, and began the hole by digging.

"The river began to rise on the night of the 19th, and on the next day (Sunday) it was up about the derrick and had submerged all the machinery and tools. It was the highest flood that had occurred on the Athabasca for many years, and our work was brought to a standstill for several days.

"After the water fell back into its proper bed, I discovered that it had cut away the bank upon which the tools had been lying, and these had dropped off into about eight feet of water. Then for many days we were fishing the tools out of water. Some of the most important ones we could not find at all, as they were buried under about two feet of mud below eight feet of water. But by using some ingenuity and doing much blacksmithing we managed to get tools enough together to proceed with the work, but we did not get started until the 1st of July.

"In the first part of the bore an unexpected difficulty was encountered. All along the river it seemed as though the shale rose to the very surface, and where we had located I did not expect to encounter more than six or eight feet of sand and gravel at the most. I put in first a large square cribbing, six feet in diameter, down to about eight feet, then a wooden conductor, 15 inches in diameter, down 16 feet, and still the sand and gravel continued. I then put down the $8\frac{5}{8}$-inch iron casing to 41 feet 4 inches, but the sand and gravel still continued. This was on the 12th of July—or two weeks that we had been getting down 41 feet.

"As we were driving on the $8\frac{5}{8}$-inch casing all I thought it would stand, and as the next size—$7\frac{5}{8}$-inch—had not yet arrived, I put down

Report on boring operations—*Cont.*

5⅝-inch casing to 67 feet to see if I could get through the gravel I then pulled this out and drove the 8⅝-inch casing to 63 feet. This was all the 8⅝-inch casing I had. As the gravel and sand still continued, I put in the 7⅝-inch casing, which had by this time arrived. At 86 feet 6 inches I struck a dark-bluish shale, and had succeeded in getting through the sand and gravel at last. This was on the 16th of July.

"The different strata, as encountered after this, are set out in the subjoined log. I used some of the heavy petroleum or maltha which flowed from the well in raising steam, and it made an extremely good fuel.

"If the hard slate stratum at 821 feet 6 inches had been pierced, a great flow of petroleum might, in my opinion, have been encountered. Indeed, it is altogether possible that at that depth we were within a few feet of a large body of petroleum. Had it been struck while the flow of gas was in the unconquered condition, the result would have been disastrous, as there might have been no possible means of checking the flow. The flow of gas was so great that a cannon ball could not have been dropped down the pipe.

"The 'tar sands' seem to have been encountered at about the expected depth, and it appears likely that the limestone will be met with before 800 feet is reached.

"Owing to the impossibility of making further progress at the time, at this place, I determined to allow the gas free escape, and it is quite likely that by next spring we shall be able to control it, and deepen the bore. The 4⅝ inch casing is in good shape, being perfectly free, the last thing I did being to rais it five feet to give the gas better vent.

"The fact that these petroleum-bearing sands are encountered at this depth so far away from the outcrop lower down the river, to my mind favours a belief in the existence of an oil-field of great extent."

RECORD OF STRATA PASSED THROUGH IN THE PELICAN RIVER BORING.

1-86	ft.	Sand and gravel.
86-101	"	Dark-bluish shale, very soft.
101-105	"	Soft sandstone.
105-185	"	Dark-bluish shale, very soft. At 185 feet struck slightly saline water. There was a distinct change in the shale at 185 feet, it changing to a reddish-brown colour.
185-225	"	Reddish-brown shale. Rather hard.
225-234	"	Sandstone. At 225 feet struck water which flowed over the top of the bore.
234-245	"	Sandstone and brown shale.

Report on boring operations—*Cont.*

245-253 ft. Hard gray cemented shale.
At 253 feet struck more water and gas.

253-280 " A light greenish-gray shale that settles very quickly about the drill, making it difficult to extract it after boring about two feet.

280-290 " Soft greenish-gray shale, cement-like.

290-308 " Brown shale, with strata of gray shale.

308-310 " Brown shale.

310-311 " Hard sandstone. More gas and water.

311-328 " Brown shale and sandstone in alternate strata.

328-340 " Sandstone.

340-353 " Brown shale.

353-365 " Hard sand-rock, with layers of softer rock. At about 355 feet struck maltha or oil of a very heavy specific gravity. This flowed in small clots on top of the water from the well, and several barrels of it ran away into the river. There was a good deal of gas with this heavy petroleum.

365-410 " Sandstone, rather hard.

By this time the flow of petroleum had nearly ceased. I concluded that the water which came from below, being icy cold, had chilled it where it came into the bore, and had thickened it so as to choke the vein.

410-427 " Brown shale.

427-450 " Hard brown shale.

450-465 " Sandstone. More water and gas.

465-481 " Gray shale.

481-498 " Gray shale, caving rather badly.

498-503 " Gray shale, very sticky.

503-526 " Gray shale, very sticky and like the cemented gray shale we had before.

526-532 " Ironstone.

532-538 " Gray shale.

538-553 " Gray shale, cement-like.

553-556 " Sandstone.

556-558 " Very hard, probably ironstone.

558-563 " Very hard sandstone.

563-573 " Brown shale.

573-590 " Gray shale, streaks of sandstone.

590-620 " Gray shale, brownshale and sandstone in alternating strata; the cuttings from the sand pump carrying distinct traces of maltha.

620-625 " Gray shale.

Struck a strong flow of gas at 625 feet. Gas remarkably pure and free from odour. Considerable maltha coming away with the water.

625-643 " Very hard sandstone.

643-648 " Soft gray shale.

648-652 " Hard sandstone.

652-665 " Soft gray sandy shale.

665-675 " Ironstone.

675-684 " Soft gray shale.

Report on boring operations—*Cont.*

684-685 ft. Hard sandstone.
685-703 " Soft dark-gray shale.
703-713 " Hard sandstone.
713-718 " Soft gray sandy shale.
718-723 " Hard sandstone.
723-733 " Sandstone.
733-743 " Soft gray shale.
743-758 " " " with streaks of soft sandstone.

Struck gas and some oil at 750 feet. Quite a strong flow of gas at this point. Heavy oil similar to that obtained before, but of a higher specific gravity came out with the cuttings in the sand-pump. The heavy oil seems mixed all through the sandstone and shale at this depth, and it looks as though the tar-sands had been entered at about 740 feet.

The water was shut off by the casing at 740 feet and the hole is perfectly dry with the exception of the water we put in to drill with. This shows that there is no water in these lower sandstones, which is of great importance and value.

758-781 " Soft dark-gray shale, and soft sandstone.

The shale and sandstone here show very little perceptible difference, the heavy oil having consolidated them into a homogeneous mass.

At 773 feet a heavier flow of gas was struck. It made a roaring noise coming out of the bore, and had quite a pronounced petroleum odour. Increased quantities of petroleum in the cuttings at these depths.

781-800 " Alternate strata of soft gray shale and soft sandstone.

These also completely saturated with heavy petroleum. Increased quantities of petroleum observed in the sand-pump. The gas increasing in volume all the time. It has a distinct petroleum odour, but, unlike the gas met with in the Petrolia oil field, it is free from sulphur and does not inflame the eyes.

800-820 " The same as foregoing.

At 820 feet a tremendous flow of gas was struck, which blew every drop of water out of the bore. The roar of the gas could be heard for three miles or more. Soon it had completely dried the hole, and was blowing a cloud of dust 50 feet in the air.

Small nodules of iron-pyrites, about the size of a wall-nut, were blown out of the hole with incredible velocity. They came out like bullets from a rifle. We could not see them going, but could hear them crack on the top of the derrick. It was impossible to do anything with the bore that day, so we were forced to let it stand just as it was. There was danger that the men would be killed if struck by these missiles.

The next day a long stick was put on the tools, so that the men could turn them without getting too close to the bore. In this way we succeeded in penetrating through 18 inches of a conglomerate mass of these iron-pyrites nodules embedded in heavy petroleum. As we drilled through this the gas threw out the nodules with clots of oil. Report on boring operations—*Cont.*

820-821 ft. 6 in. Conglomerate mass of iron-pyrites nodules embedded in oil.

At 821 feet 6 inches a very hard stratum of slate was encountered, which we penetrated about 3 inches. We could get no water down the well on account of the strong flow of gas, so we could make no further progress with the drill in this hard cutting. The danger to the men was so great that they refused to work longer over the bore. We then put the $4\frac{5}{8}$-inch casing down to the very bottom, hoping to shut off the gas, but it failed to do so.

The casing in this bore-hole is as follows:—

Casing	(wooden),	15	inches—	16	feet.	
"	(iron)	$8\frac{5}{8}$	"	63	"	7 inches.
"	"	$7\frac{5}{8}$	"	222	"	
"	"	$6\frac{5}{8}$	"	395	"	
"	"	$5\frac{5}{8}$	"	747	"	
"	"	$4\frac{5}{8}$	"	820	"	

"Just about the time the boring at the Pelican was suspended one of my men came over from Victoria, by way of Lac la Biche, bringing me intelligence that work had stopped owing to difficulties about the casing, and that the well was only 600 feet deep. I instructed the gang that had been working at the Pelican bore to proceed to Victoria without delay, and pushed on ahead myself, arriving there several days before them. Upon my arrival I found that the driller had not been carrying out my orders, and owing to this he severed his connection with the work.

"There had also been a great flood on the Saskatchewan, carrying away some of the casing clamps and a few other things.

"The bore had been located about 200 feet to the north of the mouth of Egg Creek, on the flat land about 8 feet above high-water mark. They had not been troubled much by caving in the bore-hole down to a depth of 560 feet, but beyond that it caved very badly. I found the well cased down to 560 feet with $6\frac{5}{8}$-inch casing. The driller had not used the under-reamer, and the casing was stuck at that point.

"I pulled the $6\frac{5}{8}$ inch casing out, meaning to put down the $7\frac{5}{8}$-inch, but there was an obstruction on the inside of the $8\frac{5}{8}$-inch casing and it would not go. I then put down the $6\frac{5}{8}$-inch again and used the patent under-reamer ahead of it until we got to a depth of 700 feet. Here the

Report on boring operations—*Cont.*

pressure on the casing from the caving material became so great that it could not safely be driven any further.

"This fact will convey a good idea of how the formation here encountered caved. At 560 feet there was no caving. and from there to 700 feet, a distance of only 140 feet, was sufficient to jam this string of casing so tight that it could not be driven any further.

"At Athabasca Landing each string of casing could be driven from 600 to 1000 feet.

"As the 6⅝-inch casing would have to be drawn up from the bore and larger casing put down, so that the 6⅝-inch casing could be carried to a much greater depth; and as this could not be done in the time remaining to work in during the autumn and consultation with the Department seemed necessary to decide upon the best course to pursue about the larger casing, I determined to close down the work at that time, the 20th of October.

"The work at Victoria would have been more successful could I have been there myself during the summer. But as the Department hoped for some results this season from the Pelican River boring, the depth at which oil should be obtained being much less, I remained there."

RECORD OF STRATA PASSED THROUGH IN THE BORING AT VICTORIA.

1- 10	feet.	Sand.
10- 20	"	Light-gray shale, with traces of sand.
20- 30	"	Gray sandy shale.
30- 50	"	Light-gray sandy shale.
50-100	"	" shale. No sand.
100-110	"	Gray shale, darker in colour.
110-120	"	" lighter.
120-130	"	" brownish colour.
130-131	"	Ironstone strata.
131-140	"	Light-gray shale.
140-180	"	" brownish-gray shale; quite hard. At 156 feet struck a small vein of gas.
180-260	"	Dark-brownish shale, with streaks of ironstone
260-270	"	Dark-brown shale. Strata of sandstone.
270-280	"	Gray shale. Ironstone stratum.
280-290	"	" with a 3-foot stratum of ironstone.
290-300	"	Brownish-gray shale; hard.
300-310	"	Gray shale; hard.
310-340	"	Dark-gray shale; softer.
340-350	"	" " harder.
350-390	"	Brownish-gray shale: hard.
390-410	"	Light-gray shale; hard; 2 feet ironstone.
410-420	"	Brown shale.
420-470	"	Brownish-gray shale.

Report on boring operations—*Cont.*

470-480	feet.	Very hard gray shale.
480-500	"	Light brownish-gray shale.
500-508	"	Ironstone stratum.
508-520	"	Light brownish-gray shale.
520-530	"	Gray shale, losing brown tone.
530-535	"	Ironstone stratum.
535-540	"	Light-gray shale; hard.
540-550	"	Gray shale, with stratum of ironstone.
550-554	"	Bluish-gray shale.
554-560	"	Dark bluish-gray shale.
560-570	"	" " with ironstone stratum and fragments of iron-pyrites.
570-620	"	Gray shale; very soft.
620-630	"	" " with 3 feet stratum of sandstone or ironstone.
630-705	"	Bluish-gray shale; very soft and caving very badly.

At 495 feet struck a vein of water slightly saline, which flowed over the top of the bore. Considerable gas with it.

The casing at present in this bore-hole is as follows:—

Casing (iron), $9\frac{5}{8}$-inch—31 feet 8 inches.
" " $8\frac{5}{8}$ " 170 "
" " $6\frac{5}{8}$ " 700 "

BRITISH COLUMBIA.

Work by Mr. R. G. McConnell.

The winter months of 1897 were spent by Mr. R. G. McConnell in working up the geological and topographical data collected during the previous year for publication.

Upon the work as completed during the summer, chiefly in the West Kootenay District, Mr. McConnell reports as follows:—

"I left Ottawa for Nelson on the 8th of June, and commenced field-work near Salmo, on the line of the Nelson and Fort Sheppard Railway, on the 19th of June. We remained in the field until the 12th of October. The season, as a whole, was favourable for mountain work. The early summer was wet, but the usual mid-summer smoke was not so dense as in previous years and did not cause much delay.

"Mr. Jas. McEvoy, of the Geological Survey staff, had charge of the topographical work, and Mr. R. W. Brock, also of this office, assisted in both the geological and topographical work. Mr. W. W. Leach was engaged at Nelson as topographical assistant. The staff was thus larger than in previous years; and taking into consideration the mountainous character of the country and the difficulty attending the transport of supplies, we were able to cover a comparatively large area.

British Columbia—*Cont.*

Districts examined.

"We were occupied principally in the south-eastern portion of the map-sheet in the unmapped region between the Salmon River and Kootenay Lake and River, and south of Midge Creek ; but work was also carried on east of Kootenay Lake, on the north fork of the Salmon, in the group of mountains between the Salmon, Beaver and Pend d'Oreille rivers, on the Slocan River, on Ten-mile Creek, Slocan Lake and on the Nelson and Fort Sheppard Railway. An effort was in fact made to collect sufficient data for a general geological and topographical map embracing the region in which the principal mining camps of West Kootenay are situated. The material on hand is now being compiled and drafted.

Topographical features.

"The principal topographical feature of the country examined is its persistently mountainous character. The whole region, with the exception of the valleys of the Kootenay and Salmon, being simply a succession of high mountain ranges, separated by narrow, steep-sided valleys that have been carved out by the torrential streams draining the district. The principal streams engaged in this work between the Salmon and Kootenay, north of the International boundary, are Lost Creek, Sheep Creek, Hidden Creek, Porcupine Creek and Wild Horse Creek, flowing westward into the Salmon ; and Boundary Creek, Summit Creek, Shaw Creek, Cultus Creek and Midge Creek, flowing eastward into Kootenay Lake and River. These streams head in a high range of quartzite and granite peaks and ridges that extend from the boundary north to Ymir Mountain. From the summit range transverse ridges, gradually decreasing in height, but often swelling into high peaks, extend outwards to the main valleys.

"East of the summit range, a prominent group of mountains, with peaks occasionally exceeding 8000 feet in height, occurs near Kootenay Lake, between Cultus and Summit creeks. They are built of granite, and owe their superior elevation to the greater resistance offered to denudation by this rock than by the surrounding softer schists.

"In the area between the Beaver, Pend d'Oreille and Salmon rivers the streams have not cut so deeply, and the mountains are round-topped and have a more uniform elevation.

Forest.

"The valleys and the slopes of the mountains up to an elevation of about 7500 feet, are or have been, wooded more or less densely with spruce, pine, cedar, hemlock, etc., but, as in other parts of the district, the trees have been destroyed over large areas by forest fires. A list of the forest trees is given in last year's summary.

"The geology of the district is extremely complicated, and has only been deciphered so far in a general way. It will be unnecessary to more than mention its salient features here, as it will form the subject of a report which is now being prepared. British Columbia—*Cont.*

"The four main groups of rocks are the granites, the dark eruptives and associated fragmental rocks, a schistose series of exceptional thickness which includes greenish, grayish and dark schists and slates, crystalline limestones, dolomites, quartzites and conglomerates, and the basal Shuswap series consisting here as elsewhere of mica-schists, mica-gneisses, crystalline limestones, dolomites and quartzites. It is probable that the schists and associated rocks are all of Cambrian age, the dark volcanics, so far as known, belong mostly to the Carboniferous and the granites are chiefly of post-Triassic age. Principal geological divisions.

"The dark volcanic rocks cover most of the area between the Beaver, Pend d'Oreille and Salmon rivers, except the south-west corner, which is occupied by schists that extend northwards along the main and north fork of the Salmon until cut off by the granites near Toad Mountain. They are replaced, east of the Salmon, by slates and schists that have been referred to the Nisconlith, a much older series. The rocks of this group include porphyrites of several kinds, monzonites, diabases, gabbros, breccias, tuffs, agglomerates and dark fine-grained slaty ash-rocks. Volcanic group.

"Grayish medium and coarse-grained and porphyritic granites, similar to those described in previous progress reports and belonging to the same period of eruption, occur everywhere in dykes and areas of various sizes throughout the district examined. Several areas were outlined on Boundary Creek, west of Kootenay Lake between Cultus and Summit creeks, east of the Salmon on Wild Horse, Hidden and Porcupine creeks; and a number of smaller bosses occur cutting the quartzites and schists which form the summit range between the Salmon and the Kootenay. Granites.

"Besides the ordinary gray granites of the district, an older granite, somewhat similar in appearance, occurs in a few places along Kootenay Lake, cutting the Shuswap and Cambrian schists; and a younger reddish granitic rock has a wide distribution, but except on Granite Mountain does not occur in large continuous areas.

"The great igneous activity which has characterized the district in the past, is shown by the fact that igneous rocks belonging to six distinct invasions are easily distinguished in the region examined during the season, and it is probable that with more detailed work in the field and with the microscope, the list would be increased. The oldest eruptive rock detected is a diorite, which is found intercalated in and cutting the schists of the Shuswap series. The diorite is followed in order by the older granites, the porphyrites and altered rocks so largely Igneous rocks.

British Columbia—*Cont.*

developed in the south-western part of the field, the ordinary gray granites, the younger granites and associated syenite-porphyry dykes, and, lastly, by a system of basic dykes belonging to the basaltic group. Besides the massive rocks just enumerated, a large proportion of the Shuswap and Cambrian schists represent igneous rocks which have been crushed and altered into their present conditions.

Schists.

"Between the Salmon River and Kootenay Lake and River, the rocks are mostly schists, cut by numerous granitic intrusions. The schists have a general north-and-south strike, and dip steadily eastward. Sections were examined on Sheep and Lost creeks flowing into the Salmon, and on Summit Creek which flows eastward into the Kootenay. The sections are interrupted in many places owing to the absence of exposures, but are sufficient to show a division of the rocks into three great groups each many thousand feet in thickness.

Nisconlith slates.

"From Salmon River eastward, for several miles, the rocks consist mostly of hard lead-coloured slates, usually somewhat siliceous and showing as a rule on cross sections numerous fine lines due to a separation of the laminæ by thin quartz films. The slates are always more or less altered and in places pass into micaceous schists. They include bands of greenish schists, quartzites, and grayish and whitish crystalline limestones. The slates have an average dip to the east of 50 degrees. They are succeeded and overlain on the east by a complex set of rocks consisting of alternating bands of greenish, grayish and dark schists, grayish and white quartzites, usually rather heavily bedded, fine and coarse hard conglomerates with a matrix of quartzite or schist, yellowish granular dolomites and massive green diabases. These rocks resemble the Selkirk series as described by Dr. Dawson. They are overlain by a great volume of quartzose mica-schists ranging from quartzites holding a few grains of mica arranged parallel to the bedding to well developed lustrous mica-schists. The quartzites occur in thin regular beds usually from one to three inches in thickness, separated by narrow schistose bands which are often crumpled. Crystals of kyanite were found by Mr. Brock in the ridge south of Summit Creek scattered through a band of coarse biotite-mica-schist included in this series. The schists last described extend eastward to Kootenay Lake. They dip to the east and apparently overlie the rocks referred to the Selkirk series, but show greater alteration. This may be due, however, to the vicinity of the granite masses on Boundary Creek and on Summit Creek.

Selkirk series

"The three groups of schistose rocks briefly described above, are everywhere broken through by granite intrusions, and towards the north are cut off by the great central granite mass of the district.

"East of Kootenay Lake, Lockhart Creek, La France Creek, Crawford Creek and others were examined for varying distances from the lake. On Lockhart Creek the section shows dark slaty rocks and green schists near the lake, and underlying these the conglomerates, quartzites and schists of the Selkirk series. The position of the group is the reverse here of what it is in Lost Creek where the slates underlie the quartzite-conglomerate beds and it is probable that the whole series is overturned.

British Columbia—*Cont.*

Schists east of Kootenay Lake.

"On Crawford Creek, the section commences with the gray gneisses, mica-schists, quartzites and crystalline limestone of the Shuswap series, cut by a network of granite, pegmatite and diorite dykes. The Shuswap series is succeeded and apparently overlain toward the east by the greenish and grayish schists, quartzites and conglomerates of the Selkirk series. The Nisconlith slates, which, when the section is complete, separate the Selkirk from the older Shuswap series, were not here recognized.

Shuswap series.

"The gneisses and associated crystalline rocks of the Shuswap occupy the basin and lower slopes of the valley of Kootenay Lake from its northern end to a point a few miles below Crawford Bay. They dip to the west and are apparently overlain on the west and underlain on the east by younger rocks. The conditions prevailing lead to the inference that the whole series has been thrown into a great anticline overthrown to the east. It is also probable that the folding was accompanied by considerable faulting, as the beds on the east and west of the lake do not correspond very closely. The schists have a close resemblance, but the quartzites and conglomerates so abundant east of the lake are only sparingly represented to the west.

Structure of beds.

"The region examined during the past season does not include any of the larger mining camps of the district, but it is nearly everywhere more or less metalliferous, and mining claims have been staked off by the score on all the principal creeks, and on some of these claims a considerable amount of development work has been done. We were unable to devote much attention to the examination of these, as our time was fully occupied in collecting data for the completion of a general map of the region.

"The band of dark slaty rocks east of the Salmon River, that has been referred to the Nisconlith, is traversed by a number of leads, some of considerable promise. The Ymir claim, north of Wild Horse Creek, is situated in these slates, about half a mile east of their contact with the basic eruptive series. The Ymir lead cuts the slates in a direction S. 65° W. and dips to the north-west at an angle of 60° to 70°. The principal workings at the time of my visit consisted of a

Ore deposits.

British Columbia—*Cont.* Ymir mine.

cross-cut 70 feet in length, a shaft at the end of the cross-cut 103 feet deep, and drifts 60 feet to the north-east and 105 feet to the south-west along the vein, at the bottom of the shaft. The shaft follows an ore-body varying from 10 to 20 feet in thickness, and a cross-cut of the vein on the south-west drift, 50 feet from the foot of shaft, cut nearly 30 feet of ledge matter, of which 18 feet was stated to be payable ore, carrying values of $20 or over, principally in gold. The ores consist of galena and iron-pyrites, with some blende and the gangue is mainly quartz.

Dundee mine.

"The Dundee mine, on Bear Creek, a short distance south of the Wild Horse, was examined by Mr. Leach. The vein occurs at the junction of the slate with a granite boss, and is traceable on the surface for 500 feet. The strike is almost parallel with that of the rock and it dips to the north-west at an angle of 75°. The workings consist of an incline 100 feet deep, following the foot-wall of the lead. The vein has a width of 12 feet on the surface and increases in width with depth, as at the bottom of the incline a cross-cut of 16 feet did not reach the hanging wall. The ore consists of galena and iron-pyrites, and is stated to average $23 to the ton in silver, gold and lead. A good wagon road has been built to the Dundee mine from the town of Ymir on the Nelson and Fort Sheppard Railway, and another is in course of construction from the same place to the Ymir mine. South of Wild Horse Creek a number of claims have been located along the same band of slates on Porcupine, Sheep and Lost creeks, and some development work has been done, but I was unable to afford time to examine them.

Porto Rico claim.

"West of the main Salmon, near the head of a branch of Baratt Creek, is the Porto Rico claim. It consists of a quartz vein averaging about 2 feet in width and traceable for 700 feet, carrying pyrites, pyrrhotite, chalcopyrite and mispickel. Assays from this lead are reported to have run very high in gold, but the average value of the ore was not ascertained. It is situated west of the Nisconlith slates in the basic eruptive series.

Copper camp.

"West of the summit, between Salmon and Kootenay rivers, and close to the International boundary, is situated what is known as Copper camp. A number of claims have been located here along the bands of dolomite included in the Selkirk series. The leads consist of quartz veins like the North Star, and more or less silicified bands in the dolomite, like those of the Hanna and B. C. claims. No large ore-bodies have so far been opened up, and very little development work was being done at the time of my visit. The B. C. has a width of about

2 feet, and has the same strike and dip as the dolomite band in which it is inclosed. The ore consists of gray copper (tennantite) and galena, distributed irregularly through the vein. The pay-ore, free from gangue, is stated to run $260 in copper, silver and gold. British Columbia—*Cont.*

"In the eastern part of the district numerous claims have been located on Goat, La France, Lockhart, Crawford and other creeks flowing into Kootenay Lake, but I had no opportunity to examine them."

Work by Mr. J. McEvoy.

Mr. McEvoy was engaged in the early part of the year in laying down the geological boundaries on the remaining unfinished portions of the Shuswap sheet from the information gained during the previous summer, and also in the construction of a map of the country in the vicinity of Rossland, B.C., from surveys made during the latter part of the same summer.

During the past season he was employed in making a topographical survey in the West Kootenay district on which he reports as follows:

"Leaving Ottawa on the 10th of June, 1897, I proceeded to Nelson, B.C., according to instructions and joined Mr. McConnell. The area surveyed extends from near Nelson southward to the International boundary line and from Kootenay Lake on the east to Pend d'Oreille River and Beaver Creek on the west.

Methods of survey.

"In carrying out the survey of this area two principal methods were employed. 1. Panoramic sketches with transit bearings chiefly from suitable mountain tops, by means of which a system of triangles was extended from fixed points to the north and west so as to establish the main frame-work of a map. 2. Odometer traverses of roads and trails with barometric heights (to be afterwards corrected) for the purpose of getting better details for the valleys and streams. In many cases the odometer was impracticable and paced surveys were made instead.

"Mr. R. W. Brock and Mr. W. W. Leach who were assistants to Mr. McConnell rendered valuable aid in this work.

"In the high mountainous region between Salmon River and Kootenay Lake, which is for the most part without either trail or track, travel was difficult and correspondingly slow. This was especially so toward the centre of the range where the angular quartzite ridges are impassable in many places and necessitate long detours.

"About the end of August Mr. Leach was given charge of a separate party and from that time until the close of the season continued operations independently. His surveys covered the valleys of the North Fork of Salmon River and Beaver Creek.

British Columbia—*Cont.*

"Circumstances being favourable, on the 1st of September I went to Slocan Lake and ascended Ten-mile Creek into the Kokanee Mountains. In these mountains which form the very centre of the region, with summits reaching 9500 feet above sea-level, and from which streams radiate in all directions, a considerable area remained unmapped. A couple of weeks were spent in getting sufficient information to fill up the blank.

Kokanee Mountains.

"Returning to Nelson I made a short trip, accompanied by Mr. Brock, to the Pend d'Oreille River and through the mountains to the north between it and the Nelson and Fort Sheppard Railway.

Vernon to Lower Arrow Lake.

"After this I joined Mr. McConnell at Nelson and from there went to Vernon. Here a few days were spent examining the rocks in the neighbourhood. We then procured pack-horses and travelled up the White Valley road to McIntyre's at the head of Cherry Creek. From there I made an exploratory survey via Kettle River and Fire Valley to Lower Arrow Lake.

"Mr. Leach in the meantime was working in the mountains to the east of the Slocan River. Returning once more to Nelson, I met Mr. Leach at the appointed time and we visited Copper Mountain south of Nelson. The next day a heavy snow-fall covered the mountains and rendered further work impracticable. I returned to Ottawa on the 19th of October."

MANITOBA.

Work by Mr. J. B. Tyrrell.

During the early months of 1897, Mr. Tyrrell was at first engaged in correcting the proofs of his report on the country between Athabasca Lake and Churchill River, and in arranging and labelling the rocks and fossils collected during the preceding summer. Thin sections were made of such of the rocks as needed fuller examination, and these were microscopically examined. A report was also written on the country explored during the summer of 1896, lying north of Lake Winnipeg and the Lower Saskatchewan River, west of the upper portion of Nelson River; and to accompany this report a map was drawn on the scale of two geographical miles to one inch, showing all the surveys made in the district examined. The greater part of the winter was, however, devoted to the preparation of a report on the region explored in 1893 and 1894, embracing the Doobaunt and Kazan rivers, and the country in their vicinity and to the west of Hudson Bay. The temporary loss of the specimens collected in 1893, with the considerable portions of the winters of that and the following year occupied in the field, had necessarily delayed the completion of the report, which is now, however, ready for issue. Manitoba—*Cont.*

Mr. Tyrrell had also been asked to act as one of the secretaries of the geographical section of the British Association, and in that capacity attended the meeting of the Association in Toronto, where he read a paper on the Glaciation of North Central Canada, and another on the Physical Geography of the Barren Lands of Canada. Immediately after the close of this meeting he left for Northern Manitoba. Of his work there he reports as follows :—

"At Winnipeg I had the good fortune to secure the services of Roderick Thomas, one of the men who had been with me for the three previous summers, thence I went to St. Laurent, where a boat and two additional men were engaged and we at once sailed northward to Lake St. Martin, where a close examination was made of the outcrops of trappean rock on Sugar Island, and on the low hill on the east side of the Narrows. These rocks are particularly interesting as they have evidently formed relatively high hills on the original floor of the Palæozoic sea, and, together with some hills of granite, now rise as low rounded elevations in the midst of a region of undisturbed Palæozoic limestone. Lake St. Martin.

"The flat-lying limestone on the east side of the Narrows of Lake St. Martin was closely examined, and was found to be of Trenton age, while a couple of miles further east an escarpment rises to a height of about 100 feet above the lake. On the face of this escarpment are several well developed gravel beaches, marking old shore-lines of Lake Agassiz. The underlying rock was found to be a heavy-bedded, white, porous limestone of Niagara age. Rocks of Trenton age. Rocks of Niagara age.

"Eastward from the summit of the escarpment a dry plain, covered with a thin coating of soil and overgrown with small Banksian pines extends for many miles. Dry plain,

"This escarpment was examined at two different places, the journeys being made to it on foot through deep mossy swamps, after which we returned up Fairford River to Lake Manitoba, and thence, past Duck Islands, which were sketched in with approximate accuracy, to St. Laurent. During this journey a stop was made at a hill on the east side of the Narrows of Lake Manitoba, where thick-bedded white limestones of middle Devonian age are brought to the surface by a low anticline. Some holes had been sunk on this hill to test the character of the rock as a building stone. Some of the beds could be easily cut and would yield fine large blocks, of regular even grain. A free-working stone of this character should command a good market in Manitoba for building purposes.

Manitoba—*Cont.*

Country east of Shoal Lake.

"After leaving the boat at St. Laurent, a journey was undertaken with buck-board and carts into the country between Shoal Lake and Lake Winnipeg. Passing south of Shoal Lake, we followed its eastern shore as far north as Monar, and thence turned eastward to Dennis Lake, passing through a country partly wooded with small poplar, with occasional tracts of dry open prairie. Under these prairie tracts the soil was usually very thin, and was underlain by porous white limestone of Niagara age.

Dennis Lake.

"Dennis Lake lies at an elevation of about 900 feet, and from it the water is said to drain south-eastward into Netley Creek. From Dennis Lake we returned westward across the same dry limestone plateau to the north end of Shoal Lake, where we were joined by Mr. Stephens, Land Inspector for the Canadian Pacific Railway. Together we turned north-eastward on an old Indian hunting trail, and again crossing the dry limestone plateau, visited Pijiki Lake, in Tp. 21, Range 2 W., which is said to be the source of one of the branches of Fisher River. East of Pijiki Lake is a wet and swampy country which would be very difficult to penetrate except over the snow and ice in winter.

Pijiki Lake.

"From Pijiki Lake we returned to St. Laurent, leaving Mr. Stephens at the north end of Shoal Lake. Here, taking fresh horses, we drove northward into the country around the head-waters of Swan Creek. Near Oak Point, Upper Devonian limestone was found a short distance beneath the surface, and again at Clarkleigh Mr. Clark reports that red shales, doubtless the base of the Upper Devonian, were met with in the bottom of his well. At the south end of Swan Lake similar Devonian limestone was again seen.

Swan Creek.

Birch Lake.

"After a very tedious journey, in which the horses were often wading for long distances up to their bellies in water, Birch Lake, in Tp. 23, Range 5 W., was reached, but no exposures of the underlying rock were seen, and the country was so wet that it was impossible to penetrate further into it with horses. Boulders of Devonian limestone were, however, absent around Birch Lake, showing that the rocks of that age did not come to the surface, to any extent at least, north and east of that lake, while boulders of Niagara limestone were very abundant. On the return journey southward, Upper Devonian limestone, similar to that of Manitoba Island, was found just beneath the surface at Lundyville.

Stonewall.

"At St. Laurent, fresh horses were again hired and we drove across the country to Stonewall, where the rocks in the quarries were examined, and a collection of fossils was made, among them *Pentamerus* *decussatus*, determining the age of the beds as the base of the Niagara. Thence we drove northward past Pleasant Home, finding rock in place in a few places, and ascertaining the thickness of the drift from the many wells in the vicinity.

Manitoba—*Cont.*

"We then again returned to St. Laurent, and on November 4th the party was paid off for the season, and I proceeded to Winnipeg.

"The extent of country underlain by the various formations from the Devonian down to the base of the Niagara, had now been fairly well ascertained, but, in order to complete the section of the Palæozoic rocks of the Winnipeg basin, it remained to connect the Hudson River shales of Stony Mountain with the Niagara rocks of Stonewall.

Hudson River rocks.

"From Winnipeg I examined the rocks of Little Stony Mountain, where the upper band of limestones, as well as the lower red shales were found to be of Hudson River age. After a brief examination of the rocks at Stony Mountain I again went to Stonewall, and by the examination of some wells that had been blasted into the rock, was able to complete the section from the white Niagara limestone down to the red shales of the Hudson River.

St. Andrews marsh.

"From Stony Mountain I accompanied J. A. Macdonell, Esq., M.P., the provincial engineer, on a tour of inspection of the extensive drainage works undertaken by the Provincial Government to drain the great marsh that lies north and east of that place. This marsh is produced by numerous springs that rise along its western side, near the foot of a gentle slope descending from the higher level to the west, one of these springs being said to have a flow of about 2,500,000 gallons a day. These springs rise from the underlying limestone and shales of the Hudson River formation, on a northern continuation of the artesian basin that extends as far south as Winnipeg.

Source of artesian water.

"The source from which the water comes to supply these springs, and the many artesian wells in the vicinity of Winnipeg has hitherto been unknown, but the explorations of the earlier part of the season show that the water is derived from the porous rocks that underlie the dry plateau extending north-northwestward from Dennis Lake to Lake St. Martin. The rain falling on that area, immediately runs down into the porous rock, and thence flows outwards at the lower level in numerous springs, or is stored up beneath the overlying covering of impervious till, ready to be drawn off when this till is penetrated by wells or borings.

"On my return to Winnipeg, Mr. Macdonell kindly placed his excellent drainage plans and contour maps at my disposal, and two days were spent tracing and making notes from these. After completing this I returned to Ottawa, arriving there on November 20th.

Manitoba—*Cont.*

"Much kind assistance was received in the above work, not only from Mr. J. A. Macdonnell, M.P., but also from Messrs. A. G. Hepworth and R. Blackwood, of St. Laurent, and John Dunn, of Stonewall."

ONTARIO.

Work by Mr. W. McInnes.

The winter of 1897 was spent by Mr. W. McInnes in office work, plotting and compiling the surveys of the previous season, and preparing for publication corrected editions of the Shebandowan and Seine River geological maps. A geological report on the district was partly written and will be ready for publication shortly.

Mr. McInnes left Ottawa on the 16th of June, accompanied by Mr. Aurélien Boyer, B.A.Sc., of Montreal, who had been appointed as his assistant for the season. A few days were spent in completing the log-survey of Wabigoon Lake, made last year. On the 23rd of June, Mr. Wm. Lawson, B.A., of Toronto, joined the party, and for the remainder of the season was engaged in independent surveys, for which his long experience in similar work in the district had made him well fitted.

Region covered.

The following report is given by Mr. McInnes of his field-work in that part of the district of Rainy River known as the Manitou region, and extending thence westward to the Lake of the Woods :—

"Starting from Regina Bay, Lake of the Woods, surveys were made of the lakes lying between Whitefish Bay and Lawrence Lake, and between that lake and Eagle and Manitou lakes, Mr. Lawson taking a different route from that followed by the rest of the party. Crow Lake, the largest of the series, has a length of about fifteen miles, and varies in width from four to two and one-half miles. It is a comparatively shallow lake, with clear, cold water, and studded with numerous rocky islands. The shore-line is irregularly and deeply indented, the shape of the bays being largely influenced by the direction of the schistosity of the Keewatin rocks in which the lake occurs. The comparatively small extent of its drainage-basin is a feature perhaps worth noting to illustrate the greatness of the precipitation in the region, as compared with the evaporation. The total area of the drainage-basin is roughly about one hundred and seventy-five square miles, and the lake itself has an area of about fifty-eight square miles, while the volume of water discharged at the outlet is considerable.

Crow Lake.

Geological notes.

"The more northerly of the two routes followed, led through Flint, Stephen, Cameron, Pine and Rowan lakes; the other through Cedar, Crow, Otter and Brooks lakes. On both routes Keewatin rocks only were seen, with the exception of an isolated area of intrusive granite, about two miles by one mile, lying just south of Stephen Lake, and of a few very limited exposures of a similarly intrusive granite on some of the islands in Crow Lake. A local area of gabbro on the south shore of Rowan Lake may also be intrusive in the Keewatin. The prevailing rocks on the northern route, as far east as Cameron Lake, are of the quartz-porphyry and felsite type. Along Crow Lake and easterly and north-easterly to Rowan and Brooks lakes, agglomerates in broad and continuous belts and basic intrusives, with their derived schists, are the prevailing rocks. Ontario—*Cont.*

"Following the series of lakes which flow into Lawrence Lake from the north by way of Hector Lake, the most interesting point established by Mr. Lawson was the sudden termination of the broad band of Keewatin which we have just been considering. This belt, measured north-westerly across the strike from Lawrence Lake, has a width of nine miles, and followed north-easterly along the strike it entirely pinches out within seven miles. The route from Lawrence Lake to the Manitou, by way of Picture Narrows and Calder Lake, showed only obscurely-foliated, biotite-granite-gneisses of the ordinary Laurentian type to within about two miles of Manitou Lake, where the edge of the Keewatin belt in which the Manitou Lakes lie is reached. Mr. Lawson surveyed with boat-log and metallic tape a route from Deer Lake to the Canadian Pacific Railway at Eagle Lake by way of Poplar, Fisher and Mink lakes, and defined more closely the arm of Keewatin already known to connect the Eagle Lake area with that of Whitefish Lake. Routes from Lawrence Lake.

"Three routes were then surveyed between Upper Manitou or Anjikoming and Eagle Lake. The distance between these two lakes on a direct line is only eight miles. As a canoe-route to the Upper Manitou, however, none of these routes is so easy as the old one by way of Little Wabigoon Lake. They all lie in the biotite-gneisses after the narrow rim of Keewatin bordering the Manitou is crossed. Anjikoming to Eagle Lake

"An exploration and survey was next made of Little Wabigoon River and two of its main branches, and of Clearwater and Snake lakes and the routes leading thence to Small-trout, Manitou and Peak lakes. A number of lakes of fair size were surveyed on these routes. The largest of these is Wapageise Lake, lying to the south of Snake Lake, and emptying into the Big Turtle River at Jones Lake. It consists of a main body about three and a half miles long by three broad, and a long bay extending southerly for six and a half miles. The main body of the lake lies in the diorite and green schist division of the Keewatin, with a small area of intrusive granite at the extreme Lakes east of the Manitou route.

Ontario—*Cont.*

eastern end. The long southerly arm lies wholly in the biotite-gneisses, part of the Laurentian area of Big Turtle River. The northern boundary of this gneiss area proved somewhat intricate, and was traced out in considerable detail. The route to Peak Lake, by way of Saganaga Lake, kept to the north of this boundary and altogether within the Keewatin and for the most part in the division embracing the massive diorite and green schists.

Blueberry Lake.

"Blueberry Lake, which lies to the north of Snake and Clearwater lakes, on Niven's 5th meridian-line, was surveyed and found to lie entirely within the eastern biotite-granite area, the western edge of which is less than a mile beyond the western shore of the lake. The Keewatin here, as far as could be seen from the limited number of exposures, is represented by its quartz-porphyry and crystalline-felsite division. Prospecting was being very actively carried on along and in the vicinity of this contact during the early autumn, and the discovery of some good gold-bearing veins was claimed. A peculiarity of some of these veins is the occurrence, as part of the vein-matter, of a deep purple fluorite. Prospectors stated that they had panned gold from the lacustrine clays which cover large areas of the Wabigoon country, and to this was due probably the local name 'The new Klondike' given to the region. I was not able, however, personally to verify this reported occurrence of gold in the clays.

Region north of the C.P.R.

"North of the railway a survey was made of Sandy Lake and of a number of smaller lakes in its vicinity, Mr. Boyer doing the instrumental work with a micrometer telescope and prismatic compass. The whole region immediately north of the track is largely drift-covered and a good idea of its general character is obtained by a traverse of the Hudson's Bay Company's portage-road to Sandy Lake. This road, measured by metallic tape, was found to be eight and a quarter miles long. The country over which it passes is remarkably flat for the first three or four miles and is covered by the white, silty clays so common about Wabigoon Lake, on which is situated the Ontario Government farm at Dryden. The remainder of the road is occupied by low gravelly and bouldery ridges, probably originally morainic, with intervening lower grounds covered by the clays. The country-rock crops out only at a few points.

Sandy Lake.

"Sandy Lake has a comparatively regular outline and is an open body of water with but few islands and these near the shores. This absence of shelter has given the lake a bad name for canoe navigation in uncertain weather. In depth the lake seems to be very uniform, averaging about sixty feet. The eastern boundary of the great Laurentian area of Lac Seul was found to lie from two to three miles to the west of the lake and to trend about north-east. The Keewatin rocks exposed about the lake are mainly diorites, often sheared to green schists and over considerable areas altered to fine, biotite-gneisses not unlike the Coutchiching gneisses of Rainy Lake. These extremely altered portions surround a central, apparently intrusive area of biotite-granite. Other, smaller, isolated areas of granite were defined on some of the neighbouring lakes. Keewatin schists, generally highly altered, were found all along the southern area of Minnitaki Lake as far as the survey was carried. *Ontario—Cont.*

"According to instructions, operations were transferred on the 21st of September to the Lake of the Woods, for the purpose of making certain additions to the topography and geology of that region prior to the issue of a new addition of the geological map. A survey by micrometer telescope was made of the shore of the lake lying between Niven's 7th meridian-line and his base-line which strikes the lake-shore north of Yellow Girl Point. Gibi (Chipai) Lake, Adams and Black rivers and some lakes lying in the Western Peninsula were surveyed, and necessary revision of the geology at these points and on Whitefish and Long bays was made. Work on Lake of the Woods.

"The striking diabase dyke previously traced by Dr. A. C. Lawson across several islands and well known to the Indians under the name Pingwabik (ash-rock or fire-rock) was noted by Mr. Boyer to cross Picture and Timber islands, giving it an actually traced length of seven miles, and making it quite probable that it is also continuous with that traced by Lawson across the small islands about four miles further north. Diabase dyke.

"A revision of the geological boundaries in the townships of Jaffray and Haycock was made, and the boundaries of the Keewatin belt, which extends north-easterly through these townships, rendered accessible by the opening up of that section by roads, and by its denudation of forest by fire, were fixed with greater exactness. The belt was found to have a greater width than that given to it on the old map, its eastern boundary lying nearly a mile to the east of the position assigned it on that map. Jaffray and Haycock.

"The people of the district have settled down to the development of their mining properties in a much more business-like way than ever before, and the results promise to justify their confidence in the future of the region as a gold-producer. Capital and energy are still being wasted here and there through the district, in developing properties of too low a grade for remunerative working, through the lingering Mining development.

Ontario—*Cont.*

belief, once so general among prospectors, that the gold contents of a vein must necessarily increase with depth. This often prompted them to sink blindly on prospects, which a few careful assays made as the work progressed, would have soon shown not to warrant further expenditure. This recklessness is not now, however, general. Experience has taught the miner here, as elsewhere, that to succeed he must adopt the methods applicable to any other business enterprise and see before him a reasonable expectation of return before sinking money in the acquisition and development of untested properties.

Mines on Lake of the Woods.

"Some of the mines on the Lake of the Woods have been showing very good results, notably the Sultana, which has installed, during the summer, a new and very complete stamp-mill with a No. 3 Gates crusher, 30 stamps and 6 vanners. The mining machinery has also been replaced by new and recent patterns, so that the output should be largely increased. The Regina too has been working regularly during the summer and the capacity of the mill has been increased.

Shoal Lake.

"On Shoal Lake, the mine on the Mikado property has made several 'clean-ups' with results which are satisfactory in the amount of gold recovered from the battery and plates. Neighbouring properties have been carrying on the work of development, but have not yet installed mills. At Camp Bay, the work of development has been pushed forward with vigour, and a considerable amount of ore has been sacked and brought to the lake-shore for shipment. At Gibi or Chipai Lake, a number of properties have been located, and the owners claim good prospects. These locations are situated on the tongue of Keewatin, extending north-easterly into the gneiss east of Witch Bay. They are thus near the same contact-line in the neighbourhood of which all the properties on the eastern side of the lake lie. North of the railway line, the Scramble has been carrying on the work of sinking and general development; a good wagon-road less than six miles in length has been constructed between the mine and Rat Portage making the property very easily accessible. More or less work has been done on innumerable other properties about the shores and on the islands of the lake.

Chipai Lake.

Locations on Manitou Lakes.

"In the Manitou region, prospecting has been carried forward actively during the season. Many properties have been located and considerable development work has been done on some of them, notably on Anjikoming or Upper Manitou, Mosher Bay, and on one or two properties on the western side of the lake. All the properties in the Manitou region are comparatively near the contact between the gneisses and the schists, but in this case that must necessarily be so if they lie in the Keewatin at all, owing to the narrowness of the belt.

"The building of a wagon-road about seven miles in length from the head of steamboat navigation on Grassy River Lake directly to the north end of Upper Manitou Lake, has made the transportation of supplies, machinery, etc., into this region a much easier problem. Before the building of this road, the old Manitou canoe-route was followed and the part of that route cut off by this road included five portages, a mile and a quarter in total length, and a stretch of very small and bad brook travel, nearly two miles in length. A dam on the outlet of Wabigoon Lake at Dryden, makes the Grassy River navigable for small steamboats, three of which were plying on the route during the summer. At the Manitou end of the road, another steamboat was built, and a dam at the lower end of the lake opens the whole of the Manitou water-stretches to its passage. With easy means of access and abundance of wood and water, this region affords good facilities for the economical development of its leads. Ontario—*Cont.* Communication.

"Up to the present, but little work has been done in the country lying to the north of the railway in this vicinity. A few properties have been taken up and some development work done near Sandy Lake and on Minnitaki. On the latter lake the Harvey property has been partially developed by sinking, with what result I do not know.

"Taking the region as a whole, very fair progress is being made in its exploitation and development, though little close or systematic prospecting has been done excepting that carried on by the Ontario Gold Concessions Syndicate (Limited) on their reserves and by the Regina and perhaps a few other mining companies on their locations. The 'Engledue' Syndicate has prospected its properties pretty thoroughly during the summer without the announcement, however, of any important discoveries. Whether payable leads are discovered on these concessions or not, it must be felt that to count upon such discovery within certain defined limits in untried ground is a very severe test to apply to a district in which, as far as we know, the occurrence of the gold is conditional upon a system of fissuring. General progress of region.

"Both Mr. Lawson and Mr. Boyer did very satisfactory work during the whole season, Mr. Lawson working independently. His individual part of the work has been indicated in some cases in the foregoing notes, but in others, for convenience, the work of the two parties has been treated together."

From the first of the year until the commencement of field operations in June, Mr. A. E. Barlow was engaged in plotting the various surveys made during the previous seasons and likewise in studying the Work by Mr. Barlow and Dr. Adams.

Ontario—*Cont.*

results obtained and their bearing on the complex problems of Archæan geology, which it is hoped the critical examination of the Haliburton region now being carried on by Dr. Adams and Mr. Barlow will do much towards solving. A large number of thin sections were, in this connection, examined under the microscope and the details of structure and mineralogical composition carefully noted. Some time was also employed in permanently labelling the large suite of specimens obtained illustrative of the geology of this region. Subsequent to the preparation of the last Summary Report, in which the main facts so far observed were somewhat fully outlined, a paper based on the same facts was presented by Messrs. Adams and Barlow at the winter meeting of the Geological Society of America. The general features previously given will not therefore need to be repeated in the present report.

Dr. Adams.

Dr. Adams left for the field on June 6th and returned in time to be present at the British Association meeting in Toronto. His time was spent in making a very careful and detailed study of one of the most complicated and at the same time crucial portions of the map-sheet. This is comprised in the townships of Anstruther, Chandos, Cardiff, Wollaston and parts of Monmouth and Cavendish. As these townships embrace a large number of lakes, which afford a ready means of access to most parts of the area as well as excellent exposures, the work was carried on largely by canoe.

Mr. Barlow.

Mr. Barlow was detained in Ottawa by office work until June 21st. Coe Hill, at the north-western terminus of the Central Ontario Railway, was made the head-quarters of the survey during the month of June, but as the work progressed westward by Dr. Adams and north-eastward by Mr. Barlow it was found necessary to frequently change the central camp.

Assistants.

Mr. Barlow was assisted by Mr. Joseph Keele, of the School of Practical Science, Toronto, and by Mr. G. C. Mackenzie, of Brantford. Mr. Keele's attention was directed principally to the prosecution of some of the topographical surveys and also to photography, and Mr. Barlow speaks of his services in terms of commendation.

In the subjoined report, the observations of Dr. Adams and Mr. Barlow are combined, and a notice of some length is accorded to the corundum-bearing rocks of the district because of their probable economic importance.

"The district embraced by Dr. Adams's examinations has represented in it all three of the divisions which were formerly recognized in this part of Ontario, namely, the Fundamental gneiss, the Grenville series and the Hastings series, and it was selected for especially detailed study as offering a field where the relations of these divisions could be most readily and certainly worked out. The Fundamental gneiss is very extensively developed in the township of Anstruther, which lies on one of the great batholitic masses, referred to in the Summary Report of last year as rising through the limestone rocks of the Grenville series and being wrapped around by them. It underlies almost the whole township, and as the structure was followed out in detail on the numerous lakes in the southern half of the township, a wholly unexpected but remarkably perfect subordinate batholitic structure was discovered within the large batholitic mass itself, the strike of the gneiss running in great circles and sweeps through the mass and bending back upon itself in closed curves. The lakes are all excavated in or etched out of this gneiss, their outlines closely following the curves of the gneissic structure. The centre of one circle, which is especially well seen, lies about a mile to the north of Serpentine Lake, near the middle of the township on concession XVIII. Two bands of limestone were noticed which had been caught up in these curves: one on Eagle Lake, in the southern part of the township, and the other, which is much larger, in its northern portion, to the south-west of Eel Lake.

Ontario—*Cont.*

Fundamental gneiss.

Igneous origin of Fundamental gneiss.

"The mass of this gneiss is undoubtedly of igneous origin. From Anstruther it extends around the south-eastern portion of the township of Monmouth and into the northern part of Cardiff where, however, it presents rather the character of an intrusive granite, possibly owing to its having here been more completely softened, and it can be observed cutting through and across the limestone series in many places. Great masses of amphibolite moreover come in, of which the relations have not as yet been fully determined. In the south-east corner of Anstruther, the great batholitic series of the Fundamental gneiss abuts against a series of well-foliated and banded limestones, amphibolites of various kinds and fine-grained rusty-weathering gneisses, the two being brought together by a fault. This occurs immediately to the east of Crab Lake where the strike suddenly changes from N. 75° E. to N. 15° E.,* the easterly or limestone series, having the latter strike, passing out of Anstruther into the adjacent township of Chandos, all the northern portion of which township is underlain by the last-mentioned series. As developed in northern Chandos, this series consists of limestones interstratified with several distinct varieties of amphibolite, the most abundant being thinly foliated, and characterized by the development in it of radiating bunches of slender prisms of dark-coloured

* Bearings throughout this report are referred to the true meridian unless otherwise stated.

Ontario—*Cont.*

hornblende lying in the planes of the foliation. This 'feather' amphibolite is continuous over very large tracts of country and is associated with great intrusions (?) of a massive black gabbro-like rock which is well seen at Macdonald Rapids on the North River in the XVIIIth concession of Chandos, the rapids being caused by one of these great masses which is encountered by the stream at this point. In this series the batholitic structure is also excellently developed, the most perfect example being a batholite of which the central portion is occupied by Duck Lake, which sheet of water is situated about the middle of the township on concession XI. About the shores of this lake an impure limestone is found, the attitude of which is nearly horizontal. This occupies an approximately circular area with a width of about one mile. The limestone is surrounded by a zone of a heavy, more or less distinctly foliated amphibolite, averaging about a mile in width, which forms a cliff about the lake and dips away from it on all sides. This in its turn is succeeded by a zone of limestone and 'feather' amphibolite, also presenting the same quaquaversal dips, the strike of both series circling completely around the lake.

"The southern part of Chandos and the adjacent parts of Wollaston, are largely occupied by a great mass of granite which breaks through and eats into the series above mentioned, holding inclusions of it and sending off apophyses into it in all directions. This is excellently seen along the shores of South Bay of Loon Lake in Chandos, as well as about Gilmour Bay, an extension of the same lake, and along the Wellington road in the first range of the township. It extends down into Methuen on the south.

Conclusions formed from season's investigations.

"The investigations of last summer bear out the conclusions of former work, in showing that the Fundamental gneiss consists of granitoid-gneissic rocks in the form of great batholitic masses, the limestones, etc., of the Grenville series sagging down between and wrapping around the batholites as great mantles. These gneissic rocks, in parts of the area, have become more completely molten and have developed into truly intrusive granites which no longer merely arch up the overlying strata but break through and cut across them.

"The relation of the limestone, classed as Grenville series, to the stratified rocks referred to the Hastings series, cannot as yet be considered definitely settled, but important evidence bearing upon the question has been obtained by the discovery in several widely separated localities in the area examined this summer, of considerable

Conglomerate near The Ridge post-office.

exposures of conglomerate. The first of these localities is south of Eagle Lake on the road to The Ridge post-office, on lot 12, con. III. of Wollaston. Here the conglomerate appears by the roadside, the matrix in some places being composed of silicified mineral but elsewhere of limestone. The pebbles are for the most part amphibolite and diorite, but many of them consist of quartz or quartzite and gneiss or granite. Where the matrix of the conglomerate is not limestone, they are often much flattened in the direction of the strike, as is usually the case in conglomerates found in districts which have been submitted to great pressure. Some of the pebbles, however, when the matrix is limestone, still preserve their original and nearly spherical form.

Ontario—*Cont.*

"Another locality where conglomerate was found is on lot 18 of range I. of Cardiff. Here, in the heavily wooded country to the east of the southern extremity of Pine Lake, forming part of a highly inclined series of amphibolites with interstratified limestones and quartzites, a band of conglomerate nine feet thick is well exposed on the summit and side of a cliff. The matrix of this conglomerate is fine in grain and slightly calcareous and the pebbles, as in the case already cited, are often considerably flattened. The relative proportions of the different kinds of rocks forming the pebbles was ascertained in several places, and it was found that from 75 to 79 per cent of these consisted of a fine-grained pink granite, the remainder being chiefly composed of amphibolite and crystalline limestone. A careful study of their character will be made so soon as thin sections of them have been prepared, but judging from their macroscopic character, it seems highly probable that the granite pebbles have been derived from a mass of this rock which occurs about the southern end of Pine Lake and the other pebbles from exposures in that vicinity.

Conglomerate in Cardiff.

"Two other exposures of conglomerate were noticed, one on the north side of the Bancroft and Bronson road a little over a mile east of Bancroft, and the other on the Carlow and Combermere road about five miles south of Combermere. The pebbles in both instances were rather similar to those described above, distinctly rounded and embedded in crystalline limestone matrix.

Conglomerate near Carlow.

"Mr. Barlow's work was directed chiefly to surveys and geological examinations in the north-eastern part of the sheet, covering the townships of Wollaston, Faraday, Dungannon, Mayo, Raglan, Carlow, Herschell, McClure, Wicklow, Bangor, Radcliffe and parts of Ashby, Brudenell, Lyndoch, Sherwood and Hagarty. The relations of various members of the Fundamental gneiss were closely examined and the conclusion arrived at that both basic and acidic members are differentiated portions of a single magma. Abundant evidence was obtained that the nepheline-syenite which was at first thought to be a separate

Work by Mr. Barlow.

Ontario—*Cont.*

and later intrusion must really be included with the gneissic rocks classified usually as Laurentian.

"A considerable portion of the time was spent in tracing out the corundum deposits and an account of their mode of occurrence is included in the present report.

Note on the discovery of corundum.

"The presence of corundum in the northern part of the county of Hastings and thus within the confines of the Haliburton map-sheet (No. 118) was really made known as the result of a visit made in October, 1896, by Mr. W. F. Ferrier, of the Geological Survey of Canada. In the Summary Report for the year* Mr. Ferrier relates the history of the discovery and the circumstances which led to his trip to that region. It is now, however, stated on undoubted authority that this was not the first intimation of the occurrence of corundum in the township of Carlow. Some six years previously, or about the year 1890, Mr. Woods, now a resident of Kingston, Ontario, an amateur geologist and mineralogist, was travelling through this district and was shown crystals obtained from the Carlow locality by Mr. Armstrong of Armstrong's Mills (New Carlow, P.O.), and he, after examination, pronounced them 'emery stone.' The value of the find, however, does not appear to have been appreciated by the original discoverers as nothing further was heard of it until after Mr. Ferrier's return from Hastings, although one of Mr. Armstrong's sons personally conducted him to the spot where the crystals occurred. Notwithstanding it is thus evident that although the nature of the mineral was known some years before Mr. Ferrier's visit, there can be no reasonable doubt that the true value and extent of the deposit would have remained practically unknown but for his description and report of its mode of occurrence.

Corundum mistaken for apatite.

"On the announcement of Mr. Ferrier's observations, the attention of Messrs. Robillard and Fitzgerald was directed to certain crystals which they knew to occur in the north-eastern part of the township of Raglan about five miles to the east of the Carlow locality. These had been supposed to be apatite or 'phosphate' and the gentlemen named above had been on the point of applying for the mining rights of the land on which the mineral was known to occur, when the somewhat sudden depreciation in the value of phosphate happened. Mr. Ferrier's description and the knowledge that these crystals were approximately on the same range of hills, confirmed the belief that the supposed apatite was in reality corundum, especially, as it coincided with the opinion of a so-called expert expressed some years before, although at the time no great reliance was placed

*See Summary Report, Geol. Surv. Can., 1896, p. 116 *et seq.*

on the accuracy of his determination. Immediately on Mr. Ferrier's return to Ottawa (23rd of Oct., 1896), the Director of the Survey communicated to the Ontario Bureau of Mines the results of this visit to the township of Carlow, and in consequence, the lands, which belonged to the Crown, were withdrawn from sale by the Ontario Government. Following shortly on this discovery, and doubtless as a result of it, came the news that Mr. George Bennett had found corundum at a so-called mica mine on lot 14 con. IX. of the township of Methuen in Peterborough county, about forty-five miles to the south-west of the Carlow occurrence. Ontario—*Cont.*

Mr. Ferrier's forecast verified.

"During the past summer repeated reports of alleged 'finds' of corundum were circulated from time to time and a personal examination was made of a large number of these which invariably arose from mistaking some species of grayish felspar, usually albite, for corundum. Mr. Ferrier's prediction that the Carlow locality is not an 'isolated occurrence, but that other deposits will be found in the Hastings district,' has since, however, been amply verified by the detailed examinations carried on during the past summer both by the Geological Survey of Canada and the Ontario Bureau of Mines. During last August and September, Prof. W. G. Miller, of the Kingston School of Mines, who was conducting a prospectors class in Central Ontario, undertook an exploration of this stretch of country at the instance of the Ontario Bureau of Mines with the object of securing as much additional information as possible in regard to the distribution and association of the corundum. In many cases the work was carried on in co-operation by Mr. Barlow and Prof. Miller, so that much more satisfactory result were achieved than could have been accomplished by a single party. Prof. Miller has already written an interim report in the Sixth Annual Report of the Bureau of Mines, which has just appeared,* and as a result 'the mineral rights in those lands over which the corundum belt has been found to extend have been withdrawn from sale pending the completion of the final report.'

Work by Prof. Miller.

Nature and character of corundum.

"The name corundum embraces those varieties of oxide of aluminum having dull colours; the colours generally being light-bluish, greenish, grayish or brownish. The granular corundum of a blackish or grayish-black colour, when intimately mixed with magnetite or hæmatite, is usually referred to as emery. The mineral found in Hastings county is essentially pure. The susceptibility of corundum to alteration, and the difficulty of getting rid of the scaly decomposition products seem to be the chief hindrances to a more profitable,

Alteration corundum.

* Sixth Report Bureau of Mines, Ontario 1896, pp. 64-66.

Ontario—*Cont.*

and therefore more general mining and use of the mineral. A variety of aluminous minerals result from its decomposition, the most abundant alteration product noticed being a pearly-white hydrous muscovite, evidently closely allied to damourite or margarite, and every gradation in alteration may be noticed at the different localities, from the incipient stages in which the comparatively unaltered crystals are coated with thin films or scales of this mineral, to that in which the whole individual has been converted into the magnesian mica. The circumstances under which such alteration takes place seem at present difficult of explanation, for often, even when embedded completely in comparatively fresh and unaltered rock, where the surrounding constituents have undergone little or no perceptible change, the corundum individuals may be seen, either wholly or in part, replaced by the objectionable mica. On the other hand, it was frequently noticed that crystals which had evidently been subjected for a considerable time to the action of the weather, show little or no sign of decomposition. Throughout the region examined, however, the corundum is, as a rule, comparatively fresh and unaltered, and it is confidently believed that the deposits will, if properly handled, furnish sufficient material of such uniform hardness and purity that it can be successfully treated for the removal of impurities by the use of machinery like that employed for this purpose in Georgia.

Comparison with Georgia corundum.

"In the State of Georgia, where corundum has been successfully mined since the year 1880, three varieties are commonly distinguished, and it is probable that in the Hastings area, these subdivisions will, in a rough way, hold good. 1. Sand corundum, 2. Block corundum, 3. Crystal corundum. The sand corundum is either coarsely or finely granular, usually found embedded in a gangue of decomposed felspar.

Block corundum.

The block corundum includes the massive corundum, with nearly rectangular parting or pseudo-cleavage. This type is of rather frequent occurrence, and at the Raglan locality a large irregularly oval mass was found by Mr. Henry Robillard, which measured 10 x 7 x 7 inches, and weighed 24 pounds This large, and as yet unique specimen, was divided into two pieces by the finder, one being given to Capt. W. E. James, of Combermere, while the other went to Mr. James Best, of Bird Creek. Last summer, however, these gentlemen kindly presented the specimens to the Geological Survey, and they have now been placed side by side in the museum.

Crystal corundum.

Crystal corundum is, however, by far the most common type met with in the Hastings district, and, as might be expected, it passes into block corundum on the one hand, by an increase in size, which is almost invariably accompanied by a decrease in perfection of crystallographic outline, and, on the other hand, to sand or granular corundum, when the individuals are so closely packed together that mutual interference prevents the assumption of regular crystalline forms. The crystals when normally developed are usually six-sided prisms which are sometimes terminated by a six-sided pyramid, and not infrequently by the basal plane.

Ontario—*Cont.*

Crystallization of corundum.

" Many of the crystals found here have a tolerably sharp and perfect outline, frequently showing a tapering to either extremity, thus producing the very characteristic barrel-shaped outline. The pyramidal and prismatic faces are very often more or less deeply striated or grooved horizontally. The basal planes or truncated ends of the crystals are frequently striated in three directions, forming equilateral triangles corresponding with the less perfect rhombohedral partings or pseudo-cleavages. When the crystals are large they are usually rough and imperfect. The corundum is in many instances somewhat brittle, breaking with an uneven or conchoidal fracture, but when in large and compact masses it is exceedingly tough. The hardness is 9 or second only to that of the diamond, but as might be expected from its liability to alteration this quality is somewhat variable and the chief purpose of all the manipulation it undergoes is to secure uniformity of hardness in the finished material. The lustre is in general vitreous, but in the translucent light-greenish variety noticed in Brudenell township the lustre is somewhat pearly. In a great many instances the surfaces revealed by the basal parting showed a distinct bronze-like metallic lustre, resembling very much in this particular that of the cleavage-planes of bronzite. The colour is in general brownish or grayish. Some of the crystals noticed in Brudenell were greenish, yellowish to almost colourless, while very occasional fragments and individuals have a distinct rose-red colour. Frequently, especially in the larger individuals, the colour is not uniform, but patches of gray, brown and green blend into each other.

Occurrence of corundum.

" Although a certain tract or area was mapped out in which it was definitely ascertained that corundum was present, while the rocks in the district on either side seemed altogether barren of the mineral, and although the trend of this belt agrees in a rude way with the general strike of the containing gneissic rocks, still it was found that the mineral occupied no very definite position in any particular zone or band, but that it occurred somewhat sporadically developed in the various plutonic rocks of the region, whose chief point of resemblance consisted in their community of origin. The occurrence of the mineral in this connection affords additional evidence, if such were needed, of the identity of the magma from which the larger proportion of these granitic or gneissic rocks have crystallized. At many of the rock-ex-

Ontario—*Cont.*

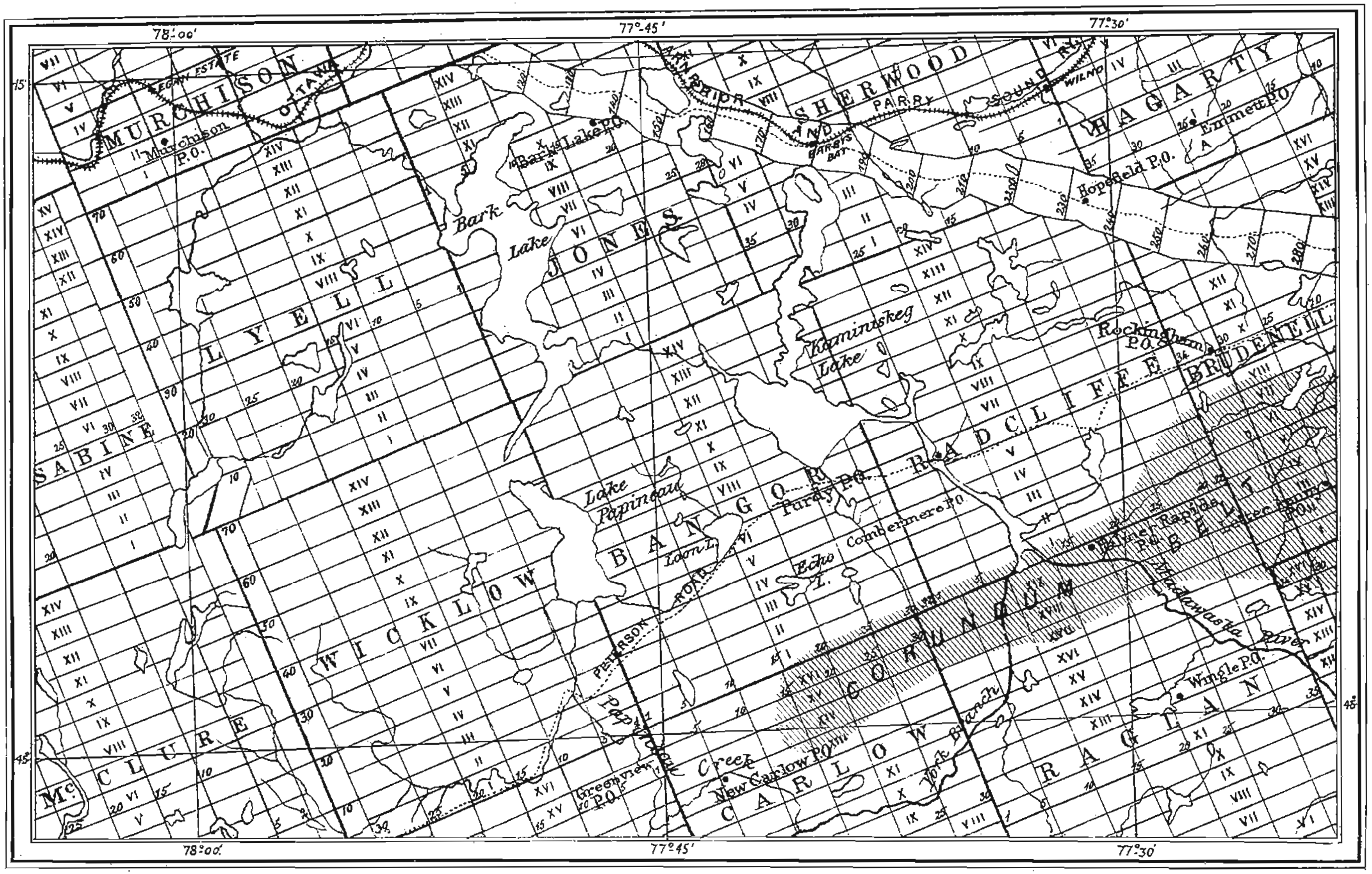
posures visited in the township of Brudenell, the corundum was frequently noticed completely embedded in and surrounded by the iron ore; in fact this association was the most common and noteworthy one. It is therefore apparent that the corundum was one of the first constituents to crystallize out from the molten magma, while at the same time sufficient material remained in the more acid residual portions to form the large and important occurrences seen in the pegmatite dykes which marked the final stage in the process of solidification. The foliated texture of many of the rocks with which the corundum is associated, show the same irregularity in their minor structural details so usual in other areas where similar rocks are exposed, while maintaining approximately the same general strike and inclination, or dip, over the whole extent of territory examined.

Limits of corundum belt.

"The limit of what may for convenience be called the 'corundum-bearing belt' extends on the west from lot 14, in the XIVth concession of the township of Carlow, where it was originally found, north-eastward as far as lot 25, in the VIth concession of the township of Brudenell. Mr. Barlow did not explore the territory further to the east, as the last-named locality corresponded very closely with the eastern limit of the map-sheet on which he is at present working in conjunction with Dr. Adams. The assumption at present seems very reasonable that corundum will be found, if careful and systematic prospecting is undertaken, in the northern portion of Lyndoch, the southern part of Brudenell and the middle concessions of Sebastopol. To the west of the Carlow occurrence, no corundum has been found on the hills forming the north-western part of the township of Carlow and the north-eastern portion of Monteagle township. The deep valley of Papineau Creek intervenes and seems to limit the occurrence in this direction, although very similar rocks prevail in this area.

Width of the belt.

"In width, the corundum belt is rather variable. In the township of Carlow corundum has been found in a large number of places over the hill which forms the north-eastern part of the township east of lot 14. It occurs at intervals at places from the XIIIth concession to the XVIth concession, thus showing a breadth of over two miles. In the township of Raglan, the mineral has been found in a large number of places on the high ridge which runs across the XVIIIth and XIXth concessions as far as the York River, a branch of the Madawaska. Prof. Miller and his assistants proved the existence of the mineral on many of the lots in the XVIIth, XVIIIth and XIXth concessions of Raglan, between the York River and the Madawaska, and likewise on a number of lots in the XVIIIth and XIXth concessions to the east of the Madawaska. In Raglan, therefore, the belt is very nearly two



Autographed by C. O. Senécal — *Geologically surveyed by A. E. Barlow*

PLAN SHEWING CORUNDUM BELT IN HASTINGS AND RENFREW COUNTIES ONT.

Scale 5 miles to 1 inch

miles wide, but further east corundum has been found on lot 32, concession II. of Radcliffe; lot 34, concession V.; lot 25, concession VI.; and lot 32, concession VII., of Brudenell township. Much of the country is either drift-covered or densely overgrown with a hardwood bush, so that prospecting is exceedingly tedious and difficult, but here and there small exposures of rock occur and these were carefully examined for the mineral. Boulders containing the mineral in the drift material, often formed excellent guides in prospecting, as in most cases it was ascertained that they had travelled no great distance from their original source. Mr. Joseph Keele, assistant to Mr. Barlow, was handed specimens of corundum said to come from the township of Lyndoch, on the road to Letter Kenny P.O., about a mile north of Quadville. Near the boundaries between the townships of Raglan, Radcliffe and Brudenell, therefore, the band of rocks in which corundum has been proved to occur is over three miles in width; and, if the Lyndoch occurrence mentioned above is authentic, the whole belt will be fully five miles wide at this place. Ontario—*Cont.*

"On lot 14, con. XIV. of the township of Carlow, a range of very high prominent hills ends somewhat abruptly in a steep cliff or precipice composed chiefly of coarse flesh-red pegmatite, cutting a dark reddish or brownish gneissic rock, which on examination under the microscope proves to be a hornblende-granite-gneiss. To the north-east this hill rises gradually for a considerable distance. At first it trends to the north-east but then bends around more to the east, following very closely the direction of the concession lines through the north-eastern part of Carlow and the township of Raglan, terminating rather steeply at the large marsh (Campbell's marsh) through which the lower portion of the York River meanders before its junction with the Madawaska. To the east, although maintaining approximately the same elevation, this range of hills does not appear in such marked contrast to the topography immediately surrounding, as the whole country is rougher and more mountainous. Carlow.

"In Carlow township, the older plutonic rock cut by the pegmatites carrying the corundum, is composed of orthoclase, plagioclase, biotite and hornblende. Quartz is present, but by no means an abundant constituent. Sphene is very abundant, of a dark-brownish colour and marked pleochroism. Apatite is also present and zircon in occasional small crystals. The felspar is much stained with red and brown iron oxide, and shows the undulous extinction due to squeezing. This gneiss has a strike of north-east with a dip to the south-east at an angle varying from 15° to 30°. The foliation is very distinct, and further to Associated rocks.

Ontario—*Cont.*

the east shows a bending around in strike corresponding to the change in direction of the hill.

"The corundum is, as has been said, by no means uniformly distributed through the mass, and large portions of the rock are completely barren of this mineral, while certain portions on the other hand contain a very high percentage, constituting as much as a quarter to a third, or even more in some cases of the whole rock.

Raglan.

"In the township of Raglan, on concessions XVIII. and XIX., granite and granite-gneisses prevail, with which is associated a small quantity of nepheline-syenite and nepheline-syenite-gneiss. This peculiar and somewhat uncommon rock occurs in several small patches and areas on lot 2, concession XVIII. of Raglan, but was not noticed elsewhere on the hill. This nepheline-syenite is composed chiefly of a flesh-red or salmon-pink elæotite or nepheline, which is generally the most abundant constituent; a light-gray, almost white, albite and a small quantity of dark-coloured biotite. The nepheline, where exposed to the action of the atmosphere, shows the characteristic weathering, occurring in irregular sunken areas with all the inequalities rounded off and leaving the white plagioclase in marked relief. The strike of the foliation is about N. 80° E., with a dip at a small angle to the south, and is somewhat uniform over the whole of the hill. The corundum was noticed in a large number of places, often in sharp well-defined crystals, but usually in large irregular individuals or masses and aggregates. All the exposures visited were on the southern slope of the hill, chiefly on lots 2, 3 and 4. On lot 2 the corundum was noticed in the ordinary red felspathic gneiss as well as in the nepheline-syenite. A small cliff was seen composed of the latter species of rock, containing embedded crystals, whose major axes were lying at right angles to the foliation. On lots 3 and 4 the rock is the ordinary red felspathic gneiss closely allied in character to syenite, being poor in quartz, cut by pegmatite, which is likewise comparatively poor in silica. The coarser crystals and fragments are present as usual in the pegmatite phases of the rock, and one case was noticed where a promising exposure really formed a mere shell or covering, which was removed by the first blast, revealing the comparatively barren gneiss beneath. The whole of this hill had, previously to our visit, been rather carefully prospected by Mr. Henry Robillard, the original discoverer of this locality, but if it should be decided to work the place a careful and systematic examination would have to be made of the whole ridge.

Brudenell.

"On lot 33, concession VII., of the township of Brudenell, corundum crystals may be noticed thickly disseminated through a well foliated nepheline-syenite-gneiss which as well as the ordinary red felspathic gneiss crosses the road running southward from the village of Rockingham to the German settlement towards the Madawaska. The two varieties of rocks are interfoliated and have a north-west and south-east strike. The corundum was noticed at intervals in rather small crystals but more thickly and evenly distributed than usual, for a distance of about an eighth of a mile across the strike of the foliation, although they are not so abundant in the ordinary felspathic gneiss and are altogether absent from many of the interfoliated bands. On lot 34, concession V. of Brudenell, the corundum occurs in large irregular crystals and masses embedded chiefly in the nepheline-syenite, and these are present in considerable quantities in the ordinary red syenite rock. At one place, a rather sharp contact was seen between these two rocks, the larger crystals being developed in the nepheline-syenite close to the line of junction. The rocks occur on a lot belonging to Mr. Frederick Black. The strike is here about north-west and south-east. The corundum is generally of a brownish colour, but some of the small crystals in a light-gray albite-gneiss are light-greenish, yellowish and grayish to almost white or colourless. The fields to the south-west of the exposures are covered with a great many boulders most of which are seen to contain corundum. The nepheline-syenite is composed of a very beautiful salmon-pink nepheline, gray albite and small spots or areas of deep-blue sodalite. The crystals of corundum are sometimes decomposed to the pearly magnesian mica already mentioned, the combination of all these constituents making a very striking and beautiful rock.

Ontario—*Cont.*

"At present the chief obstacles presenting themselves to the successful and profitable mining of this mineral, is the exceeding irregularity of the deposits and their wide separation from one another. Careful search may get rid of much of the latter objection, as the prospecting so far undertaken, though done very carefully, has been by no means exhaustive and the richness of some of the masses already encountered seems to show that the average yield of considerable bodies of rock will be satisfactory.

Obstacles to successful mining.

"In the event of treating the mineral on the spot, there are several good water-powers in close proximity to the various localities where corundum is now known to exist. In Carlow the water power now operating Armstrong's saw-mill on Papineau Creek is only about three miles from the corundum cliff. In Raglan a good water-power is already utilized by a small roofless saw-mill on a stream which flows through the valley immediately south of the hill on which the mineral occurs. Palmer's Rapids on the Madawaska would furnish good and

Water powers.

Ontario—*Cont.*

sufficient power for the treatment of corundum found in the surrounding country. All of these water-powers have already been considerably improved and would probably only need some minor alterations to make them immediately available.

Accessibility of deposits.

"The corundum deposits are rather readily accessible, the chief means of communication being by means of the York and Madawaska rivers and Kaminiskeg Lake as far as Barry's Bay, an important station on the Ottawa, Arnprior and Parry Sound Railway, about 108 miles west of Ottawa. A small steamer with scow attached now runs from Havergal (Campbell's Farm) on the York River to Combermere and Barry's Bay, passing the foot of the hill on which the Raglan deposits occur. Wagon roads approach the other deposits very closely and although most of them are exceedingly rough they could be considerably improved at a comparatively small outlay. Labour and supplies are cheap and abundant.

"The following notes may be of assistance to prospectors working in the district:—

Hints to prospectors.

"The great hardness of the unaltered corundum, the sharp edges of which will readily scratch the hardest steel, is perhaps its most valuable distinguishing characteristic. Its greater weight in contrast to any of the associated materials is also of value in recognizing this material, and the barrel-shaped outlines of many of the crystals is likewise very characteristic.

"The presence at the surface of a relatively greater abundance of the pearly or light-coloured mica, which so frequently results from the alteration of corundum, is in many cases a valuable indication of the probable proximity of the unaltered material. The rocks in which corundum has been found are relatively much poorer in quartz than the prevailing gneissic rocks of Laurentian areas. The presence of nepheline-syenite may also be considered as a promising indication locally, and a quartzless pegmatite, or one nearly so, seems to be especially favourable to the development of corundum.

"Frequently, especially on those glaciated rock-surfaces from which the covering of soil has been but lately removed, the corundum crystals and fragments stand out in bold relief and form very conspicuous objects. Many of the deposits were also found by following up boulders containing the mineral to the places of their origin, in a N.N.E. direction, as indicated by the glacial striation, which runs about S. 25° W."

The winter of 1896-97 was devoted by Dr. R. W. Ells to the plotting and compilation of the surveys pertaining to map-sheet No. 119, and to the arrangement of the notes of the late Mr Giroux, in connection with the mapping of the adjacent sheet, No. 120. Ontario—*Cont.* Work by Dr. R. W. Ells.

The month of June was spent by Dr. Ells with Mr. Fletcher and Dr. Ami in Nova Scotia, in the examination of some points connected with the conglomerates and associated Carboniferous rocks which flank the Cobequid Mountains, the relations of which are somewhat obscure. Some time was also devoted to the investigation of the rocks between Truro and Pictou, as well as to the examination of the Horton and Wolfville section. It was thought desirable that Dr. Ells should be associated with the above-mentioned gentlemen in this work because of his previous experience in the same field.

The greater part of the season was, however, employed by Dr. Ells in the continuation of the work upon sheets 119 and 120 of the Ontario series, known respectively as the Perth and Ottawa City sheets. The results are outlined by Dr. Ells as follows :—

"Upon my return to Ottawa on July 1st, I proceeded almost directly to Barry's Bay, on the Ottawa, Arnprior and Parry Sound Railway, in order to make an examination of the upper portion of the Madawaska River. This stream was examined from Bark Lake east to the High Falls, at which point our surveys of the river ended in 1896. Thence the river was ascended to Mackey's Creek, by which a portage-route for canoes extends across to the Mississippi River near the village of Ardoch. This route crosses the Snow road by a portage between Brulé and Buckshot lakes, the latter of which discharges into the Mississippi. An examination was also made of a number of lakes in this vicinity in order to fix the limit between the Hastings limestones and the granite-gneiss of the Upper Madawaska district. Upper Madawasca River.

"The months of August and September were devoted to the completion of the surveys necessary for the compilation of map-sheet No. 119. In this work the wheel odometer was employed to a large extent, though details were filled in frequently by pacing. The surveys of the area embraced in this sheet have now been nearly completed and the map is ready for compilation, except for the survey of certain base-lines required for the purposes of ensuring geographical accuracy. In the surveys of the eastern portion of this sheet Mr. Wilson, of this office, did a large amount of excellent work, principally in connection with the tracing out of the Potsdam and Calciferous formations. Work by Mr. Wilson.

"In connection with Mr. James White, surveys were also made in the district south of the Ottawa River, in the southern portion of map-sheet South of the lower Ottawa.

Ontario—*Cont.*

121, and along the line between this sheet and the one to the south, 120, which had been partially surveyed by the late Mr. N. J. Giroux. The latter part of the season was devoted to the survey of the district more immediately adjacent to the city of Ottawa, where a somewhat complicated piece of structure is presented, owing to the presence of numerous faults which traverse this district.

Calciferous and Potsdam of Lanark and Carleton counties.

"The rock-formations in the area examined include crystalline schists and limestones of the Hastings series as well as the granites and gneisses connected with these. In the eastern areas the Palæozoic formations are well developed, the principal being the Potsdam sandstone and the calciferous limestone which are particularly well exposed in the south-eastern part of Lanark county and the southern portion of the county of Carleton. The beds of these formations are in a nearly horizontal position, though in places they are inclined at angles of ten to fifteen degrees. They constitute the lowest members of the Ottawa Palæozoic basin and rest directly upon the gneiss and limestone of the Archæan. In the townships of Huntley and Nepean, as also in Ramsay, the Calciferous passes regularly up into the Chazy and on into the Black River and Trenton. There is usually a gradual passage upward from the Potsdam sandstone into the Calciferous limestone, and in places these transition beds are from thirty to fifty feet thick. This portion frequently contains an abundance of fossils, as in the township of Goulburn, though they are not often easily obtained in a good state of preservation.

Transition

Fault near Fallowfield.

"In Carleton county, on the road from Bell's Corners to Richmond, a sharp line of fault is seen about a mile to the north of Fallowfield on lot 28, range V., township of Nepean, by which the Trenton is brought in contact with the Potsdam sandstone. The Trenton beds are here highly fossiliferous and to the east of Fallowfield they pass down into the Chazy.

Faults in Gloucester.

"In the township of Gloucester, a well-defined break is also seen on the Russell road, about lot 17, ranges IV. and V., Gloucester. Here the Utica shales are in contact with the Calciferous limestones. This fault extends a considerable distance to the east, and also appears near the Rideau River about one mile above the Hog's Back. It is seen near the road up the east side of the Rideau on lots 2 and 3, range II., Gloucester township, where the contact is between the Chazy and Calciferous. The location of these faults is rendered uncertain at many points by the great covering of clay and sand which is widely spread over much of this area. The Utica basin does not reach the Rideau, but apparently is terminated by a fault which divides it from the Trenton and Black River about the road leading south near the line between ranges II. and III., Gloucester. Ontario—*Cont.*

"The recent examination of certain areas south of the Ottawa River has fixed several of the boundaries of the Palæozoic formations more accurately. The Trenton and Black River have a considerable development south of the river, resting upon the Chazy. The Trenton extends south of the village of Cumberland from lot 1, almost to the village of Navan, which is a short distance east of the boundary of Carleton county. Here the formation passes up into the Utica about half a mile north of the latter village. Westward the line between the Utica and Trenton continues to Robillard P.O., on the Montreal road, the contact with the Trenton being about two miles and a half south of the Rideau River. This contact can also be seen along the road to the south of the Roman Catholic cemetery, about 250 yards east of the Montreal road, and the eastern limit of the Utica is seen in New Edinburgh, near Charles street, about 100 yards from the road to Rockliffe. The Utica occupies the flat country to the south of the Ottawa and east of Billings bridge, and the area along the road south of the latter place, extending to Hawthorn Corner, where the black shales are overlain by, or pass upward into, the gray sandy shales of the Lorraine (Hudson River) formation. Delimitation of the Utica near Ottawa.

"To the east of Carleton county, the Utica has been traced for a long distance. It has been conclusively shown that the formation extends in an unbroken area from the vicinity of Ottawa city for more than fifty miles east, or nearly to Vankleek Hill, with a breadth in places of nearly twelve miles. To the south-east of Ottawa, the Lorraine shales come in and extend in the direction of the Mer Bleu or great peat-bog, which they apparently underlie, as the Utica shales again appear along the road which crosses southerly not far beyond the eastern limit of the bog. In the extreme south-west portion of Cumberland and the corner of Russell adjacent, a considerable area of reddish shales occurs, the location of which is easily recognized by the presence of bright red soil. The red shales are rarely seen at the surface, as they decompose readily, but the ledges were noted in several excavations, while the débris from wells also showed the presence of these rocks. They appear to have a thickness of at least fifty feet, though in the wells the bottom of the formation was not apparently reached. These are supposed to represent the Medina formation, and they are apparently newer than the Lorraine shales which appear both to the north-west and to the south. Medina and Lorraine shales of Russell.

"In the crystalline rocks, the relations of the diorites and granites to the crystalline limestones and associated gneiss have been worked

Ontario—*Cont.*

Relations of Hastings limestone to those of Grenville.

out as carefully as the broken nature of much of the district would permit. The peculiar striped limestone or marble so characteristic of the Hastings series has been traced south-eastward beyond the Rideau Lakes into the township of South Elmsley. The strike of these rocks varies from N. 50° E. to N. 10° E.; and this course would carry the rocks of the series directly across the Ottawa River into the area occupied by the Grenville series. The passage of the striped limestones into the white marbles of the Grenville area is frequently noticed and the trend of the strike of the rocks to the south of the Ottawa, where they are overlain by the Palæozoic formations of the Ottawa basin, appears to follow the same courses as seen in the several members exposed along the upper Ottawa, in that the course gradually changes from an easterly direction to a northerly one. In this respect the conclusions already stated as to the apparent relations and equivalency of the Grenville and Hastings series have been maintained by the most recent observations.

Corundum deposits.

" One of the most important facts arrived at in the work of the past season, is the extension of the corundum-bearing rocks eastward from the county of Hastings, where they were first discovered, into the county of Renfrew. The characters of the rocks comprising the belt were recognized as similar in both areas several years ago; and during the present season the extension of the mineral-bearing portion was traced from the original location in Hastings county eastward across the Madawaska, by Mr. Barlow and his assistant. The mineral has now been found as far east as the western portion of Lyndoch and Brudenell townships. Drift blocks of the nepheline were also found along the south side of Clear Lake in the township of Sebastopol, as also along the Opeongo road in that township, so that the mineral may now be looked for in the country to the north of, or in the vicinity of Clear Lake in the direction of Eganville. The nepheline-syenite was observed along the road which passes from the Opeongo road, east of this lake, to Eganville.

Nepheline-syenite.

Pyrrhotite of Dalhousie.

" Nothing further has yet been done in the utilization of the iron deposits of the district along the Kingston and Pembroke Railway. A deposit of pyrrhotite was examined in the township of Dalhousie near the road leading north from Watson's Corners towards Poland, on the east half of lot 18, range III., Dalhousie. The deposit appears to be extensive, occurring with a dark-gray fine-grained diorite which cuts a rusty gray gneiss. An assay of this ore made in the laboratory of the survey showed it to contain neither gold nor silver, but 0·165 per cent of nickel. In the vicinity, quartz veins also occur cutting the diorite, and these are reported to be gold-bearing.

"Prospecting work for gold has been prosecuted on the area to the south of Joe's Lake, noted in the Summary Report of last year. The shaft has since then been sunk to a reported depth of about seventy feet, and the ore contains mispickel, copper and some gold. No direct returns have yet been made to this office from this area, and the work so far done has apparently been development only.

Ontario—*Cont.* Gold mine near Joe's Lake

"In the Calciferous and Black River formations many quarries of excellent building stone have been opened and are in places somewhat extensively worked for local use. A new outlier of the Black River was discovered in the low tract to the west of Clear Lake, in the township of Sebastopol, and the Palæozoic formations seen around the south-west corner of the lake, comprising the Trenton and Utica, appear to extend westward and to underlie a depression which continues as far as the road from Brudenell Corners to Killaloe. From the character of the drift and soil on the road leading up the mountain from Castile post-office, it is very probable that the Utica outlier of the south side of Clear Lake also extends in this direction for several miles, overlying the Trenton and Black River formations. It is probably from this Black River outlier, west of Clear Lake, that the large masses observed along the north slope, as well as along the top of the mountain, on the Opeongo road, have been derived. The direction of the ice movement in this district was a few degrees west of south.

Black River and Utica outliers of Sebastopol.

"It is still quite possible that gas or oil may be found in commercially important quantities in the Trenton rocks in this part of Canada, and in this connection it is worth noting, as already explained, that these rocks are well developed in the vicinity of Ottawa city and along the south side of the Ottawa River, over a very extensive area, In that part of this area where the Trenton is overlain by Utica and Lorraine shales, constituting an impermeable capping, the conditions would of course, be more favourable than elsewhere. Several trial borings in the area to the north of the Canada Atlantic Railway, have shown that gas can be found, although the quantity so far met with has been inconsiderable. The conditions and formations here observed are very similar to those which occur along the eastern side of the St. Lawrence below Montreal, where boring operations for gas have been carried on in a desolutory manner for some years, with fair indications of ultimate success.* The covering of the red Medina shales in the eastern St. Lawrence basin appears, however, to be much heavier than in the Ottawa basin. No results of value were obtained in an attempt

Conditions for gas and oil near Ottawa.

Bore-hole at Ottawa

*See Summary Report, Geol. Surv. Can., 1887, p. 33 A.

Ontario—*Cont.*

made some years ago in the vicinity of Ottawa, when a depth of 1005 feet was attained, but the faulted character of the rocks at the place chosen rendered it a particularly unsatisfactory one for the purpose.*

Peat bogs.

"The extent and importance of the deposits of peat in the vicinity of Ottawa have been pointed out in former reports, and in view of the new applications of this material, not only for moss litter but as a disinfecting agent, its value will doubtless soon be recognized. The facilities for the production of prepared peat in the vicinity of this city are very great, and the proximity of the peat deposits to the two principal lines of railway, which skirt the principal area on either side, would greatly facilitate its being placed on the market.

"The season's work extended from June 1st to October 7th."

QUEBEC.

(With adjacent parts of Ontario.)

Work by Mr. R. Chalmers.

Subsequent to the date of the last Summary Report, Mr. R. Chalmers was engaged for some time in writing a report on the surface geology of south-eastern Quebec, including the gold-bearing deposits of the 'Eastern Townships,' and in laying down the work on a map to accompany it. A paper on the gold-bearing rocks was also prepared by Mr. Chalmers, and read at the meeting of the Federated Canadian Mining Institute, held in Montreal in February, 1897, and another paper on The Pre-glacial Decay of Rocks in Eastern Canada, was completed, and presented at the Toronto meeting of the British Association for the Advancement of Science, in August. Both the above communications were based largely upon the observations made by Mr. Chalmers in the course of his field-work.

On the 31st of May, Mr. Chalmers left Ottawa to resume his work in the field, returning on the 6th of November. It will probably be possible during the present winter to complete a general report for publication, including the work of two seasons, and giving a connected account of the gold-bearing deposits and their associated conditions.

The following is a preliminary report by Mr. Chalmers on the work accomplished during the past summer :—

Field-work during the season of 1897.

"The field-work assigned me during the season just closed was, briefly, the further investigation of some points in connection with the gold-bearing alluviums of south-eastern Quebec, with observations on

*See Annual Report, Geol. Surv. Can., vol. V. (N.S.) p. 22 Q.

the surface geology of the St. Lawrence Valley generally, including the glaciation, the Pleistocene changes of level, etc., the two last being regarded as of sufficient importance to warrant more systematic and detailed exploration and study than have hitherto been accorded them. To carry out this investigation properly it seemed necessary to make an examination of the whole St. Lawrence Valley from the Gulf to the Great Lakes. A portion of this work has been accomplished, although, owing to the extent and varied character of the region, not in as great detail as seems desirable. Sufficient has been done, however, to show in a general way at least, the character of the superficial deposits, and throw some light on a number of the problems pertaining to their origin. The great Pleistocene marine plain of the St. Lawrence—unequalled in North America as a field for the study of the deposits of this age and their fossil contents—was explored and traced out to its furthest limits in as many localities as time and circumstances would permit. The Pleistocene shore-lines which border it and rise in terraces, three or more in number, were levelled by aneroid from the seaboard as far west as Lake Ontario, and also, with some interruptions, along the Ottawa and Mattawa valleys to Lake Nipissing. In addition to these investigations some time was spent in endeavouring to work out the relations of the marine and lacustrine deposits, although with indifferent success. Discussion regarding these and other matters will have to be reserved for a detailed report.

Quebec—*Cont.*

"The information obtained respecting gold mining and development work connected therewith in the 'Eastern Townships,' during the past season will first receive attention.

Gold mining in the Chaudière Valley.

"*Gold Mining.*—Gold mining operations in the Chaudière Valley, and in the 'Eastern Townships' generally, have been somewhat restricted during the past season, owing to causes unnecessary to relate. In the first-mentioned district an advance has, however, been made and new methods of operating the alluvial mines there have been inaugurated. Two new companies have been formed—one called the Gilbert-Beauce Mining Company, whose object is to re-open and work the gold mines of the Gilbert River Valley; another, known as the Central Quebec Gold Fields Company, to explore the gravels of Rivière du Loup Valley. To carry on the work more advantageously in the Gilbert Valley, a scheme of draining the mines by an open-cut or trench has been adopted, the slope of the valley being sufficient to allow this to be done, an opening of twenty or thirty feet in depth affording an outlet to the drainage of that portion of the old pre-glacial channel above lot 15, DeLery. At the time of my last visit (November 4) this open cut or trench had been carried up stream to a point where it was from sixteen

Quebec—*Cont.*

to eighteen feet below the surface and tunnelling was in progress. The bottom of the pre-glacial river-channel, it was expected, would be reached at a depth of twenty feet, when sluicing for gold would commence. If this scheme is successful, the whole of the Gilbert River Valley above the point mentioned can be drained into this trench by gravitation.

Meule Creek.

"On Meule Creek, a branch of Mill River, Mr. Coupal has been washing for gold during the whole season, and is reported to be meeting with fair success.

Rivière du Loup.

"The Central Quebec Gold Fields Company, organized to work the auriferous gravels of Rivière du Loup, with Mr. Louis Gendreau, of Jersey Mills as manager, has sunk several shafts some two or three miles above the mouth of the river to a depth of sixty feet, reaching the pre-glacial gravels. Water came in so rapidly, however, that work had to be suspended until pumps were put down. Mr. Gendreau informs me that he found gold in the gravels near these shafts and nuggets of an ounce weight or more.

Dudswell.

"At Dudswell work has been in progress under the Rodrigue Mining Company during the whole season. In order to obtain a greater supply of water for sluicing it was found necessary to raise the dam formerly constructed near the source of Kingsley Brook. Further prospecting along this stream revealed the fact that gold exists in the gravels all along its channel nearly to the source. Gold has also been found in the bed of a small stream to the west of Willard's or Maynard's Brook. The facts at hand render it evident now that all the streams which flow off Dudswell Mountain contain gold in small quantities, and that the source of the precious metal is probably at or near the summit.

Sherbrooke.

"Reports having reached the office of the Geological Survey that gold was found in the rocks (Pre-Cambrian) of the Stoke Mountain range at Sherbrooke, an examination of the locality was made. Pits had been opened by blasting along the summit of a low ridge, and a number of the specimens obtained therefrom had been forwarded for assay to this office. In the autumn these were assayed for gold in the laboratory of the survey; but the results were negative.

"No further information is available respecting the Ditton gold mines. At Massawippi Lake nothing has been done during the past season.

Shore-lines of the St. Lawrence Valley.

"*Pleistocene Shore-lines of the St. Lawrence Valley.*—In the investigations regarding the height of the shore-lines, the St. Lawrence Valley was traversed from Orleans Island westward to Lake Ontario and to Lake Nipissing. Longitudinally, the valley may be said to rise from the estuary and gulf westward, its bottom preserving nearly the same gradient throughout till it enters the Lake Ontario basin. The lateral valley of the Ottawa also exhibits the same contours from its confluence with the St. Lawrence to Chalk River, west of Pembroke. From this point upwards the latter ascends more rapidly; but the river itself flows in a comparatively deep and narrow valley on the north side to Mattawa and beyond. This higher, broken, or undulating and wider valley of the Ottawa continues along the Mattawa River also till it joins the Nipissing Lake basin.

Quebec—*Cont.*

Contours of the valley.

"Transversely, the St. Lawrence Valley also ascends from the river northward and southward to well-defined limits, though apparently forming a level plain. Along its margins the shore-lines or terraces extend, abutting against higher slopes, usually in a series of three or more, the lower distinct, the higher often interrupted. These, like the bottom of the St. Lawrence Valley itself, have an ascending gradient westward, *i.e.*, up the valley. The gradient of the shore-lines rises more rapidly than that of the bottom of the plain, however; but neither is exactly uniform, as local uplifts or deformations occur here and there, or what may be termed a 'bulging up' of the surface. These when near the border of the marine plain seem to have affected the shore-lines, some of the local deformations apparently extending beyond the limits of the valley and its marginal terraces. The upward grade of the shore-lines westward is greatest on the north side of the Ottawa, increasing towards the region immediately north of the Great Lakes, although, from the lower end of Orleans Island, or rather from Cap Tourmente on the north, and St. Thomas on the south, westward to Montreal Island, they are of nearly equal height on both sides of the valley. The general or regional upheaval, however, has been on the whole tolerably uniform.

Method of work.

"The method pursued in tracing out the Pleistocene shore-lines was to proceed from the known marine fossiliferous beds outwards, towards the margin of the plain, and to follow those which extend along the slopes and face the open valley. This work had been in progress during 1895 and 1896* on the south side of the St. Lawrence from Métis as far west as Richmond or Shefford, in Quebec, the elevation of the highest being about as follows:—At Gaspé, 230 feet, at Ste. Flavie, 345 feet, at Trois Pistoles, 375 feet, at St. Anselme, 555 feet, at Ste. Henedine, 750 feet, and in the vicinity of Danville and Richmond, 895 feet. To the west of this, the shore-lines seemed on first examination to decrease in height, but a more careful exploration during the past season showed that this supposed descent towards Lake

Heights of shore-lines on south side of St. Lawrence.

* Summary Report 1895, p. 96 A.; Summary Report 1896, pp. 81-82 A.

Quebec—*Cont.*

Champlain, if any, is but slight. North-west of the Pinnacle in Sutton Mountain, and within a mile or two of the International boundary, the elevation of the highest shore-line was found to be about 885 feet.

Beaches in northern New York.

"In the autumn a cursory examination of the evidences of the post-glacial uplift was made along the northern slope of the Adirondacks as far west as the Iroquois beach. This is a beach which has been traced along the south side of Lake Ontario by Mr. G. K. Gilbert, and found to ascend from a height of 385 feet at Lewiston, N.Y., to 730 feet near Watertown. Thence it was taken up by Dr. J. W. Spencer and followed eastward to Fine and beyond, at the latter place reaching a height of 972 feet.*

"Ascending from the marine plain at Valleyfield, in Quebec, to Malone, N.Y., the slope was found to rise with a comparatively even surface to an elevation of 1100 or 1200 feet, and the superficial materials occupying it to be fine, stratified sand with gravel in places, forming ancient deltas and spits, and stratified clay beneath, resting on boulder-clay, the whole apparently identical in character and composition with the deposits upon the low-lying tracts. The slope faces the great St. Lawrence valley, and the streams have cut narrow, steep-sided, trench-like water-ways into the deposits, showing that they have been eroded recently, that is since the uplift took place. Westward from Cherubusco and Chateauguay stations (Lake Champlain and Ogdensburg Railway), as far as Lake Ontario and Watertown, N.Y., similar deposits were seen to occupy the district, evidencing submergence and deposition of sediments under water with subsequent uplift.

Differential uplifts.

"The inference deducible from the observed facts along the northern base of the Adirondack Mountains, is that a greater uplift may have taken place there than to the north-east of the International boundary, and perhaps even greater than to the west. A similar local uplift above the normal gradient, though much less in range, occurs in the height of the shore-lines between Ste. Julie and Richmond in Quebec. But that the north-eastern part of the Iroquois beach, at least, as levelled by Gilbert and Spencer, belongs to the same system of shore-lines as that which occurs east of Lake Champlain valley there seems now little reason to doubt.

Relation to Warren beach.

"To the west of the Adirondack Mountains, however, the shore-line or beach which seems to approach nearest to the height of the uppermost marine shore-line of south-eastern Quebec, is that named the Warren

* Bull. Geol. Soc. Am., vol. III., pp. 488-495.

beach. It has been traced from Skaneateles Lake, west of Syracuse, along the southern side of Lake Ontario and Lake Erie, its elevation being from 860 to 890 feet.* Quebec—*Cont.*

"On the north side of the St. Lawrence and Ottawa rivers, the shore-lines were traced from Cap Tourmente or Ste. Anne de Beaupré, where the height is 540 feet, along the ascending grade westward to Lake Nipissing. The upper border of the marine sediments can, in many places, be followed more closely and to better advantage on this side of the St. Lawrence; but it often runs in among the hills, forming a very irregular line. Generally, however, the border of the Pleistocene marine region is coterminous with that of the lake area of the Laurentides, the marine sediments having filled up all the smaller lake basins to the limit of submergence. North of Quebec city the highest shore-line is 560 feet; at the St. Maurice River, 670 feet; at Lake Maskinongé, 865 feet; at St. Jérôme, about 900 feet; at Lachute, 975 feet, and at Kingsmere Mountain, north of the city of Ottawa, about 965 feet. Between these two last points, there seems to be a part of the country which has not been raised to the same extent as that to the east and to the west of it, as no shore-lines have been observed at a greater height than about 825 feet. Lower shore-lines well preserved, occur, however, at two or three levels, and it may be that the higher exists there also, but owing to the fact that the slopes are usually covered by forest detailed examination was impracticable.

Shore-lines on the north side of the St. Lawrence and Ottawa rivers.

"On the north side of the Ottawa River, just above Allumette Island, sand and gravel terraces and benches were found at different levels up to a height of about 800 feet. The Ottawa for forty-five or fifty miles here, viz., from Allumette Rapids to Joachim Rapids is lake-like, and in places is said to be 200 feet deep or more. If the depth stated is correct then the bottom of the river in this part of its course lies as low as it does above the Chaudière Falls at the city of Ottawa, or lower. This fact, together with the general appearance of the valley at Calumet and Allumette islands, and from there to Joachim Rapids, would indicate that there may have been a sag or reduced uplift along this part of the river valley at least. Beyond Joachim Rapids the uplift seems to have been much greater as far as the divide north of Lake Nipissing. The Ottawa above Fort William, and the Mattawa also, run along the north side of the valley and have trenched their courses considerably below its level. Terraces and benches are therefore, rare on the north bank. On the south side, however, we find heavy beds of fine stratified sand underlain by stratified clay, the

Sand deposits.

* Bull. Geol. Soc. Am., vol. VIII, pp. 269-286. Geol. Magazine, December, 897. Science, vol. XI, 1888.

Quebec—*Cont.*

whole resting on boulder-clay, which, in places, protrudes in hummocks through the overlying series. Deposits of this kind are abundant from Madawaska River westward, and on the lower grounds contain Pleistocene marine fossils. They are especially noticeable along the Ottawa, Arnprior and Parry Sound Railway, between Killaloe and Barry's Bay, constituting sand-hills rising from 1000 to 1100 feet or more above sea-level. Denuded sand beds of the same series occur to the south of Deux Rivières, Canadian Pacific Railway, where they reach about the same elevation. The latter have been described by Mr. F. B. Taylor* but appear to be Saxicava sand beds, probably marking the upper limit of the Pleistocene submergence in this part of the Ottawa Valley.

Stratified deposits at Mattawa.

"At Mattawa, a fine, blue, stratified clay or silty clay, slightly calcareous, was found in sinking wells in the terrace to the west of the Canadian Pacific railway station, between the track and the river. The owner informed me that in one of the wells he passed through the following beds:—(1) Four or five feet of gravel and sand, and (2) sixteen feet of the clay or silt above described, without reaching its bottom. Concluding that he was not likely to find water there, he sank another well nearer the railway track and hill-side, passing through (1) gravel and sand, five or six feet; (2) clay, the same as described, about six feet; (3) sand and gravel, reaching water.

"These deposits show that at the close of the ice age, or during the Leda clay period, if the upper gravels and sands correspond with the Saxicava sands, quiet, deep waters existed in the basin where the Mattawa now joins the Ottawa River.

Beaches at North Bay.

"High-level beaches and terraces (1100 to 1200 feet), described by Mr. F. B. Taylor,† occur north of North Bay. Whether these beaches are marine, as first supposed by him, or not, is, for the present, left an open question. But the great sand and silt beds spread over the region up to a height even greater than that of the beaches, and to which the name of 'Algoma Sands' was applied by the early Canadian geologists, demand further investigation than has yet been given them.‡

Boulders of the Ottawa valley.

"*Boulders.*—The Ottawa valley is remarkable for the great quantities of boulders, as well as for the deposits of sand and gravel, which it contains. Some curious accumulations of these boulders were noted, *e.g.* at Rigaud Mountain,|| at Hull opposite the city of Ottawa, and at Mattawa

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* American Geologist, vol. XVIII., p. 114.

† Bull. Geol. Soc. Am., vol. V., 1893. Am. Geologist, vols. XIV. and XVIII., 1894 and 1896. ‡ Geology of Canada, 1863, pp. 907-908.

|| Geology of Canada, 1863, p. 896.

and other places, which evince the great denudation to which the materials of this valley have been subjected during, and at the close, of the Saxicava sand period, as the land rose from beneath the Pleistocene sea, as well as in the interval between that period and the present. Many of them have, doubtless, been transported by floating ice during the submergence of the region about the close of the glacial period and afterwards. Those at Rigaud Mountain seem to have accumulated in their present situation on the shore of the river from the sifting out of the finer materials at the time that the Ottawa debouched into the sea, when it was at or near this elevation. At Hull, the boulders are partly imbedded in a deposit of sand and gravel, probably the equivalent of the Saxicava sand, as beneath it, Leda clay, containing fragments of marine shells, was found by Mr. W. J. Wilson, of this Survey, and the writer. The Leda clay rests upon boulder-clay. At Mattawa the succession is the same, but no fossils have yet been detected in the clays there.

Quebec—*Cont.*

"The boulders of the Ottawa Valley seem, therefore, to have been brought to the surface by the denudation of the beds of which they formed a part, as the valley emerged from beneath the Pleistocene sea, and these beds became subjected to erosion by the Ottawa River. The upper portion of the series of deposits now found in the valley may be partly marine and partly fluviatile. Whether the upper Great Lakes once found outlet by the Mattawa-Ottawa Valley, is a question which cannot be entered into here.

Origin of the boulder beds.

"Along the Canadian Pacific Railway to the east of Toronto, viz., at Myrtle, Burketon and Pontypool, sand and gravel plains, consisting of water-laid materials, occur at a height of 1100 or 1200 feet. The sands are fine and clean, and form terraces filling in the inequalities of the boulder-clay surface beneath. No barrier exists between these plains and Lake Ontario.

Terraces and plains near Toronto.

"*Waterfalls.*—A remarkable feature of the St. Lawrence Valley is the number and beauty of the waterfalls in the tributary rivers, both on the north and south sides. These waterfalls appear, in many instances, to have been caused by dislocations of the rocks due to faulting, or orogenic, or regional differential uplifts. Examples of dislocations of this kind can be seen in the valleys of the Chaudière and St. Francis rivers in south-eastern Quebec, also on the north side of the St. Lawrence in the St. Maurice Valley at Grand Mère, and along other rivers. In very few instances could the origin of these waterfalls be traced to diversions of the rivers from in-filling of the pre-glacial channels by boulder-clay and sediments. None of the tributaries of the

Probable origin of waterfalls.

Quebec—*Cont.*

St. Lawrence, rising in or traversing the pre-Cambrian rocks on either side of the valley, have succeeded in reducing their channels to the base-level of erosion since the last differential upheaval of the region.

General upheaval of the region.

"*Extent of upheaval.*—The foregoing facts indicate that the general upheaval of the St. Lawrence basin in the Pleistocene period was differential throughout, increasing to the westward; but that portions of the region were besides raised higher than others locally, the uplift being somewhat unequal. The greatest upheaval seems to have been immediately to the north-east and north of the Great Lakes, and the maximum heights there will probably be found to be represented by a number of axes, or uplifted belts, not always trending in the same direction, but conforming more or less to the longer axes of these great bodies of water. It is probable that these uplifted areas, too, almost necessarily implying correlative subsidence in the same region, have a close relation to the lake-basins as regards their origin. Upward and downward complimentary movements of greater or less amount and complexity, with faulting and displacements, doubtless occurred. And it seems, therefore, not unreasonable to assume that it was at this stage of the Pleistocene that the lake-basins referred to attained their present form and dimensions and sank so far below the level of the surrounding country. The period at which this great upheaval of the region took place, appears to have been that of the deposition of the Saxicava sands, or rather during the latter part of that period. Had the Great Lakes existed in their present form and at their present depth from an earlier date, it is difficult to see why the deposition of boulder-clay, from glacial action, and subsequent sedimentation, when the thick beds of clay, sand and gravel found in the region were laid down, should not have partially filled in and raised the deep-lying portions of their basins to a higher level than they now have.

Agreement between ice-movements and post-glacial attitude of the region.

"Before leaving this subject, it may be remarked that the foregoing view respecting the changes of level to the north-east of the Great Lakes is in agreement with the facts regarding ice-movements in this region during the latter part of the glacial period.

Leda clay and Saxicava sand.

"Some time was spent in examining the Leda clay and Saxicava sand along the canals now being constructed and deepened, between Soulanges and Cardinal, on the north side of the St. Lawrence River, and the deposits from Brockville to Kingston were also critically examined. The excavations along the Trent Valley canal were visited, also the upper part of the Rideau canal.

"Within the Lake Ontario basin the clays were found to contain great numbers of limestone nodules or concretions, but no marine fossils have yet been detected in them. Quebec—*Cont.*

"*Glacial Striation.*—The glaciation of the St. Lawrence Valley was studied in considerable detail, and a large body of facts relating to that subject was collected. Previous observations on the south side of the St. Lawrence River had shown that three systems of striation by land ice were produced upon that slope during the glacial period, and one in the bottom of the valley by floating ice. *First*, a northerly ice-flow from the axial divide of the Notre Dame and Green Mountain range down to the bottom of the valley. East of the Chaudière River this ice flowed to the east of north, west of St. Francis River west of north.* *Second*, following this was an invasion of that region by the earlier Laurentide glacier, which spread over the slope up to an elevation of 1800 or 2000 feet, distributing Laurentian boulders upon it. *Third*, on the retirement of the Laurentide ice, local sheets moved down the slopes in different directions, as they were influenced by the contours. *Fourth*, floating ice striæ, produced by ice moving generally up the valley. These are, of course, found only within the limits of the valley and below the highest Pleistocene shore-lines. Striation. On south side of the St. Lawrence.

"On the north side of the St. Lawrence Valley, and on the Laurentian plateau, the oldest striation seems to have been that produced by the earlier Laurentide glacier referred to, the striæ of which were observed everywhere from the summit of the hills to the bottom of the valley. In many parts of the region this system is very much defaced—in some places entirely obliterated—from weathering and the action of later ice. Its general course is from S. 10° W. to S. 15° E.; but it often veers from S. 25° W. to S. 45° E., and has still more divergent courses in river-valleys. This system corresponds, for the most part, with that observed on the northern slope of the first range of mountains on the south side of the St. Lawrence River, (sometimes called the Sutton Mountain range,) that attributed to the earlier Laurentide glacier. The ice producing it did not cross the St. Lawrence River below the city of Quebec, but from the portion which occupied the St. Lawrence Valley tongues or lobes diverged eastward in different places—one flowing down the valley of St. Charles River and along the depression between Orleans Island and the north bank of the St. Lawrence, overriding the eastern portion of the island diagonally, but leaving the western and southern part unglaciated. Another swung round out of the Chaudière Valley among the ridges on the west side of that river and On north side of the St. Lawrence. Earlier Laurentide glacier.

* All these courses of striæ are referred to the true meridian.

Quebec—*Cont.*

flowed across the district drained by the Etchemin River, while a third crossed the divide above the head-waters of the north-west branch of the St. John, moving eastwardly towards the upper valley of that river. Other lobes or tongues entered New England by the valleys and passes along the International boundary, especially by Norton Mills, Hall Stream, Memphremagog Lake and Lake Champlain. The striæ of this older glacier are distinct in the latter basin, and have been also observed in the vicinity of Ogdensburg and other places in northern New York. In the Lake Ontario basin, the movements of this glacier, although in many places effaced, have been traced as far west as my examinations extend, *viz.*, to Tweed station and Peterborough, and in the Ottawa Valley to Lake Nipissing. The striation of this system does not seem to be as heavy as that produced by the later ice.

Later Laurentide glacier.

"*Later Laurentide Glacier.*—Succeeding this system of ice movements there was a second, which has left the most distinct striation met with in the region, especially on the north side of the St. Lawrence River and the Great Lakes. The general course of this ice-flow was between S. 30° W. and S. 65° W., and the striæ produced by it have been found superposed on those of the earlier Laurentide glacier in a number of places. From the fact that this system of striation occurs over a large area and with such a persistent trend, it would seem as if it must have been produced by a separate body of ice. It has been found as far east as the hilly country at Bonhomme Mountain, west of Quebec city, and along the St. Lawrence and Lake Ontario valleys as far as my examination extended, and was also traced throughout the Ottawa and Mattawa valleys to lake Nipissing. From the observations of others, it is known to be the dominant system along the north and north-east sides of the Great Lakes. Is this south-west striation due to land or floating ice? As seen in the St. Lawrence Valley from Montreal to Kingston, it certainly seems to have been produced by the latter agent, as it follows the course of the valley for the most part, and the exposures exhibiting the striæ are often scratched as if by means of a body touching the more prominent parts only, and not by one moving slowly over and accommodating itself to all the inequalities of the rock-surface. On the other hand, the height at which the striæ are sometimes found above sea-level, especially west of Quebec city, along the Upper Ottawa and in the region of the Great Lakes, together with their persistent south-west trend over a large area, especially west of Montreal and St. Jérôme, seem opposed to this view. Without coming to any conclusion at present in regard to this system of striation, I lean to the opinion that it has been produced by both agencies—in the St. Lawrence Valley proper, by floating ice; on the higher grounds, by land ice—the region to the south-west, as far as the Great Lakes, having apparently been lower relatively to the Laurentian area to the north at that stage of the Pleistocene than at present. Whether at any time during the interval between the maxima of these two glacier systems (assuming the last to have been partly land ice), there was a withdrawal of glacial conditions in Eastern Canada and an interglacial epoch, or whether the second really followed the first consecutively, the south-westerly flow having been caused by a subsidence of the region north of the Great Lakes after the first glaciation, are questions requiring further detailed work to enable me to decide. Provisionally, however, the ice producing this system will be referred to as the second or later Laurentide glacier, as it seems to have had its source also in the highlands to the north of the St. Lawrence.

Quebec—*Cont.*

"Striæ produced, to all appearance, by this second system, were noted on the south side of the St. Lawrence Valley at Ste. Julie, Arthabaska Danville, Shefford and Brome mountains, Sweetsburg and Pigeon Hill; also in numerous places between the Upper St. Lawrence and the base of the Adirondack Mountains.

Floating ice.

"There seems, however, to be another set of striæ in the St. Lawrence Valley, which leaves no doubt as to its having been produced by floating ice at the close of the glacial period when the region stood at a lower level. This may be a part of the second system or later Laurentide striation described above, although it was observed to cross those of the latter, as well as the striæ of the earlier system in some places. It is evidently due to the very latest ice which existed in the region, and is a continuation westward of those striæ along the Lower St. Lawrence described in reports and publications by Sir J. Wm. Dawson and the writer, the production of which is attributed to floating ice. The striæ of this system were observed at Lévis, Mount Royal (Montreal), St. Jérôme, Soulanges Canal, Valleyfield, Ogdensburg, N.Y., the Thousand Islands at Kingston, Perth and other places. The course is generally between south-west and west; but is often very irregular.

"Many other irregular courses of striæ were noted, some doubtless produced by land ice, others by floating ice. They belong, apparently for the most part, to the closing stage of the glacial period.

Crag-and-tail form of trap hills in St. Lawrence Valley.

"The stossing on the north-east brow of Mount Royal, Montreal, described by Sir J. Wm. Dawson* was found to be a common feature on all the isolated trap hills of the St. Lawrence Valley, Montarville or

* The Canadian Ice Age, p. 43.

Quebec—*Cont.*

Belœil Mountain, Mount St. Hilaire, Rougemont, Yamaska, and Johnson mountains, and Shefford and Brome mountains are all more or less abrupt and stossed on the north-east sides and have a crag-and-tail form on the south-west, with terraces and shore-lines. On the south-west side of Shefford Mountain ancient dunes and spits occur at a height of 865 to 883 feet. It is evident that there must have been strong currents flowing up the St. Lawrence Valley during the period of submergence, carrying drift ice which impinged heavily against these hills.

Soils of the region.

"*Agricultural character.*—The soils of the region everywhere bear an intimate relation to the underlying or subjacent rocks. In their present condition these soils are the result of a long series of degradation processes,—subaerial, glacial, marine, lacustrine and fluviatile—acting upon the rocks of the country, and the clays, sands, gravels, boulders, etc., entering into their composition, have often been transported considerable distances from their parent sources. An assortment of the materials constituting the soils has taken place in many districts by the agencies mentioned, the result of which has been to give those of some tracts a greater degree of fertility than pertains to others, nevertheless, their character in this respect is largely dependent upon the nature of the rocks from which they have been originally derived. Upon the great marine plain of the St. Lawrence Valley and the lower grounds of the region of the Great Lakes, where the superficial deposits are, perhaps more closely related to the limestones and slates of Palæozoic age underlying them, some of the best lands in Canada for general agricultural purposes are to be found. The principal portions of these in Quebec and Ontario are cleared and have been under cultivation for many years. Although more thickly settled than most other parts of the country, they, nevertheless, seem capable of supporting a larger agricultural population than at present subsists upon them."

HUDSON STRAIT.

Explorations in Hudson Strait.

As already explained, it was decided to take advantage of the despatch of the steamer *Diana* to Hudson Strait and Bay by the Department of Marine and Fisheries, to geologically examine and explore as much as possible of both shores of Hudson Strait. This work was entrusted to Dr. R. Bell and Mr. A. P. Low, the north coast being assigned to the first named gentleman. Dr. Bell being in Europe on leave of absence from February 1st to May 1st, the duty of looking after the building of two small yachts and other preparations for this work devolved upon Mr. Low, as elsewhere noted. Hudson Strait—*Cont.*

Dr. Bell reports as follows upon the exploration carried out by him during the summer :— Work by Dr. R. Bell.

"On the 19th of May I left Ottawa and arrived the next day at Halifax, from which place it had been arranged that the sealing steamer *Diana* was to convey Mr. A. P. Low and myself with our parties to Hudson Strait and to bring us back as far as St. John's, Newfoundland, at the close of the season which we might find suitable for field-work. The small yachts built for the work had already arrived at the wharf of the Department of Marine and Fisheries in Halifax. I engaged four men as sailors, one of whom was to be responsible for sailing the yacht and another was to act as cook in addition to his other duties. I had no assistant. The yachts, together with a small jolly-boat for each, were hoisted upon the deck of the *Diana* and we sailed from Halifax on the 3rd of June.

"Passing by the west coast of Newfoundland and through the Strait of Belle Isle, we met with considerable delay in the field-ice off the coast of Labrador, nearly abreast of Hamilton Inlet. On our entering Hudson Strait on the 22nd of June we found it entirely clear of ice. On proceeding up the northern side of the strait we were, however, again detained by ice close to Big Island, but the *Diana* completed her first run into Hudson Bay on the 12th of July. Outward voyage.

"It had been intended that I should explore as much as possible of the northern shore from the vicinity of King's Cape eastward, and that the *Diana* should pick me up to return home at some place of which the position had been already determined, because in the absence of any chart of the coast this precaution was necessary to avoid any mistake about the meeting place. To carry out this programme, it was decided that I should be landed from the ship near King's Cape, which is at the junction of the north shore of Hudson strait with the east side of Fox Basin, whence I was to work eastward to Ashe Inlet on Big Island. But on attempting to make the land in this vicinity on the 13th of July, the floe-ice was found to be moving about so rapidly, in consequence of currents, that the attempt was abandoned and we proceeded to King George's Sound on the south side, where Mr. Low and his party were placed on board their yacht. To explore the north shore.

"The best course which now remained for me was to begin work at Ashe Inlet and to proceed as far as possible to the north-westward, returning to the same place to meet the *Diana* at a date to be agreed upon, which was fixed for the 10th of September. Accordingly the

Hudson Strait—*Cont.*

Land at Ashe Inlet.

Diana brought me to Ashe Inlet on the 19th July, and my yacht was launched there on the 20th. The following day the wind blew too strongly for us to get out of the inlet and the time was spent in fixing its position relatively to other geographical features of Big Island, as a commencement of a track-survey of the coast. On the 22nd we made a start to windward, intending to pass up on the outside of Big Island. Before leaving the inlet, early in the morning, we fortunately found an Eskimo who had some knowledge of the English language and was acquainted with the south coast and the southern interior of Baffin Land, and I engaged him to go with us as guide and interpreter for the whole of our journey. He had slept near our anchorage and had nothing with him but a gun.

Eskimo guide.

"The hull of our yacht was made of one inch white-pine boards. She was, therefore incapable of contending with the ice, and our safety lay in avoiding it altogether. We had not gone many miles up the outer coast of Big Island, when we met an ice-pack laying in our course as far ahead as the eye could reach. Our Eskimo guide now advised us to try the passage between the island and the mainland, and accordingly we turned back and attempted to get round the south-eastern extremity, but on account of the wind failing us altogether we were able to make only about six miles to the south-eastward of Ashe Inlet. Here we discovered a much better harbour than Ashe Inlet, and I named it after Reeves, our sailing master. It is about a quarter of a mile in diameter, has two deep narrow entrances, a good bottom for holding and a depth of from five to fourteen fathoms at low water. The next day we rounded the south-eastern extremity of Big Island, which is about thirty miles long, but owing to a strong north-west wind we were obliged to anchor for the night among some small islands lying north-east of this point. It was fortunate that we took this route, as we found the family and relatives of our guide camped on the lower end of the island, and he was now able to make arrangements with them for his absence till September. He had not previously told us anything about his people.

Take inside passage.

Reeves Harbour.

"At this season of the year there was continuous daylight in Hudson Strait during the whole twenty-four hours, and we sailed at two o'clock the following morning (24th) and made a track-survey of the inner side of Big Island as well as of a part of the main shore opposite. Two good harbours were discovered on this side of the island towards the northern end, and two more on the coast of the mainland in this vicinity.

Four harbours discovered.

"In proceeding north-westward up the coast from Big Island the shore began to be fringed with innumerable rocky islands thickly clustered together. The breadth of the belt or archipelago increased as we advanced, until we approached the long inlet or fiord called Tcharkbach, where our exploration ended. Here the islands became less numerous. The maximum breadth of the archipelago is about midway between Big Island and this inlet, and is about twenty-five miles. The islands vary in size from ten miles in length down to mere rocks. The spaces between the large ones are filled up with smaller islands having a great variety of dimensions and forms. As a rule, the largest and highest islands lie towards the mainland, while the outermost ones are smaller and lower. In sailing among these islands it was only when near the outer edge that we could see a clear horizon to the southward.

Hudson Strait—*Cont.*

Archipelago, 25 miles wide.

"The whole coast is rugged and for the most part mountainous. The innermost islands interlock with the bays and points of the mainland in such a manner that it is impossible to know without the aid of a guide whether one has reached the main shore or not. On ascending the higher hills or mountains of the outer ranges on the mainland, long channels of the sea can be seen running inland in different directions among the hills, which so closely resemble those among the adjacent large mountainous islands that only a person already acquainted with the geography could trace the coast-line of the mainland. The larger islands are equally hilly and rugged and the channels between them are usually not wide. Viewed from the top of a distant hill, so that the intervening channels cannot be seen, the eye fails to detect any difference between the general appearance of the islands and the mainland. The conditions may be best described if we imagine a rough mountainous country, rising as a whole gradually to the northward, to have been half submerged. The outer islands, which are also the smallest and most scattered, represent the more completely sunken hills, while as we proceed inward the progressingly larger and larger ones represent the less and less submerged areas and ranges, until, at last, we find only narrow channels of the sea running into the solid land. Besides these narrow and sometimes tortuous channels, numerous wide and tolerably straight fiords run inland. These generally have high hills on either side of them.

Mountainous coast.

Many channels.

The islands.

"On leaving Big Island, it soon became evident that it would be impossible to make an instrumental survey of any considerable part of such a coast as this in the limited time that would be at my disposal, and that this time would be most advantageously spent in making the best track-survey possible under the circumstances, especially as it was necessary to devote a portion of the time to geological observation. I therefore determined to keep an accurate record of all the courses we

Character of survey.

Hudson Strait—*Cont.*

followed among the islands or up the fiords, under the guidance of our Eskimo pilot, and also as good an estimate as possible of the length of each course, plotting them on diagrams as we went along. On these diagrams the relative positions of all the surrounding points, bays, islands, hills, etc., were also marked by the aid of many cross-bearings and estimated distances. Observations for the latitude and the variation of the compass were taken every day and I also obtained numerous sights for longitude.

Astronomical observations.

Good harbours.

"The coast abounded in good harbours, and careful sketch-plans with soundings were made of all those that we visited. The heights of numerous hills, which I climbed, were ascertained by barometer. A sufficient number of photographs for illustration were obtained; collections of rock specimens and of plants and insects were made and notes were recorded on all subjects that might be of interest in regard to this little-known region, whether from personal observations or or from information supplied by the natives.

Observations and collections.

Weather.

"From the time of our leaving Ashe Inlet, on the 21st of July, until we returned to it again on the 1st of September, the weather was mostly fine and bright, although cold upon the water, but we suffered much delay from calms. The main obstacle to our progress, however, was the field-ice, which appeared to have come into the strait from the eastward during the winter or early spring, and to have insinuated itself into every channel and fiord. When not tightly packed, it was constantly moving hither and thither under the influence of the rapid and changeful currents generated by the high tides of the strait.

Calms and field-ice.

Tides of Hudson Strait.

"The height of the mean tide at Big Island was ascertained by Mr. Ashe to be 30 feet, and the time of high-water at full and new moon to be 9h. 32m. Further west we could not determine the time of high or low water, which was irregular on account, apparently, of the effect of the reflux from Hudson Bay upon the in-coming or out-going tide of the strait; while the local conditions, such as the directions, divisions, depths and widths of the channels still further complicated the problem. In trying to navigate our frail yacht in the open spaces, the heavy ice would set down upon us or run together and threaten to crush our little vessel in the most unexpected manner. Our undertaking was, therefore, constantly accompanied by great danger and anxiety, and it was only by constant vigilance night and day that we were fortunate enough to escape any harm during the entire trip.

Amadjuak Fiord.

"When we had reached a point a little beyond the entrance of Amadjuak Fiord, we found the ice closely packed among the islands all around us. But the next morning the wind or tide had opened a lane up the fiord itself and I explored it to its extremity. The ice outside still remained packed, and in order to utilize the time most profitably, I determined to make an exploration into the interior of the country. Two seamen were left in charge of the yacht with instructions to make lines of soundings in the fiord, and with the other two and the Eskimo guide, I started on a journey northward towards Amadjuak Lake, one of the bays of which was supposed to be at no great distance from this part of the coast. It proved, however, to be upwards of fifty miles inland. This journey occupied seven days, and the results will be described further on. When we returned to the head of the fiord, the sea was found to be open and we immediately set sail to continue the westward exploration of the coast.

Hudson Strait—*Cont.*

Journey inland.

"On the 22nd of August we had reached Tcharkbach Inlet, and in case of being detained by calms or head winds on our return journey, I judged it prudent to turn back from this place in order to be sure of being able to keep our appointment to meet the *Diana* at Ashe Inlet on the 10th of September. In returning I followed a course which lay outside of that of the westward journey, so as to make a second line of track-survey among the island belt and of the outside of Big Island. We had good weather and anchored again in Ashe Inlet on the 1st of September. In order to fill up the time with advantage till the 10th, I ran across to the main north shore opposite the island and explored it topographically and geologically nearly to Icy Cove. I then returned to Asle Inlet before the 10th, but owing to stormy weather, the *Diana* was not able to enter until the 12th. It only required two or three hours to transfer our outfit and surplus stores to the steamer and to dismantle the yacht and make her ready to tow across the strait to Fort Chimo, where I proposed to leave her, as it was not considered advisable to risk taking her to St. John's, Newfoundland, on the deck of the *Diana.* On the following morning we reached the northern extremity of Akpatok Island in Ungava Bay, and after coasting along the eastern side of the island we anchored close to the shore about half-way to the southern extremity. This afforded me an opportunity of landing in order to take photographs, examine the rocks, collect fossils and ascertain the heights of some of the cliffs and hills by the barometer. This was, so far as I am aware, the first landing of a white man upon this island. Its position and general form and direction are erroneously represented upon the latest charts. The hypothetical 'Green Island' of the charts corresponds with the northern part of Akpatok Island as determined by the observations of Captain Whiteley, and it is probable that this, seen from the northward, was mistaken for a different island.

Turn back from Tcharkbach Inlet.

Rejoin the *Diana.*

Land on Akpatok Island.

Hudson Strait—*Cont.*
Fort Chimo.

"At Fort Chimo, Mr. Low and his party were taken on board and the *Diana* sailed for St. John's on the 17th and reached that place on the 22nd of September. Leaving her at this port we reached Halifax by steamer, and there I paid off my men, disposed of some surplus provisions and reached Ottawa on the 11th of October.

Geology.

"*Geology.*—The rocks of the whole northern shore of Hudson Strait from Big Island and the coast of the mainland opposite as far north-west as Tcharkbach Fiord, belong to the Laurentian system. They consist of a variety of gneisses associated with numerous bands of crystalline limestones and light-coloured felspar rock, often of great thickness. These limestone and felspar bands are generally associated with gneissoid schists, full of graphite, fissile when weathered and stained brown, yellow and red by the decomposition of disseminated iron-pyrites. Small garnets are common in most of the gneisses. The strike is usually straight, with uniform dip, and it is parallel to the general trend of the coast, which is about north-west (astronomically.) The prevailing dip is to the north-east at angles which approximate to 45°, but sometimes the inclination is nearly vertical and occasionally it becomes almost horizontal.

Crystalline limestones and felspar rocks.

"The most notable feature of these rocks is the abundance and persistence of the crystalline limestone and felspar bands and their associated rocks. On this account and for other reasons the series may be considered as belonging to the higher part of the Laurentian system. Whatever theories may be suggested to account for the origin of similar crystalline limestones in other Laurentian districts, there is little doubt that in this region they are bedded or stratified rocks. On the mainland, nearly opposite the Spicer Islands, there is one band of these rocks which must be about 5000 feet thick, and other bands nearly as wide were observed on other parts of the coast.

Origin of crystalline limestones.

Extent of crystalline limestones.

"The south-western border of the limestone-bearing belt, appears to correspond with a north-westerly line passing through Big Island, the outer side of which shows no limestone. Between this island and Amadjuak Fiord, the light-coloured limestones are seen in the bare mountains in great abundance as far inland as the eye can reach, and in this section of Baffin Land the limstone-bearing belt may have a width of forty miles or more. On my journey northward from the head of the Amadjuak Fiord, which is at a distance of about twelve miles inside of the general line of the mainland coast, the limestones become scarce after passing over the first ten miles, and in the second half of this traverse they are not seen at all.

"These limestones are generally coarsely crystalline and they usually vary in colour from gray or light-gray to pure white, but sometimes they are reddish or flesh- and salmon-coloured. The Red Islands near the Spicer group are formed of coarsely crystalline limestone of this colour. The limestone and felspar are often mingled in the same band, and the two rocks have generally a rude parallelism to one another in a variety of irregular fashions.

Hudson Strait—*Cont.* The Red Islands.

"In addition to the gneiss, gneissic schists and limestone-felspar bands, I observed a few bands of quartz-rocks, some veins or dykes and small patches of coarse granite, an occasional bed of black hornblende-rock, pyroxenite on an island off Amadjuak Fiord. At the extremity of Fair Ness, some of the islets and points consist of a black-looking rock, of which the weathered surface resembles the form of a cauliflower on a great scale. The rough water and rushing tide prevented us from landing to examine this rock.

Various rocks.

"The economic minerals of the rocks above described, consist of the felspars and limestones, together with mica and graphite. The Eskimos of Big Island had shown me, both last summer and on previous visits, good specimens of the last two minerals, and had stated that they had brought them from one place on the main north shore opposite the island, but when I proposed to visit the locality last September, they said the owners of the discovery were absent, and nothing would induce them to point out the occurrence. A diligent search by myself and men in the vicinity indicated failed to reveal either mineral. Some specimens of vein-stones were collected at different places, to be assayed for gold.

Economic minerals.

"In the valleys on the way from Amadjuak Fiord to Lake Mingo, fragments of unaltered gray limestone were observed, sparingly at first, but becoming more numerous as we went inland, and towards the lake they began to be noticed upon the hills as well. On a mountain near Lake Mingo, one of these fragments contained two specimens of a species of *Pentamerus*, which is closely allied to *P. decusatus*, if not identical with that form. These limestone fragments are like the rock of Mansfield Island, which, from the fossils I collected there in 1884, appears to be of the age of the Niagara formation.

Fragments of fossiliferous limestone.

"The country between Lakes Mingo and Amadjuak, and on the south and east sides of the latter, is low and generally level, but by the aid of a powerful binocular, in looking from a height I could detect hummocks of the crystalline rocks rising here and there all over these plains.

Hudson Strait—*Cont.*

Levels of lakes.

"Our barometric observations seem to show that Lake Mingo may be only about 300 feet above the sea, and from my guide's description of the short river which discharges it into Amadjuak, I should judge that the latter is only slightly lower. Mount Mingo, overlooking both lakes, rises to a height of 666 feet above the lake of the same name. Fragments of the unaltered gray limestone are abundant on the shores of this lake, and from the description given by my Eskimo guide, who had walked over the ground in summer, I would judge that the Niagara limestone may occur in its north-western part, and also on the south and west sides of Lake Nettilling to the northward of it, this name meaning 'flat-floor.'

Flat country.

Trenton limestone.

"I have found fragments of limestone containing Trenton or Galena formation fossils on the floe-ice towards the north side of Hudson Strait (see report for 1884), and it is stated that Messrs. Power and Shaw, during the past summer, examined the Silurian limestones at the head of Frobisher Bay which had been previously discovered by Hall. In this connection I may mention that small icebergs are known to drift from this bay up the north side of Hudson Strait as far as I went, and some of the floe-ice which accompanies them probably comes out of the same bay.

Rocks of Akpatok Island.

"As stated above, the *Diana* coasted along the eastern side of Akpatok Island, Ungava Bay, when on our way from Ashe Inlet to Fort Chimo. The portion of the island which I saw (from the northern end to the middle of the east side) consists of unaltered gray limestone in horizontal beds, and it presents a perpendicular wall 400 or 500 feet high all along. This sea-wall is clean-cut and the beds appear thick and solid, but wherever their edges have been long exposed to the weather or in the hill-sides and ravines of the interior, they split up into thinner layers. Some fragments observed in one place had the appearance of lithographic stone.

"I was enabled to land opposite the place where the *Diana* anchored, as already mentioned, about the middle of the eastern side and I improved the opportunity to collect fossils which, however, were not abundant. Those obtained indicate the Hudson River formation. Just above the landing place, I ascertained, by the barometer, the height of a hill to be 700 feet, and I estimated others to the southward and a short distance inland to be 200 feet higher, so that this formation must here have a thickness of 900 feet above the sea-level, and there is possibly a great additional thickness of Cambro-Silurian rocks beneath the sea-level.

Hudson River formation.

Glaciation.

"On the north side of Hudson Strait, the evidence of glacial action is everywhere conspicuous, and, except on the higher levels, the effects of former submergence may be observed in many places. The glacial striæ are best seen in the valleys, but they are also common on the hill-tops. The general course of the ice-movement has been from the interior towards the strait, with a tendency to turn eastward on approaching the latter. Ancient shore-lines were noted at various levels up to about 600 feet above the sea. Shells of a few common species of marine mollusks occur in stony clays in several places, the highest noted being about 200 feet above sea-level.

Hudson Strait—*Cont.*

Ancient shore-lines.

"The effects of the action of land ice in former times, may be observed in the form of moraines of different kinds, and heaps and even small hills of boulders without any admixture of fine material, besides the boulders and broken fragments of rocks which are scattered everywhere over the valleys and hills or perched on their sides. Ridges and large mounds of coarse gravel, taking a variety of forms, were met with in some of the valleys between the strait and Amadjuak Lake. Occasional deposits of coarse sand were also seen in the bottoms or on the sides of valleys in this part of the country. Nothing that could be called soil was observed in any part of the region examined.

Moraines and boulders.

"I collected about 200 trimmed rock-specimens, about 90 fossils on Akpatok Island, 460 specimens, (embracing upwards of 100 species) of land plants, already determined by Professor Macoun, 60 specimens of Lepidoptera which have been submitted to Dr. James Fletcher, a fine walrus skull and some other bones, besides geological specimens in addition to the above, and a few objects of ethnological interest. A considerable number of photographs were also taken to illustrate physical and geological features of the country examined."

Various collections.

During the early part of the past winter, Mr. Low was engaged in mapping the surveys made by him during the previous summer, in order that they might be added to the north-west sheet of the Labrador map. Later, he was occupied in writing a report on the explorations of 1896 in the northern part of the Labrador Peninsula between Hudson and Ungava bays. In March he was sent to Nova Scotia to arrange for the building of two suitable small yachts to be used during the coming summer in the exploration of the shores of Hudson Strait. The dimensions of the yachts decided upon as best suited for the work were, 35 feet in length, 10 feet beam and a draught of about 3 feet; with accommodation below deck for five men. They were built at Mahone Bay, and proved entirely suitable for the work.

Work by Mr. A. P. Low.

Hudson Strait—*Cont.*

On his return to Ottawa, he was kept busy attending to the details necessary for the fitting out of his own and Dr. Bell's parties (in the absence of the last-named gentleman) until the time arrived for his departure to join the steamer at Halifax.

On his summer's work Mr. Low reports as follows :—

Leave for Hudson Strait.

"I left Ottawa for Halifax on the 14th May, to take over the yachts from the builders and to purchase supplies and outfit for Dr. Bell's and my own party. Everything was shipped on board the *Diana,* the sealing steamer chartered by the Dominion Government, and we left Halifax on June 3rd, carrying the two yachts with their attendant small boats on deck.

Members of party.

"My party consisted of Mr. G. A. Young, who again performed the duties of assistant in a highly satisfactorily and efficient manner, a sailor and carpenter, and a cook. It was proposed to add an Eskimo interpreter to the crew, but owing to the quantity of ice met with along the Atlantic coast of Labrador, it was found impossible to get near any of the places where such a man could be engaged, and in consequence the crew was completed by the loan of a sailor from the *Diana,* through the kindness of Commander Wakeham. On account of obstruction, due chiefly to ice, we were not landed from the *Diana* until July 16th, in a bay called Douglas Harbour, situated on the south side of Hudson Strait, about 150 miles from its western end. The yacht having been got overboard and the outfit and provisions stowed away, the *Diana* left us, with instructions to meet her at Fort Chimo on September 15th. Douglas Harbour is about sixteen miles long and is divided nearly half-way up, into two narrow arms. The surrounding country is high, rough and barren, without any trees, the only vegetation being dwarfed arctic mosses, and flowering plants which were in full bloom at the time and partly covered the hillsides with a gorgeous display of colour. We remained six days in this bay, thoroughly exploring it, and also making excursions inland from the head of the south-west arm. The interior country is exceedingly desolate when viewed from the top of the higher hills, some 1500 feet above sea-level. It has the characteristic outline of the glaciated Laurentian region, low rounded hills formed into long broken ridges, with small narrow lakes dotting the valleys between. The vegetation is not sufficient to mask and soften the surface, and in every direction the bare rock is seen, strewn over with innumerable blocks and boulders of all sizes. The lack of trees and the presence of numerous patches of snow and ice in the valleys with a northern aspect, enhance the desolation of the view. The winds blowing off the

Douglas Harbour.

Character of the country.

highlands into the narrow reaches of the bay were always strong and gusty, sweeping down in squalls that often tore the surface of the water into miniature waterspouts. This, together with the amount of floating ice in the bay, caused considerable delay and occasional danger in the navigation of the yacht. Hudson Strait—*Cont.*

"Leaving the bay with a strong gale, we explored the coast twenty-five miles eastward, to the next large inlet called Fisher Bay, which lies immediately south of Prince of Wales Island. About a dozen families of Eskimos were found camped near its mouth, where they were engaged harpooning white porpoises and seals for their winter supply of oil. These people were dressed wholly in hairy skin clothing, without any shirts or other garments bought from the shop at Fort Chimo, where they send picked men, with dog-teams, in the spring, to trade their year's hunt for tobacco, powder and shot. They were supplied with guns, and some had rifles, but the rest of their outfits were of native manufacture. Every man had a kyack, the frame of which was made from wood hauled several hundred miles from the southward for that purpose. Their encampment consisted of five seal-skin tents, set up on a rocky hill-side covered with boulders. Most of them were located on an ancient beach, made up of rounded boulders from four to eight inches in diameter, directly on which the deer-skin beddings were spread, making a somewhat hard and lumpy bed. All were anxious to trade, but had nothing to exchange except a few seal-skins and some oil, having already disposed of their furs at Fort Chimo. As we could not use any of these articles, we presented each individual with a piece of tobacco for allowing us to take their photographs. Tobacco is a most highly prized article, as they all offered to exchange any and all their possessions, including clothing, boats or hunting implements for it, and did not appear to greatly want anything else that we possessed. It is used for smoking, chewing and snuffing by men, women and children; mothers passing their pipes to small infants carried in the hoods of their coats, and it was amusing to see the youngsters set up a howl when the mothers took their own turn at the pipe. These people, like the other Eskimos met along the coast, are rather above than under the average height of Europeans, but appear much shorter owing to the clumsy, hair-covered clothing worn by them. Fisher Bay. Eskimo.

"Having examined Fisher Bay and found a good sheltered anchorage for ships behind its islands, we left next day and proceeding south-east along the coast entered Wakeham Bay, ten miles farther on, and sailed up it twenty miles, to its head. This bay varies from half a mile to five miles in width, and penetrates into the same high, barren country. Returning the next day to near its mouth, we found the Wakeham Bay.

Hudson Strait—*Cont.*

entrance blocked with ice that was driving into the bay with a north-east wind, then blowing. Finding it impossible to get the boat through this barrier, we anchored in a small bay on the south side near the outlet, where the currents kept the water comparatively free from ice.

Detention by ice.

The wind continued from the same direction for several days, all the time forcing a steady stream of ice into the bay, so that by the third day it was completely full and we were forced to ground the yacht at high-water in order to escape being crushed by the heavy ice, often more than twenty feet thick. On the fourth day, the wind died out at evening, and taking advantage of a narrow belt of partly open water along shore, we towed the yacht out of the bay into a small cove facing the strait, about four miles away. The yacht had several narrow escapes from crushing between large 'pans' moving about with the strong currents and eddies, and her sides were badly scarred by contact with the ice. In our new harbour, we were again forced on the beach and remained ice-bound for three days longer, until a steady wind from the westward opened the ice along the coast and permitted us to sail, through narrow lanes of water, twenty miles eastward, to Cape Prince of Wales. Rounding the cape, we anchored in Stupart Bay, where the house, used as an observation station in 1884-86, was found in a good state of preservation, but quite unfit for future use owing to its filthy state, the natives having used it as a store-house for oil.

Character of the coast.

"The coast from Douglas Harbour to the vicinity of Cape Prince of Wales, is high and rocky with few islands and with deep water close in shore, so that there is little danger in approaching it with large vessels, while excellent shelter and anchorages are to be found in all three of the large bays explored. As Cape Prince of Wales is approached, the land becomes lower and the highest hills do not rise more than 500 feet above sea-level. The water at the same time becomes shoaler, and small islands render the approach to the coast dangerous. At Stupart Bay we had our last experience with floating ice on the 2nd of August. After that date very little ice was seen, none of it being near the course followed by the yacht.

Coast south of Stupart Bay.

"From Cape Prince of Wales, the general trend of the coast is south for upwards of twenty-five miles; the shores are comparatively low and the country behind seldom reaches an elevation of 500 feet. The coast is indented with a number of shallow irregular bays, the two largest being called Whitley and Joy bays. Both are dotted with islands at low-tide, and are largely obstructed by reefs and bouldery shoals; while a wide margin of boulder-strewn, muddy flats, extends outwards from high-water mark. This is a dangerous coast for vessels, owing to the hidden obstructions and the strong currents caused by the tides, which have a rise and fall of more than 30 feet. The general direction of the coast next changes to nearly east; and with a rise in the coast and country in rear, the water again becomes deep. These conditions continue for fifty miles, to Diana Bay; the intervening shore-line being indented by many bays, none of which afford shelter from a north or north-east wind. Diana Bay is about fifteen miles wide, but appears from seaward to be two bays, owing to the large island lying in its mouth. It is nearly twenty miles long and towards its extremity the water is shallow with a number of rocky islands and shoals. The general level of the country falls from over 1000 feet to less than 200 feet on the east side of the bay, where a flat point from five to ten miles wide only separates it from the entrance to Ungava Bay.

Hudson Strait—*Cont.*

"We finished the exploration of Diana Bay and arrived at Cape Hope's Advance, or Prince Henry Foreland, on August 10th. From here the trend of the coast is southward, forming the west shore of Ungava Bay. A wide fringe of rocky islands extends along the shore for thirty miles from the cape; the water between them being so shallow that they are practically joined to the mainland and to one another when the tide is low. Outside the islands the water continues shallow for a considerable distance, and the bottom is lumpy, rendering approach dangerous. The coast is low and is broken into numerous wide, shallow bays, that at low-water show great expanses of boulder-strewn flats. The country behind is nearly flat, being broken only by a few rocky ridges none of which are over 300 feet high.

Coast south of Cape Hope's Advance.

"For the next forty-five miles, to the mouth of Payne River, similar conditions prevail, except that the islands are fewer and there is consequently less shelter for small craft. We encountered considerable difficulty and some danger in coasting along this shore, owing to the great rise and fall of the tides and the strong currents caused by this. As an example, it may be stated that one night we anchored in 42 feet of water between some small islands, and after an exciting time, caused by the yacht swaying and jerking at her anchor chain, we grounded for a short time on a mass of boulders in a tidal current running six or seven miles an hour. On another occasion, we were forced by stress of weather into a small rocky cove at the head of a wide bay, where we beached the yacht near high-water mark and remained for two days. The appearance of the bay at low tide was astonishing, the water retreated about three miles, leaving an uneven bottom of mud and reefs covered with innumerable boulders, some of which were the size of a small house. At high-tide the bay became a mass of foaming breakers.

Hudson Strait—*Cont.*
Payne River.

"The mouth of the Payne River is situated exactly on the 60th parallel of north latitude. The bay into which it empties is about twelve miles, proper, wide and is full of shoals and islands. The mouth of the river is about twelve miles up the bay, where it is over two miles wide. From its mouth it gradually narrows, so that it is only a mile across eighteen miles up, where a reef, connecting a small island with both shores, causes a heavy shallow rapid up and down stream with the rise or fall of the tide, and we had a critical experience in passing with the yacht. Above the rapid the river is deep and navigable for about twelve miles to where it is blocked by a ridge of boulders stretching obliquely from shore to shore. At low-tide there is a fall of eight feet at this place, the water passing down by a number of small channels between the boulders. The volume of fresh water discharged was estimated to be about equal to that of the Gatineau River at Ottawa. The Eskimos met with on the river, informed us that it divides into three branches a few miles further up and that one of the branches flows out of Payne Lake some miles to the westward of the upper rapid. There are no direct falls on the river as far as the lake, but the current is often very swift, with a number of rapids. This is the only important river flowing in along the coast between Douglas Harbour and its mouth. The numerous other streams seen entering into the heads of the several bays were all small, and none of them could be more than thirty miles in length. This would lead to the conclusion that the land along the coast is higher than the interior, and that the main drainage is away from the northern coast toward the southern interior, and thence east and west into Ungava and Mosquito bays. This inference is borne out by the statements of the natives, who report that the country to the west and south of Payne River is a comparatively low plain, where the barren-ground caribou feed during the summer.

Character of the interior.

"The Eskimos were on their way to the caribou grounds in order to procure skins for their winter clothing and bedding. They stated that in September, the caribou would be found crossing the river in great bands on their way southward, and that, as usual, they would kill all they required by spearing the animals in the water from the kyacks. A quantity of large trout were seen at the upper rapid but they would not take either bait or the fly. Some were obtained from the Eskimos near the mouth of the river, where they were caught in nets, and they proved to be the same as those taken at Fort Chimo, being not the ordinary southern sea-trout, but a larger arctic species, or Hearne's salmon, which is found abundantly in all the northern rivers. The natives informed me that both trout and the Atlantic salmon were usually

Fisheries.

plentiful in Payne River, but none of the latter were caught in the nets while we were on the river. Hudson Strait—*Cont.*

"It may be mentioned that the salmon fishery in the rivers of Ungava Bay was almost a total failure in 1897, the catch at the different Hudson's Bay posts being less than a quarter of the average catch. Ice in Ungava Bay and clear calm weather during the time the fish were passing into the rivers were the only reasons given for this failure. Failure of the salmon fishery

"We left the mouth of Payne River on August 19th and continued southward along the coast. The danger of shoal water over an uneven bottom, gradually forced us away from the mainland, so that for forty miles we could not get within four miles of the shore and only landed on the outer islands. For this reason we could not explore Hope's Advance Bay, which is shown on the maps as a great inlet free from islands, extending westward more than sixty miles, with a breadth varying from ten to twenty miles. Looking for some such conditions, we passed the bay without knowing it, as its entrance is blocked with large islands and none of the channels between them are more than three or four miles wide. From information obtained from the natives, Hope's Advance would appear to be about ten miles wide and not more than thirty miles long, while the water at its mouth is so shallow that no large vessel could enter it without great danger, especially as the tide sets in and out through the shallow channels at an astonishing rate. Hope's Advance Bay.

"About fifty miles south of Payne River and to the southward of Hope's Advance, the land becomes higher and is thrown into sharp ridges with steep slopes to the westward. Innumerable islands of all sizes so mask the shore for twenty miles from Hope's Advance, to the mouth of Leaf River, that it is impossible to distinguish the mainland. According to the statements of the captain of the Hudson's Bay Company's yawl, who makes an annual trip to Leaf River for the porpoise fishery, the river is reached through a narrow channel between steep rocky cliffs, connecting the head of a long bay with Leaf Lake. The lake is a large body of salt water, some ten miles wide, that stretches from twenty to thirty miles both south-east and north-west from the entrance. The river flows into the lake almost directly opposite the outlet and is about equal in volume to Payne River. From the entrance to Leaf Lake to the mouth of the Koksoak River, a distance of about fifty miles, only a few islands occur along a more regular shore, that rises slowly inland to a general elevation of between 200 and 300 feet. The navigation along this coast is not difficult, as the water deepens gradually to six or eight fathoms within a mile of the beach; the only drawback is the absence of any convenient Leaf River.

Hudson Strait—*Cont.*

harbour for small craft. We reached the mouth of the Koksoak on the morning of August 24th, and ascended it thirty miles to Fort Chimo on the rising tide in the evening. The Hudson's Bay Company's steamship *Erik* was found anchored opposite the fort, having arrived from Churchill on the 20th, the earliest arrival on record.

Fort Chimo.

"We remained at Fort Chimo, making a few necessary repairs to the yacht, until the 27th, when we left to continue the exploration as far as George River, in the south-east corner of Ungava Bay, about 100 miles east of the mouth of the Koksoak. Before leaving, arrangements were made with Captain Gray, of the *Erik*, on our return, to transport the yacht and equipment to Nachvak, in order that it might be available for future use. Our course was due east from the mouth of the Koksoak for about twenty miles, past the mouth of False River, a long, shallow bay that has been taken for the entrance to the Koksoak by several vessels. We then turned south along the western side of a mass of shoals and rocky islands that extend nearly twenty miles outward from the mouth of Whale River, and ascended that river about eight miles to the small Hudson's Bay post situated there. The river, as far as the post, is about a mile wide, but it soon becomes much smaller, and beyond tide-water it is only a medium-sized stream, not comparable in length or volume with the Koksoak or George rivers.

Whale River.

Character of coast between Whale and George rivers.

"We left Whale River by its eastern channel, which is only navigable at high-tide, and continued along the coast in a north-east direction sixty miles, to the mouth of George River. Three large bays were passed on the way, each having a small river flowing in at its head. Along this portion of the coast, low rocky hills extend inland from high-water mark, and soon rise into the irregular uplands that are nearly 1000 feet above sea-level. Between high- and low-water marks there is usually a wide interval of mud, covered with boulders, and the large bays are practically dry at low water. Except in the vicinity of George River, few islands are found, and consequently there are no harbours where shelter can be obtained without grounding the boat.

George River.

"The George River is nearly eight miles wide at its mouth, but it soon narrows to about three miles, and twelve miles up it is about a mile and a half wide. From here to the Hudson's Bay post, some twelve miles further, it varies from one to two miles in width. According to information obtained at the post, a short distance above, it narrows to less than a mile, becomes swift and shallow and is broken by a rapid at the head of tide some ten miles above the post. Above tide-water the stream is less than half a mile wide and is very shallow, with a constant swift current for a long distance to a large lake, which it passes through. Its head-waters are in a number of large lakes situated to the north of Michikamau and the Hamilton River, in the centre of Labrador. Hudson Strait—*Cont.*

"Having finished the exploration to George River, we returned to Fort Chimo, reaching there on the 4th of September. We immediately stripped the yacht for shipment on the *Erik*, which sailed on the 8th. We then awaited the arrival of the *Diana*, on the 16th, and left Fort Chimo on the 18th. After a pleasant and uneventful trip we were landed at St. John's, Newfoundland, on the 25th. Taking advantage of a freight steamer calling at Halifax we left St. John's on the 27th, landed at Halifax on the 30th and reached Ottawa on October the 2nd. Return journey.

"Among the results of the expedition may be mentioned the exploration and survey of 650 miles of coast, most of which was practically unknown, while the remainder had been only roughly charted by passing ships. The rocks along the coast were examined in many places, and, although work in detail could not be undertaken, sufficient information was obtained to show that only the older formations are present, and it is thought that a study of the large collection of rock specimens brought home will show that the only formations represented in this portion of Labrador are the Laurentian and the so-called Cambrian, the former consisting chiefly of various granites and granite-gneisses, the latter of a more or less altered series of bedded schists and gneisses associated with basic eruptive rocks. These schistose rocks are often penetrated by numerous quartz veins, and their proximity to large masses of igneous rock are conditions favourable for the occurrence of gold. Specimens from a number of promising looking veins were brought home and are now awaiting examination. Along with the schists are large beds of impure iron ore which appear to correspond to the enormous deposits of bedded iron ore already found in the less altered Cambrian rocks of the Koksoak and Hamilton rivers. The schists and gneisses are usually highly garnetiferous and in many localities dark-red garnet crystals upwards of an inch in diameter were observed. About three-fourths of the coast explored appeared to be occupied by the granite and granite-gneisses, the remainder being schists and their associated basic eruptive rocks. Geological information.

"The glacial phenomena observed point to a total covering of the country by an ice-cap that flowed outwards to the sea, most of the glacial striæ having a direction transverse to the general trend of the coast where they occur. The land along the coast has risen about 400 feet since the time of glaciation, that being the elevation above the present sea-level of the highest terraces and beaches fronting seaward. Glacial phenomena.

Hudson Strait—*Cont.*

The upward movement of the coast in modern times has been very little, if any, as no evidence of such motion was noted.

Collection of plants.

"A large and nearly complete collection of lichens, mosses and flowering plants was made by Mr. Young, and although little new material was secured, the range of many species was extended. During delays caused by ice and wind, dredging operations were carried on to a depth of twenty fathoms, and an interesting collection of arctic sea life was obtained and brought home for determination.

"The usual meteorological observations were taken three times daily, together with the surface temperature of the sea, and notes were also made on the condition and nature of the ice-pack while it lasted. Photographs were taken of all interesting objects, giving a good idea of the general scenery and of the rocks, and also affording a pictorial census of the Eskimo living on the coast from Douglas Harbour to Fort Chimo, together with their houses, boats and other effects."

NEW BRUNSWICK.

Work by Prof. L. W. Bailey.

Professor L. W. Bailey, having completed the geological examination of south-western Nova Scotia in 1896, so far as to admit the writing of a general report on the area (now in the press), was last summer requested to undertake a general re-examination and review of the minerals of economic value in the province of New Brunswick. His completed report on this subject will undoubtedly form a useful handbook of the mineral resources of the province, in regard to which frequent inquiries are received. Professor Bailey's account of the work accomplished with preliminary notes on certain minerals, is as follows:—

Plan of operations.

"In accordance with your letter of instructions, dated the 26th of May, 1897, the purpose of my investigations in New Brunswick was to obtain the most recent and trustworthy information respecting mineral developments of economic value throughout the province, with the object of compiling a general account of such resources for the public information.

"With a view to the above result, examination having first been made of the data in the possession of the Mining Branch of the Department of Crown Lands in Fredericton, and correspondence sought with parties interested in mineral development, personal visits were made to all localities throughout the province which seemed to afford any promise of useful information. These localities include the Newcastle coal-field; the granite quarries of Hampstead, Weldford, Bocabec and St. George; the freestone and grindstone quarries of Hopewell (Albert county), Newcastle (Northumberland county), Stonehaven and New Bandon (Gloucester county); the gypsum deposits of Hillsborough (Albert county) and Tobique River (Victoria county); the bituminous shale and albertite deposits of Albert and Westmoreland counties; the manganese deposits of Tattagouche River (Gloucester county), Markhamville and Jordan Mountain (King's county), and Shepody Mountain and Dawson Settlement (Albert county); the iron ores of Jacksontown (Carleton county) and Lepreau (Charlotte county); the nickeliferous pyrrhotites of St. Stephen and La Tete (Charlotte county); the copper-bearing rocks of Grand Manan, Adams Island, Simpson's Island, Magaguadavic River, Beaver Harbour and La Tete (Charlotte county), and those of Alma, Point Wolf, etc., (Albert county); the antimony deposits of Prince William (York county), and the limestones and graphites of St. John. New Brunswick—*Cont.*

"A canoe exploration, of a fortnight's duration, was made of the Serpentine River, a branch of the Tobique River, where discoveries of gold had been reported. Serpentine River.

"Information was also sought and obtained as to a variety of substances which, though not of the nature of ore or rock-deposits, as ordinarily understood, possess a commercial importance. These include brines and other mineral waters, petroleum, peat, infusorial earth and other siliceous deposits, clays and sands.

"In the majority of instances the substances and localities above enumerated have been long known, and little that is new is to be gathered concerning them. The difficulty of so doing is further enhanced by the fact that while in but few instances the several deposits have been sufficiently exploited to enable one to form any just conception of their extent and value, even those which have been more fully opened and which, like the Albert Mines and manganese beds of Markhamville, gave for a time remunerative returns, have apparently become exhausted, and having been abandoned, afford now no opportunities for further study. To so great a degree, indeed, does this condition of things prevail that, excepting the operations in building and ornamental stones, in coal and gypsum, one locality only (that of Dawson settlement, in Albert county) can be named where anything like systematic mineral development is now in progress. Minerals now actually worked.

"That the above statement should be, in view of the great variety of useful minerals represented and the geological conditions, equally varied, under which they are found, is not a little remarkable, and can only be accounted for on the supposition that the agencies con- Causes deterrent to mineral development.

New Brunswick—*Cont.*

trolling such conditions have failed to produce here their usual results,—results, too, which find abundant illustration in the neighbouring provinces of Quebec and Nova Scotia,—or that our knowledge upon the subject is still very incomplete. That the latter belief is the more probable (and that with no discredit to the officers of the Geological Survey) will be readily understood, when it is remembered that a large part of the province, and nearly the whole of the portion likely to be most productive of useful minerals, is still covered with unbroken forest, while it has not been the work of the geological surveyors to undertake systematic prospecting. Until this is done, it is impossible to form any just conception of what the mineral resources of the province really are, and plans are now under consideration by the provincial government, by which it is hoped that such knowledge may be obtained.

Influence of new processes and methods.

"It is also important to observe, in this connection, that recently introduced processes of manufacture or the application of products in new directions, may at any time give value to substances previously considered as worthless, or nearly so. The following examples, based on recent information, afford good illustrations of this:—

Iron.

"*Iron.*—The hæmatite deposits of Carleton county have been long known and were at one time the basis of somewhat extensive operations, the manganiferous ore proving to be especially well adapted for the manufacture of steel, thus anticipating the subsequent employment of spiegeleisen for a like purpose. It carried, however, also a considerable proportion of phosphorus, and this, together with the increasing scarcity of fuel, was the main cause of its abandonment. By the introduction of improved methods of working (especially the basic process of Thomas and Gilchrist), the presence of phosphorus is now of far less importance, and ores previously regarded as worthless on account of its presence, are becoming available. It is doubtful whether, under existing circumstances, the Woodstock ores could be worked with profit, but, the above facts being taken into consideration, they at least deserve to be ranked among possible reserves.

Manganese.

"*Manganese.*—The ores of this metal are another admirable illustration of the increased value given to comparatively useless materials as the result of new methods and directions of application. While the deposits of manganese formerly mined somewhat extensively at Markhamville, and which from their purity and large oxygen-content were so highly esteemed for chemical purposes, have apparently become exhausted, a low-grade ore, in the form of wad or bog-manganese, which a few years ago would have been regarded as worthless, or nearly so, and which is still worthless for the uses referred to, now promises to become the basis of a comparatively new and important industry, viz., the manufacture of ferro-manganese, an alloy largely employed, if not essential, in the economic manufacture of steel. The deposits which it is proposed to employ in this way are situated in Dawson settlement, in Albert county, where they cover an area of about seventeen acres, with a thickness varying from a few inches to thirty-five feet. The material is a fine, jet-black powder, quite free from pebbles or other foreign matter, and carrying about 45 per cent of manganese, with a little iron and silica, and only a trace of phosphorus. The average value of the ore is about $13 or $14 per ton (while that of Markhamville ranged, in its higher grades, from $70 to $80 per ton), but would not possess even this value except through the operation of a special process whereby the incoherent powder is cemented and compressed into solid briquettes, capable of ready transportation and of direct addition to the iron of the Bessemer furnace. A large plant has been erected for the production of these briquettes, which are loaded directly on a short branch railway connecting with the Harvey and Salisbury Railway, by which and by the Intercolonial Railway, they are to be forwarded to Bridgeville, N.S., to be there used in connection with the plant of the Pictou Charcoal Iron Company, both plants being now the under control of the Mineral Products Company of New Brunswick. The cost of the plant at Dawson settlement, including the branch railway of about one mile and a half, is said to have been about $30,000. New Brunswick—*Cont.*

"*Pyrites and Pyrrhotite.*—Deposits of these minerals, usually regarded as of but little value, have for some years been known to occur in the vicinity of St. Stephen in Charlotte county, and at times have aroused considerable interest on account of the fact of their yielding nickel, in this as well as in other respects bearing a somewhat close resemblance to the deposits of these minerals found at Sudbury, in Ontario. It is not yet known that the percentage of nickel in the St. Stephen deposits will in any part average as high as those of the locality last-named, or even sufficiently high to admit of profitable extraction (a point which is now under examination). Apart from this question, however, one cannot pass over the extensive tract occupied by the pyrrhotite and pyrite deposits, of which the thickness is still unknown, without being impressed with the possibility of their useful application in other directions, and especially for the production of sulphuric acid, in connection with the wood-pulp industry now being so rapidly developed in New Brunswick. Iron-pyrites.

New Brunswick—*Cont*

Gypsum.

"*Gypsum.*—This comparatively cheap and abundant material affords still another illustration of varied adaptability and a possible largely increased production resulting therefrom. While still extensively quarried both for use in the raw state as 'land-plaster' and, after calcination, as plaster of Paris, it is said that new processes are being introduced whereby ground plaster may become, on a more extensive scale than formerly, the basis of the manufacture of artificial stone.

Gold.

"With further reference to this subject of possible future developments of mineral resources, the facts relating to the occurrence of gold in New Brunswick deserve some attention. For many years finds of this metal have been reported, and there seems to be no good reasons to doubt that some at least of these are authentic. Indeed, so impressed have some parties been with the belief that certain tracts, especially those bordering upon the Serpentine River, in Victoria county, are auriferous, that they have incurred the expense of transporting and erecting a small stamp-mill into that remote and comparatively inacessible locality. My visit to the region, made by your desire, tended strongly to confirm the justice of this belief. It is true that I was unable to find any free gold, but the character of the rocks, consisting of glossy slates and schists, together with the nature of the quartz veins by which these were found to be abundantly intersected, and, finally, the evidences of mineralization afforded by an abundance of pyrite and mispickel, were all features favourable to a belief in its occurrence. Should that belief, for the testing of which appropriate samples were selected, be confirmed, it will be important to notice that the same belt of rocks, with evidently the same characters, has a wide distribution in northern New Brunswick, as also that it is the tract in which the larger part of the reported discoveries of gold have been made. At present the greater portion of it is densely forest-clad, and thus removed from ordinary observation.

Coal.

"The question of coal supply in New Brunswick is also one in regard to which the interest lies quite as much in the possibilities of the future as in the present development. As to the latter, the mines at Grand Lake, Queen's county, continue to be the only producers, and here little or no change is to be noted either in the extent of the output or in the conditions of occurrence. The facts and conclusions as to the Newcastle coal-field fully given in the Report of Progress for 1872, remain unaltered, and no observations have been made which tend to indicate that other and larger seams occur here than those which have been so long worked near the surface.

"It also remains true of the New Brunswick coal-field as a whole that, with large area and nearly horizontal beds, it has probably but little thickness, and therefore affords but little prospect of containing many or large deposits of coal. But this conclusion, however probable, is by no means beyond question, more especially as regards that portion of the field lying between Grand Lake and the shore of Northumberland Strait. It is definitely known that the Carboniferous rocks of the province rest upon a floor of older rocks, which has been both extensively folded and eroded prior to the deposition of the coal-bearing strata. Thus the latter must undoubtedly be at many points thicker than at others, with of course the possibility of carrying proportionate quantities of coal. This question can only be finally settled by means of systematic borings throughout a considerable area; and one cannot help thinking that if, instead of using the diamond-drill, owned by the provincial government, within a few rods of a prominent ridge of Pre-Carboniferous rocks, as was done during the past summer, without result, in the vicinity of Moncton, this had been employed in the direction above indicated, the results, even if negative, would have been far more conclusive and satisfactory.

New Brunswick—*Cont.*

Boring operations proposed.

Building stones.

"Of other mineral products, it is only necessary to say in this brief summary that the operations in building and ornamental stones continue to be fairly active, although, as in the case of the lime industry at St. John, the output would be many times increased were it not for the depressing influence of adverse tariffs. While the granite industry still continues at St. George, and smaller quarries of so-called 'black granite' have been opened at several points, the operations in freestone and grindstones, formerly so extensively carried on at the head of the Bay of Fundy, have there almost ceased, the principal centres of this work at present being the vicinity of Newcastle, Northumberland county, and the shores of Bay Chaleur.

Other metallic minerals.

"Veins of pyrolusite (manganese oxide) were observed in the vicinity of Tattagouche Falls, in Gloucester county, at points not previously reported, affording some ground for the belief that much larger deposits of this mineral may yet be found in that vicinity.

"Veins of magnetic iron ore, from a fourth of an inch to eight inches in thickness, were observed in the vicinity of Lepreau River, St. John county, and small veins of galena and copper-pyrites at several points along the coasts of St. John and Charlotte counties, but none large enough to give much promise of successful working.

Peat bogs.

"The subject of peat bogs and their applications is one of considerable economic interest. Those of NewBrunswick have been studied by Mr. R. Chambers* and also for several summers by Prof. W. F. Ganong,

* See especially Annual Report, Geol. Surv. Can. (N.S.), Vol. VII., Part M.

New Brunswick—*Cont.*

of Northampton, Mass. An account of the attempts made to work these for moss-litter and other purposes, upon an extensive scale, will be contained in my final report of which a summary only is here given.

"In the same report an effort will be made to include, as to all the minerals and mineral localities alluded to above, as full particulars, historical and otherwise, as is possible to obtain.

"Specimens from numerous localities have been collected, and will be sent to the Survey office for examination."

NOVA SCOTIA.

Work by Mr. H. Fletcher.

Mr. Hugh Fletcher was engaged during the winter of 1896-1897 in plotting his surveys and in revising those made and plotted by his assistant, Mr. M. H. McLeod, and with other work connected with the preparation of several sheets of the geological map of Nova Scotia. Vertical sections were also drawn of the rocks of Chignecto Bay, from Shulie to Spicer Cove, and of the upper divisions of Sir W. Logan's section for comparison with them. Sections were also prepared of the rocks along Sutherland River and of those between McGregor Mountain and Deacon's Cove, on the East River of Pictou, with a view to defining the relations of the beds in these places, with the information now available, and of ascertaining the points upon which additional facts are required.

Of the field-work carried out during the past summer, Mr. Fletcher writes as follows:—

Examinations made with Dr. Ells and Dr. Ami.

"Leaving Ottawa on June 1st, 1897, with Dr. Ells and Dr. Ami, I spent several days with these gentlemen on the shores of Chignecto Bay, and in various parts of Pictou and Colchester counties, in the examination of certain crucial points in the geology of parts of the district comprised in the 'Cumberland' sheet, previously published on the scale of four miles to the inch, and in collecting further evidence respecting the age of the New Glasgow conglomerate and the rocks immediately overlying it, as well as those of Riversdale, which lie beneath the red rocks of Union, upon which in turn rest unconformably Lower Carboniferous limestone and gypsum.

"Dr. Ells and I examined also the rocks of Greenville, Wentworth, the Florida Road, Swallow settlement, Waugh River, River John, Scotsburn and the Big Island of Merigomish, in regard to the stratigraphical position of some of which considerable difference of opinion has been entertained. The coarse rocks of Big Island, between Savage Point and the overlying coal, are precisely like those of King Head, Begg

Brook and the Drummond Railway, near the north fault, containing large trunks of trees, cordaites and obscure ferns, while the coal of Little Harbour, Smelt Brook, Deacon's Cove and Abercrombie, appears to be, in these several places, separated from the top of the New Glasgow conglomerate by about the same thickness of strata. Several months have been spent by Dr. Ami during the last three seasons in collecting fossils from these strata, and his report on them may perhaps throw more light on their relations.

Nova Scotia—*Cont.*

Fossils.

"In August I again visited McAra Brook, in company with Mr. H. S. Poole and Dr. Ami, where we discovered and collected fossils from several new beds containing fish remains, among others abounding in carbonized plants; as laid down in the section subsequently measured along the banks of the brook, both above and below the shore-road. In October, with Mr. Lee Russell, of the Truro Normal School, I further examined parts of the shore of Chignecto Bay.

"The remainder of the season was spent in the district to be covered by the Springhill and Joggins map-sheets, many interesting facts being observed, the bearings of some of which are not yet entirely clear. The observations in the immediate neighbourhood of the coal mines are too disconnected to be of value before all the surveys shall have been plotted; and the relations of the coal measures to the underlying and overlying rocks are so imperfectly ascertained, and the questions involved of so great economic importance, that they must be further studied in the various sections before they can be presented.

Cumberland county.

"The explorations of Mr. James Baird seem to have proved the coal measures to exist parallel with a band of conglomerate, traced by the late Mr. McOuat, ninety-five chains east of the old Economy road to a fault recognized both by Mr. McOuat and Mr. Scott Barlow. It seems probable that, as in Cape Breton, certain bands may be traced out by superficial indications, so as to indicate the geological structure in the absence of definite outcrops or of pits. Much has been already done in this way by Mr. G. W. McCarthy, of Springhill, and bands of conglomerate, of concretionary limestone, gypsum and massive sandstone have been followed by him with great skill. As a fire last spring destroyed the notes of Mr. McCarthy's surveys and the company's maps, together with many valuable records of pits, bore-holes, etc., Mr. J. R. Cowans, manager, kindly allowed him to accompany me and point out features of interest in the coal-field. Wherever such distinctive beds of the kind mentioned above were observed, an attempt was made to follow them, aided in many cases by the prospecting pits so numerous in this field; the

Coal measures.

Beds traced by Mr. McCarthy at Springhill mines.

Nova Scotia—*Cont.*

Relation of conglomerates to coal-seams.

records of which, if they had been properly preserved, would probably serve to clear up every point that is now obscure in the geology. The particular importance of tracing the two conglomerates of Polly Brook and Rattling Brook cannot be overestimated, for on their position depends the relation of the coal-seams to the rocks of Athol, Southampton and the country to the westward, and the extent and depth of the basin of the Springhill coal measures. Even if it should be found that all the rocks where they lie near the old hills are conglomeratic, while on Logan's section, between Shulie and Minudie, they consist entirely of relatively fine sediments, this is a difficulty not perhaps insuperable, but requiring close study. The thickness of strata on opposite sides of the syncline near Athol—assuming that the fault separating the gypsum of Stewart Meadow from the upper red beds of Little Forks River and the Stony Half-mile either does not pass here, or is unconformably overlapped—may give the relative positions of the strata and show whether the gray sandstone and conglomerate of Rattling Brook are not the massive sandstone of the Stony Half-mile.

"The workings at the mines from the Aberdeen slope (which suggests the existence of a great fault by its steep dips and the proximity of the Carboniferous limestone) to the southerly-dipping coals of the Herritt road, have proved the direction of the coal-seams hereabout, but in other parts of the field this is not so plain, and more surveys, aided perhaps by a few shallow pits, may still be required. It is hoped that a study of the fossils so abundant in this field may serve to determine the relations of the different sections that have been measured.

Section at Chignecto Bay.

"A careful examination was made of all the brooks and roads of the district above referred to. This included a re-examination of Atkinson Brook, Shulie and Hebert rivers and most of the streams east of Chignecto Bay, where it was desirable to ascertain the dip more precisely, as well as the differences of strata and possible unconformities and faults, which could only be detected by careful tracing from point to point, owing to the similarity of the rocks and the absence of distinctive fossils. I am at present inclined to think that all the rocks of this section represent Logan's Joggins section only as far as the upper part of Division 3, and are not to be placed in the lower part of that section, although previously so mapped on the Cumberland sheet. If the three breaks already known to interrupt the continuity of the strata between the top of Logan's section and the old rocks of the Cobequids may be considered as of trivial importance, the above-mentioned supposition must hold. These breaks or faults, as already mentioned, occur at Sand Cove, at Sand River, and at

Spicer Cove. They did not appear to me to bring in any new rocks, but only to displace slightly the conglomerate, gray sandstone and red shale of the upper series, but this view requires verification. The Sand Cove fault is no doubt that seen on Shulie River, about a third of a mile above the shore-road, as its bearing deduced from the dip carries it directly to that point. Nova Scotia—*Cont.*

Carboniferous rocks near Cobequid Hills.

"Wherever the rocks are well exposed near the Cobequid Hills, it has been found that there is no such great thickness of red conglomerate as at Waugh River and New Glasgow, notwithstanding the great horizontal extent of such rocks produced by the low dip at Glasgow Mountain and towards the east branch of Apple River. They are succeeded by gray conglomerate and flaggy, coherent sandstone, like the rocks assumed by McOuat (Report of Progress, 1872-73, p. 169), to rest upon the coal measures. Next above these come fine gray sandstones and flags, like those of Shulie River, above the old Sand River road. The absence of coarse conglomerate towards the head of Shulie River, is remarkable; the gray and green flags overlying seem to take their place either by a fault or unconformity. Logan's Division 1 extends to the vicinity of Ragged Reef. The rocks generally have a low dip, and perhaps encroach by overlap upon the underlying strata.

Copper.

"On the farm of Mr. Amos Blenkhorn, on the east side of the road between Maccan and Nappan, a considerable quantity of copper ore has been taken from a slope sunk on a belt of gray sandstone, carrying trunks and leaves of carbonized trees, and charged with pyrite and gray copper ore, with barite in breaks and small veins, a little coal in gashes and veins and traces of chalcopyrite. In addition to large aggregations of the ore, much is scattered through the sandstone. The rocks, which dip steeply south, are probably Lower Carboniferous, like those of Downing Cove. From Nappan Station they extend, as shown on Dr. Ells' map, towards the Salem road, where a limestone holding manganese has been largely quarried at Mr. Fred Shipley's, occupying a broad belt near his house. From several of the openings manganese ore has been extracted which is said to have nearly paid the cost of working. The limestone is concretionary, yielding no fossils, and produces good lime, a kiln capable of burning three hundred bushels at a charge being operated by Mr. Shipley. Manganese

Cape Breton.

"On November 16th I visited Sydney, and spent some time at and near the coal mines, collecting details of the most recent workings and explorations, preparatory to the revision of the map-sheets of this coal-field.

Nova Scotia—*Cont.*

Discovery of coal at Cochran Lake.

"At the western end of the Cow Bay basin, Mr. Moseley has continued his borings of last year, and has satisfied himself, as did Mr. Charles Archibald at the east end, that no seams of greater thickness than three feet immediately underlie the McAulay seam, and its extension to the westward as the Neville seam. He has also put down two bore-holes and sunk a trial shaft further west on the Ferguson road, about a mile south of Cochran Lake. In the shaft I measured five feet six inches of clean coal of good quality. Immediately overlying this was a black streak, probably representing the upper bench of the bore-holes, but not well-defined owing to the want of a solid roof. The section of the bore-holes, as given by Mr. Moseley, is as follows:—

No. 1.

	Ft.	In.	Feet.	Inches.
Surface			13	0
Gray sandstone and argillaceous shale			15	2
Top coal	0	9	8	2
Shale	0	4		
Coal	5	5		
Mixture	0	0½		
Coal	0	3½		
Coal and clay	0	11		
Coal	0	4		
Rock, principally shale			31	0

No. 2.

	Ft.	In.	Feet.	Inches.
Surface			12	3
Sandstone and shale			38	6
Top coal	0	11	7	7
Clay	0	2½		
Coal	5	0½		
Clay	0	7		
Coal	0	10		
Underclay			1	7

"No. 2 lies one hundred feet north of No. 1 towards the dip. The shaft is fifty feet to the rise of No. 1, and the coal was reached at a depth of about twenty-four feet from the surface.

"Explorations are still being made on Mira Road, and a slope is being sunk on the two foot nine inch coal in the hope that it may improve in thickness*.

Dr. White's report on petroleum in Cape Breton.

"Dr. I. C. White, of Morgantown, West Virginia, has made, on behalf of gentlemen interested in that district, an examination of the supposed oil producing territory of Lake Ainslie, referred to in the report for 1882-84, page 90 H, and has expressed himself as satisfied that, although there is petroleum in a thick stratum of sand-rock on the western shore of Lake Ainslie, the area of the field is so limited and the dip of the strata so high that there is hardly a chance of its being obtained there in large enough quantities to pay for development.

"Dr. White adversely criticises the borings previously carried on at Lake Ainslie, pointing out that in one place there are six holes in an area of not much more than half an acre—two of them only thirty or

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*By a mistake in last Summary Report, p. 95 A, line 13, the top coal of the Tracy mine was said to be two feet seven inches, instead of three feet seven inches.

forty feet apart—when of course a single well would have been quite enough to test that amount of territory. From one of the wells a small quantity of heavy, black petroleum was obtained by lowering into it a bunch of rags at the end of a pole, and from another, natural gas was escaping in small quantities and could be lighted with a match, but in the others there was no sign either of oil or gas. More than a dozen wells in all were found, eight or ten on the western shore of the lake and three on the eastern. Dr. White made a journey of about 125 miles around Lake Ainslie and through the valleys of the Margaree, Middle and Baddeck rivers, but did not find there a field level enough and extensive enough to pay for development, even assuming that it contained oil. Sand-rock having the characteristic odour of petroleum was found in several places, but its contents had long before disappeared, and in some cases a substance supposed to be oil proved to be nothing more than a film or stain of iron. Dr. White's conclusion is that, in the parts of the island visited, there is no geological evidence of the existence of petroleum in quantities large enough to make it commercially valuable. On the contrary, all the geological evidence goes to negative the supposition."

Nova Scotia *Cont.*

The first two months of the winter of 1896-97 was devoted by Mr. E. R. Faribault to the plotting of surveys made during the previous summer and to the revising of those made by assistants, but the greater part of the winter was spent completing the compilation of the Lawrencetown and Stewiacke map-sheets and in continuing the compilation of the Preston, Middle Musquodoboit and Halifax sheets. The Ship Harbour, Moose River, Upper Musquodoboit and Eastville sheets were also prepared for the engraver, and structural sections made for the two first-named sheets. Some time was also occupied correcting proofs from the engraver of the Fifteen-mile Stream, Ship Harbour and Moose River sheets which are now published, and progress was made in compiling a report on the gold-fields of the eastern part of the province.

Work by Mr E. R. Faribault.

Map-sheets in course of compilation.

On the field-work accomplished in 1897, Mr. Faribault reports as follows :—

Field-work.

"In compliance with your letter of instructions, I left Ottawa on the 5th of June, to continue the mapping and study of the structural geology of the gold-bearing rocks of the Atlantic coast of Nova Scotia, devoting much of my time to a review of the gold-fields of the eastern part of the province, already surveyed, with the object of producing a general report on these fields during the winter.

Nova Scotia—*Cont.*

Lunenburg county.

" Mr. Archibald Cameron was engaged the whole of the season with preliminary work in the south-west part of Lunenburg county, surveying with the odometer and prismatic compass the roads to be used as tie-lines in the compilation of the Lunenburg and Vogler's Cove map-sheet. He also completed the topography and made preliminary geological surveys of the Mahone Bay sheet, as well as the north-east portion of the Lunenburg sheet lying to the north-east of La Have River. He has now completed the plotting of his summer's work.

Gold-districts surveyed in Guysborough and Halifax counties.

" My own time in the field was principally devoted, assisted by Mr. J. McG. Cruickshank, to the study of the structural geology of the principal gold districts lying east of the Musquodoboit River included in the county of Guysborough and the eastern part of the county of Halifax. Special detailed surveys were made and plans partly completed of the gold-districts of Isaac's Harbour, Upper Seal Harbour, Forest Hill, Cochran Hill, Goldenville, Salmon River, Fifteen-mile Stream, Killag, Caribou, Moose River and Mooseland. It was found most difficult in some districts to get the necessary informations regarding abandoned mines, some of which have not been in operation for over twenty-five years, and the time at my disposal did not permit me to prepare as complete and accurate plans of these districts as the importance of some of them should require. No mining plans have been kept by the different companies operating the older districts from time to time for the last thirty-five years, or if plans have been kept they are now lost or in possession of private individuals. Such plans would be most valuable in affording the data necessary to work up the geological structure, and they would be very useful to companies re-opening old abandoned workings, as well as to capitalists and mining engineers seeking information. It is most desirable and important that some steps be taken by the proper authorities to have this want remedied. I must say, however, that I have been the recipient of much courtesy at all the mining centres, and I have to thank more especially many old miners for valuable information regarding the nature of the ore-deposits of these abandoned mines and the extent to which they have been worked.

Upper Seal Harbour gold-district.

" *Upper Seal Harbour Gold District.*—Thirteen days were spent making a survey of this new district, discovered at the time we located the anticline in the spring of 1892, and a plan on the scale of 500 feet to an inch has been prepared, giving the geological structure of the anticlinal fold from Country Harbour to the head-waters of Seal Harbour streams, a distance of 28,200 feet

This anticline has a general course of N. 60° W. (*mag.*),* with a pitch to the east of 10° at the west end, increasing to 32° at the east end, the strata on both sides of the axis having about the same inclination to the north and south, the angle of dip averaging 50° near the apex and increasing to 80° some distance off. Three main parallel faults have been discovered and located this summer, cutting the fold diagonally at angles varying from 40° to 50°, with horizontal displacements varying from 500 to 1100 feet and running about N. 15° W. (*mag.*). As the gold-bearing veins are here confined to the crown of the anticlinal fold, where they bulge out to large size, and as the greater part of the district is covered with heavy drift and woods, the exact location of these faults becomes most important in tracing out the auriferous belt; and I may say that several hundred areas were taken up by local prospectors last season on finding out the extent of the displacements of these faults. Nova Scotia—*Cont.* Faults.

"The eastern fault lies west of Dolliver Mountain gold mine, passing in the vicinity of the north branch of Davidson Brook, with a displacement of 500 feet to the north on the east side, shoving the anticlinal fold from area 772 to area 869 on the east side.

"The middle fault lies 600 feet west of the mouth of Isaac's Harbour River and follows the general course of the Northwest Branch Brook to the head of the harbour, down which it runs passing between Hurricane Island and the eastern shore. The anticlinal fold is cut off on the east side of this fault on area 906, block 6, and shoved to the south-east some 1100 feet, in the vicinity of the discharge of the Branch Brook into Isaac's Harbour.

"The western fault runs parallel to the other two, along the valley of the south branch of Smelt Brook of Country Harbour, and is well seen at the Porcupine Rock, but, on account of heavy drift, the anticline could not be located on either side in the vicinity of the fault. The fold is, however, well exposed further west on the shore of Country Harbour, on areas 780 and 781 of block 10, giving a horizontal shove of some 500 feet.

"The only mine in operation in the district, at the time of my visit, was the Richardson gold mine, working an auriferous quartz vein that follows a belt of slate lying between two heavy beds of quartzite, curving to the eastward around the anticlinal fold, which dips to the north at an angle of 70°, to the south at an angle of 50°, and with a pitch of 21° along the axis. The belt on the north dip has a width of 7 feet, and has been worked 150 feet on the incline; on the south, Richardson gold mine.

* The magnetic variation in this part of Nova Scotio is about 23° E.

Nova Scotia—*Cont.*

the width is 8 feet, and it was worked to a depth of 200 feet, while on the apex, the belt increases to a thickness of 25 feet, half of which is quartz, and has been worked on the incline to a depth of 400 feet. The slate, as well as the quartz, contains milling gold, but it also holds an important amount of auriferous sulphides, which, from analysis made by Mr. F. H. Mason, of Halifax, contain a good percentage of gold that is not free-milling, and should be saved by suitable concentrators.

Development work.

"A great deal of exploratory work has been done in the last few years to the east and west of the Richardson property, along a distance of some five miles, on both sides of the anticlinal axis; notably, on the Dolliver Mountain property where some twelve veins showing gold have been opened, and also on the McMillan, the Samuel Grant, the O. J. Griffin, the H. Richard and the East Gold Brook areas, where some rich drift has been found. Large belts of low-grade ore, similar to that of the Richardson vein, certainly occur along this fold, but they will only be found on the apex of the fold, where more prospecting should be done; and this could be accomplished most readily and at least cost by sinking perpendicular shafts along the axis.

Belts of low-grade ore.

Isaac's Harbour gold-district. Faults.

"*Isaac's Harbour Gold District.*—The three faults above described as affecting the Upper Seal Harbour belt, have been traced across this belt lying two miles further south. The middle fault and the western fault run down the harbour and pass between Hurricane Island and the eastern shore, and converge at Dung Cove, giving a horizontal throw of some 1500 feet to the north on the east side of the harbour. The Mulgrave belt should thus be the continuation of the Hurricane Island belt, where an anticlinal and synclinal fold only 12 feet wide is developing on the western side of the harbour, into the Burke mine anticline and North Star mine syncline which are here 100 feet apart. This explains why the Mulgrave belt can not be traced on its natural course on the western side of the harbour, and it gives also the theoretical reason for the occurrence of an auriferous belt apparently remote from an anticlinal fold.

Importance of faults in future development.

"The Hattie belt, now operated by the Griffin Gold Mining Company, on the south side of the Isaac's Harbour anticline, is likewise shoved by the same fault some 1500 feet to the south on the west side of Dung Cove at Red Head, where rich drift has been found.

"The eastern fault described above appears to pass a few hundred feet west of the Skunk Den mine, apparently cutting the Mulgrave leads between areas 13 and 14, but the extent of this fault here could not be exactly made out. It may have a displacement of 500 feet, like that two miles further north.

"The knowledge of the location and displacements of these faults should assist in tracing out rich veins beyond them and encourage the prospecting of new areas.

Nova Scotia—*Cont.*

Country Harbour gold-district.

"*Country Harbour Gold District.*—No work was being done here at the time of our visit. More evidence was gathered, however, confirming the views expressed before regarding the structure of the district. The quartz veins, so extensively worked here for some years with large returns, are situated along a very sharp anticlinal fold which is a part of the Cochran Hill and Forest Hill anticline swung into a north-and-south direction by the Country Harbour fault, which has caused a horizontal displacement of over one mile to the south-east on the north-east side of the fault.

Forest Hill gold-district.

"*Forest Hill Gold District.*—One week was devoted to making a plan on the scale of 500 feet to an inch of this newly discovered district, where a belt of gold-bearing rocks occurs between two axes of granite, from which numerous dykes and veins are sent into the adjoining rocks which are altered into andalusite, staurolite and garnetiferous schists. The belt is plicated into an anticlinal fold which has a north-west course, gradually curving to the west and south-west and most probably joining the Country Harbour anticline. On the McConnell property the anticline has a pitch to the east of 3°. The Mudstock, McConnell, Mason and Phœnix companies are working a group of some ten veins 1000 feet south of the granite on the south side of this fold, which has an overturned dip to the north varying from 90° to 70°. The Salmon River and Ophir leads, which have so far been the most productive, are the nearest to the anticline, being respectively 100 and 500 feet distant from it; and, judging from the present developments, it appears that the outcrops of the pay-streaks on the different leads are situated along an imaginary line crossing diagonally the course of the leads, and running N. 73° W. (*mag.*) from the McConnell mill. I would thus suggest cross-cutting north from a shaft on the Salmon River lead in the vicinity of the O'Connell mill, where the anticline is well exposed twenty feet north of the mill, to develop leads on the line of the pay-streak which do not crop at the surface.

Pay-streaks

Granite cutting quartz veins.

"Auriferous quartz veins have also been prospected on three different properties one mile further west, on the south side of Mile Lake, where granite spurs from the mass lying immediately to the north cut the stratified rocks and interbedded veins in all directions, creating disturbances which render prospecting very difficult. This district is the most interesting place yet visited in the province for studying the relation of the granite to the sedimentary rocks.

Nova Scotia—*Cont.*

Cochran Hill gold-district.

"*Cochran Hill Gold District.*—A hurried survey of this district has been made and partly plotted on the scale of 300 feet to one inch. The axis of the anticline, not located here before, was determined at the crusher, on area 533, block 77, and traced eastward, where gold-bearing drift was discovered last season, a fact which ought to encourage prospecting along its course, which is S. 79° E. (*mag.*) This anticline is a very sharp fold overturned to the south, the dip on the north side being to the north at an angle increasing from 60° to 70°, as we recede from the axis, while the south leg has an inverted dip to the north increasing from 75° to 85°, as we approach the axis. The pitch is to the west, at a very low angle.

"At the time of my visit a large belt of leads, called the Mitchell belt, which had been worked from time to time with more or less success, was being re-opened. This belt is 250 feet south of the anticline, 100 feet wide, and composed of several veins of low-grade ore from two to fifteen inches wide.

Goldenville gold-district.

"*Goldenville Gold District.*—One month was devoted last season to this most important district, in making a detailed survey of over 125 auriferous quartz veins which have been worked from time to time. A plan, on the scale of 200 feet to an inch, was plotted in the field, showing the size and cropping of the veins, as far as they can be traced on the surface, the extent to which they have been worked in depth, and the faults and disturbances affecting them.

Pay-streaks following anticlines of minor undulations.

"These veins occur on both sides of a main anticlinal fold, which has a general westerly pitch varying from 0° to 30°, with a perpendicular dip on the south side, and a north dip of 43°. In studying the structure of this anticline more closely, we find that gentle undulations leave the main fold in a north-westerly direction, and that the enlargements and pay-streaks of the veins are found along well-defined lines, having the same north-westerly directions and corresponding to the anticlines of these undulations, while the synclines correspond to a narrowing or disappearance of the veins and to lower grade or barren ore. Three well-defined transverse undulations have been traced on the north side of the saddle, the most easterly of which leaves the main Cobourg shaft near the anticline and runs N. 65° W. (*mag.*) to the shafts on the Gold Hill belt, then curving slightly to the north, it runs N. 57° W. (*mag.*) to the shafts on the Gladstone, developing enlargements and rich streaks on the veins it crosses. Important pay-streaks have been worked along this line on the Cobourg lead to a depth of 200 feet on the incline; on the Gold Hill 75 feet; Bung, 280 feet; Wellington, 750 feet; Dewar, 400 feet; Cameron Whin, 100 feet; Blue, 300 feet;

Wellington line of pay-streaks.

McKenzie, 150 feet; Zwicker Big, 300 feet; Gladstone, 140 feet; McClure, 300 feet; Harrison, 300 feet; Dougald Cameron, 60 feet; Dan McKenzie, 90 feet, and on the Wheel lead, 75 feet. Nova Scotia—*Cont.*

"The second undulation leaves the Mayflower belt on the anticline, and runs N. 50° W. (*mag.*) to and beyond the Little Hayden lead, creating enlargements and pay-streaks on the veins crossed. The most important are those worked on the Mayflower, Roothog, John R, to a depth of 90 feet, Murray, Serpent, Bailey 130 feet, Old Hayden 90 feet, Jumbo 180 feet, and on the Little Hayden worked to a depth of 350 feet. A swamp lying north-west of the Little Hayden has, no doubt, prevented prospecting further north-west on this undulation, but there is every reason to believe that rich streaks occur there. Hayden line of pay-streaks.

"The veins crossing the space between the two most easterly undulations have been found of no value, and prospecting done to the west of the Hayden undulation has proved that the veins pinch out and are completely wanting for a space of 700 feet, at the west of which the western undulation begins. Barren ground.

"Only a few veins have so far been opened on the western undulation, passing about the McRae vein, but good streaks may yet be discovered on some of the veins crossing this line. McRae line of pay-streaks.

"On the south side of the Goldenville anticline, the interbedded auriferous veins are perpendicular and run straight, except on the saddle where they curve to the north-west and the angle of dip decreases gradually. Here again, as a general rule, the richest streaks have been found where the strata and the inclosed veins begin to curve around the main anticline. One well-defined line of pay-streaks leaves the anticlinal axis at the Mayflower belt and runs S. 35° E. (*mag.*) developing the rich streaks worked on the Palmerston and the Meridian big belts to depths of 100 feet. Palmerston line of pay-streaks.

"The above general conclusions are sufficient to prove that the mode of occurrence of the veins depends entirely on the structure of the folds and the lateral pressures to which they owe their origin. If, therefore, the structure of a gold district can be ascertained and mapped out it becomes quite simple to locate the lines of pay-streaks and to trace them to great depths, as is done in Bendigo, Australia, where mining operations have been pushed down, at six different mines, to depths of over 3000 feet, by means of perpendicular shafts on the top of anticlinal folds. Importance of structural geology in deep mining.

"Enormous lateral pressure has induced, at the east end of the district, small cross-faults, the two largest giving a horizontal displacement Faults.

Nova Scotia—*Cont.*

of 40 and 42 feet respectively on the south side of the fold, of later origin than the auriferous veins.

Mining operations.

"The district, once a centre of much activity and from which over $2,000,000 worth of gold has been extracted, has been little worked for the last fifteen years, but within a year or two abandoned properties have been re-opened and worked with very satisfactory results, so that it is safe to say this district is destined in the near future to resume its position as an important gold producing centre.

"At the time of our visit, operations were being prosecuted with renewed energy on the Cobourg, the Springfield, the New Glasgow, the Stuart-Hardman and the Sutherland properties. The return from the four first-named properties for the month of August was 397 ounces of gold from 1245 tons of quartz.

Salmon River gold-district.

"*Salmon River Gold District.*—A few days were spent in a survey of this district, but the plotting of the field-notes is not yet completed. The surface of the district is largely covered with drift and only a few out-crops could be seen, outside the Dufferin mine, at the east end of the district, where some veins have been opened. Large plans and sections of the extensive underground workings of the Dufferin mine have been made by the company. By the courtesy of Mr. R. G. Leckie, manager of the company, these plans have been placed at the disposal of the Geological Survey and will be of great value in affording the data necessary to work out the structure of this important district.

Large veins on anticlines to great depths.

"The quartz veins worked at the Dufferin mine are situated on the apex of a very sharp anticlinal fold. At the main shaft the apex has a westerly and easterly pitch, which has caused a sliding and an uplift of the strata, developing large auriferous quartz veins on the crown of the saddle. These latter occur one under another in the same manner as some of those in Victoria, Australia, to which allusion has already been made. No work was done here last summer, but I was informed that the company contemplates the erection of a suitable plant and will sink a deep perpendicular shaft on the crown of the saddle to work the large ore-bodies converging at this point.

Fifteen-mile Stream gold-district.

"*Fifteen-mile Stream Gold District.*—Ten days were spent in a survey of this district and a plan on the scale of 300 feet to an inch was completed in the field. The north anticline of the Moose River mine passes through this district and is here composed of three minor anticlinal folds. The two most northerly folds are only 130 feet apart at the east end of the district, on the New Egerton property, and have a pitch to the east at an angle of 30°. The northernmost is well exposed at the west end of the district, on the east shore of Sheet Harbour

Three anticlines.

River, 100 feet south of the Free Claim lead, where the pitch is to the west at an angle of 18°, but the middle fold could not be located here as the bed-rock does not crop out immediately south of the Free Claim mine. The east and west pitches of the north anticline meet and form a dome a short distance west of the Hudson property, where good ground is most likely to be found.

Nova Scotia—*Cont.*

"The southern anticline is well exposed at the west end of the district on area 905, block 2, 750 feet south of the Free Claim lead, also on the Sheet Harbour portage-road on area 858, block 4. Further east, it passes about 50 feet north of the Halliday lead, beyond which, it is thrown to the north, about 150 feet, by a fault, and passes north of the McCuaig lead and south of the Hudson and White leads, prospected here on the eastern pitch of the anticline. No veins have, so far, been operated on this fold, but some very rich drift, derived, no doubt, from its axis, has been found 600 feet to the south of it on areas 706 and 713, block 6, and at other places, and considerable prospecting has been done through a great thickness of drift to find the auriferous veins. No doubt systematic prospecting along this anticlinal fold will bring to light rich veins.

Southern undeveloped anticline promising.

"Mining operations have, so far, been confined to the quartz veins lying along the two northern anticlines. The New Egerton Gold Mining Company has lately taken possession of the principal properties which had been worked from time to time by different companies, and they are now operating on a large scale the important belts of low-grade ore known as the Mother Seigel, and the Nonpareil, on the synclinal fold, immediately south of the middle anticline, at the eastern end of the district. The returns for the first nine months of 1897 are, 8269 tons of quartz passed through a 40-stamp mill, giving 2557 ounces of free gold, or an average of 6·19 dwt. per ton, and last September, 1000 tons gave 445 ounces, or an average of 8·90 dwt. per ton.

Mining operations.

"This district is one of the most promising for new discoveries, and is likely eventually to become one of the most important mining centres in the province. But on account of its isolated position, with only one bad road of thirty miles for ingress, it has not been given all the attention it deserves.

District very promising.

"*Killag Gold District.*—A few days were employed surveying this comparatively new district, a plan of which was plotted on the scale of 300 feet to an inch. The anticline passing through this district is the continuation of the Goldenville fold from the east, and of the Gold Lake fold from the west. It has a course of S. 79° E. (*mag.*), but instead

Killag gold-district.

Nova Scotia—*Cont.*

of having a westerly pitch as in the two latter districts, its axis has a pitch to the east at an angle of 15°. The measures on the south side have a due east-and-west (*mag.*) course and perpendicular dip, while on the north side the measures have a general course of S. 55° E. (*mag.*) and dip to the north at an angle averaging 35°.

Much rich ground undeveloped.

"Only a few veins have so far been worked in this district, but very rich drift has been found for some distance along the course of the axis, indicating that more will yet be discovered. The veins are much larger and more numerous on the apex of the fold than at a distance from it, and more prospecting should be done along this line and operations carried down to greater depths on the saddle.

Operations.

"At the time of my visit, the H. S. McKay property was being operated on two different leads, one on the north dip and the other on the south, with good results. Prospecting was being done on the Mott-Stuart property, on some areas where very rich quartz was found, and two leads dipping to the north have been discovered showing gold quite freely.

Caribou gold-district.

"*Caribou Gold District.*—Twelve days were devoted to surveying this district, a plan of which was plotted on the scale of 500 feet to an inch. The anticlinal fold passing through this district is the continuation of the Cochran Hill and Cameron Dam anticline, which has brought up the upper measures of the lower quartzite group of the gold-bearing series on an elliptical dome, 2900 feet broad and four miles long, surrounded and overlain by the upper slate group. This dome has its centre on areas 328 and 329, block 2, where many quartz veins have been segregated in slate belts interbedded with quartzite beds, dipping away from the centre at low angles along the axis of the fold, increasing gradually to 65° on the north dip and to 70° on the south dip. The course of the fold from the centre of the dome is N. 79° E. and S. 76° W. (*mag.*)

Fissure veins operated.

"Besides the many interbedded veins which have been operated from time to time for some years, four important large fissure-veins, cutting the strata at small angles, have also been worked extensively with good returns. One of these cuts the quartzite and slate group and the other three cut the slate group near its base. Two of the latter are at present worked.

Promising belt on dome of anticline.

"More attention should be paid to the large belt of flat veins lying close together on the centre of the dome, on areas 328 and 329, block 2, on the property of the Caribou Gold Mining Company; for the structure of the fold shows that they probably overlie a succession of similar veins, all of which could be worked most economically by a perpendicular shaft sunk on the apex. Nova Scotia—*Cont.*

"*Moose River Gold District.*—Twelve days were spent in this district and a plan on the scale of 200 feet to an inch was plotted in the field. The Fifteen-mile Stream and the Beaver Dam anticlines converge as they approach this district from the east, and are here only 450 feet apart, with two minor plications between them. The folds have a general east-and-west course. The most northerly, which is the more important, has a north dip increasing gradually from 35° to 80° and its axis has a pitch to the west at an angle of 10°. The measures on the south side of the south fold dip south at an angle averaging 60°, and the axis has a pitch to the east at an angle of 15°, and the minor intervening plications lie at an angle seldom higher than 45°. The immense strain and pressure accompanying the meeting of these folds have greatly disturbed the measures and have caused many flexures and faults which complicate very much the structure of the district. The main lines of faulting have a general course varying from N. 10° E. to N. 25° E. (*mag.*), with displacements from a few feet up to 165 feet. Moose River gold-district. Several broad folds.

"With the exception of one or two small, true, fissure veins of but little importance, cutting the strata at small angles, all the veins worked in this district are of the interbedded class. The most important are those worked on the north dip and on the crown of the northern anticline, by the Touquoy and the Moose River Gold Mining companies. Some veins have also been worked on the south anticline and on the two smaller plications lying between these two main folds.

"A belt of slate, over 100 feet wide, plicated by these folds, contains a large percentage of auriferous quartz occurring in corrugated veinlets and filling fissures generally following the stratification. A large quantity of this slate has been mined on the Moose River property by open quarries, and a considerable percentage of the slate as well as quartz has been crushed and is said to have given satisfactory returns. This large belt of slate could be mined at a very low cost, and if certain parts of it were sampled separately, tested and found to contain enough gold to cover expenses of mining, it would become a great source of revenue, as the belt is repeated by these plications and gives a considerable width, and can be traced for some distance east and west. Belts of slate of a similar nature that occur in other districts seem worthy of consideration. Important belt of slate

"The discovery, last summer, of a 100-ounce pocket on the Britannia lead, newly opened on the south dip of one of the middle plica- 100-ounce pocket.

Nova Scotia—*Cont.*

tions, on the Touquoy property, has created more interest in the district, and, as a result, prospecting has been begun on the east and west ends of the district, where much good ground is yet undeveloped.

Mooseland gold-district.

"*Mooseland Gold District.*—One week was occupied in surveying and plotting this district and a plan on the scale of 200 feet to an inch is in progress. All the leads worked occur on the south leg of a very sharp fold, dipping 75° on both the south and north sides, the axis of which runs from the centre of a dome east, magnetic, and N. 81° W. (*mag.*), and has a pitch of 10° to the east and 5° to the west.

Faults.

"Several lines of faulting have caused important displacements at the east end of the district. The westernmost of these runs S. 35° E. (*mag.*) along the edge of a flat on the west side of the Tangier River and gives a horizontal displacement of 560 feet to the north on the east side, the anticline situated 48 feet north of the Irving lead being the same as that immediately south of the Bismarck lead.

"On the east side of the Tangier River, another main fault, running parallel with the first, passes through the west Otter Pond and follows its brook to the south, while northward it follows the river along Grassy Lake. The Bismarck lead anticline is shoved 1500 feet to the north on the east side of this fault, to a ridge 150 feet north of the west Otter Pond, and 50 or 100 feet north of the Brown lead opened here. The pitch of the anticline, which is to the east on the Bismarck lead, is changed to the west on the east side of the fault where the veins will curve westward around the fold. Small faults exist no doubt between this fault and the Bismarck lead, and one was located at the east end of the workings on this lead, but a great thickness of drift east of the river prevents the determination of the others.

Undeveloped ground.

"The location of the anticline to the east of these faults opens up an important new field for the prospector ; and the block of country situated between the two main faults and lying to the south of the Bismarck lead anticline, is certainly very valuable, as it contains the continuation of the Irving and other rich leads worked years ago on the old Musgrave property.

Large belt of quartz.

"The very large belt of four veins, giving fifteen feet of quartz in the space of 35 feet, and exposed for 1850 feet along the apex of the anticline north of the Irving lead, contains some sulphides and it should be properly tested for gold by means of perpendicular shafts along the eastern pitch of the apex. The same may be said of the continuation of this belt on and under the Bismarck lead fold, the latter lead having been found quite rich on the eastern pitch of the apex where it reaches the thickness of fourteen feet."

CHEMISTRY AND MINERALOGY.

Reporting on the work done in these branches of the Survey's operations Dr. Hoffmann says:—"The work carried out in the chemical laboratory during the past year has been conducted upon the same lines as those heretofore followed. It having been almost exclusively confined to the examination and analysis of such minerals, ores, etc., as were considered likely to prove of economic importance. Briefly stated, it embraced:— Chemistry and mineralogy.

"1. Analyses of fuels—including peat, lignite, lignitic coal, coal and anthracite—from the provinces of Nova Scotia and New Brunswick, the North-west Territory, and the province of British Columbia. Analyses and assays.

"2. Analyses of natural waters—with the object of ascertaining their suitability for domestic or manufacturing purposes, or possible therapeutic value—from springs in the provinces of Nova Scotia, Quebec, and British Columbia; also of the waters of the Bow, Elbow, Highwood, and Sheep rivers, and of Fish Creek, in the district of Alberta, North-west Territory.

"3. Analyses of limestones and dolomites, from various localities,—in continuation of the series of analyses of such stones already carried out, in connection with an enquiry into their individual merits for structural purposes, for the manufacture of lime, or of hydraulic cement, or for metallurgical purposes, etc.

"4. Analyses of iron ores—including magnetites, hæmatites, and bog-iron ores—from various parts of the Dominion.

"5. Analyses, in regard to nickel content, of certain ores from the province of British Columbia.

"6. Assays, for gold and silver, of ores from the provinces of Nova Scotia, New Brunswick, Quebec, and Ontario, also from Hudson Strait, the North-west Territory, and the province of British Columbia.

"7. Analyses of several highly interesting and for the most part, from an economic point of view, important minerals.

"8. Miscellaneous examinations, such as the partial analysis or testing, as the case might be, of samples of copper ore, iron ochre, graphite, carbonaceous shale, clays, marls, iron sands, and other material not included under the above headings.

Mineral specimens examined.

"The number of mineral specimens received during the period in question, for identification or the obtaining of information in regard to their economic value, was greatly in excess of that of any previous year—amounting to not less than nine hundred and eighty-five. 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. The number of letters personally written—almost exclusively of the nature of reports and embodying the results of the examination, analysis, or assay, as the case might be, of mineral specimens—amounted to three hundred and thirty-five. The number of those received to one hundred and seventy-two.

Work by assistants.

"Messrs. R. A. A. Johnston and F. G. Wait, assistants in the laboratory, have, as a result of the interest taken by them in their work, and their great assiduity, rendered excellent service. Of these, the former has, in addition to the carrying out of a very large number of gold and silver assays, also made numerous analyses of important minerals, and likewise conducted a very great variety of miscellaneous examinations, whilst the latter has made analyses of a great many natural waters, of some iron and manganese ores, also of some rocks, and in addition carried out some miscellaneous examinations.

"In the work connected with the mineralogical section of the museum, I have had the hearty co-operation and assistance of Mr. R. L. Broadbent. Apart from the general museum work, including the labelling and cataloguing of all newly received specimens, and the maintenance of the collection generally in an orderly condition, he has replaced—in the collections illustrating the distribution of iron, copper, lead, antimony, and other ores—close upon a thousand manuscript, by printed labels; and also labelled and catalogued the contents of four recently added new cases, consisting of one hundred and eighty-three specimens of gold and silver ores, collected by Mr. R. G. McConnell, from various mines and claims in the Trail Creeek, Nelson, Toad Mountain, Slocan, and Ainsworth mining districts, in West Kootenay, British Columbia.

"Some of the specimens contained in the cases have been replaced by more characteristic ones, and others, to the number of one hundred and twenty-four, added—including the following:—

(A.) *Collected by members of the staff or others engaged in field-work in connection with the Survey:—*

Bailey, L. W.:—

a. Magnetite and specular iron ore from Lepreau, Charlotte County, N.B.

Contributions to museum—*Cont.*

b. Limestone from L'Etang, Charlotte County, N. B.
c. Umber from Letite, Charlotte County, N. B.
d. Pyrite from Red Head, St. John County, N.B.
e. Copper ore from Adams Island and Simpson Island, Charlotte County, N.B.
f. Copper ore from Alma, Albert County, N.B.
g. Dolomite with galena from Frenchman's Creek, Lancaster, St. John County, N.B.
h. Pyrolusite from Quaco, St. John County, N.B.
i. Bog manganese (wad) from Dawson Settlement, Albert County, N.B.
j. Stibnite from Prince William, York County, N.B.
k. Nickeliferous pyrrhotite from St. Stephen, Charlotte County, N.B.
l. Clay from near Deadman Harbour, Charlotte County, N.B.
m. Serpentine from the Narrows of the St. John River, St. John County, N.B.
n. Felsite (polished) from Chamcook Mountain, Charlotte County, N.B.
o. "Black Granite" from Bocabec, Charlotte County, N.B.
p. Grindstone, nile-green scythestones, etc., from Stonehaven, Gloucester County, N.B.
q. Specular iron ore from Cranberry Head, St. John County, N.B.
r. Pyrolusite from Tête-à-gauche, Gloucester County, N.B.

Barlow, A. E.:—

a. Sodalite, nephelite, cancrinite and zircon from the Township of Dungannon, Hastings County, O.
b. Auriferous rock from the Crystal gold mine, Wahnapitae Lake, District of Nipissing, O.

Cole, A. A.:—

Columnar graphite from lot 21, range VII., Buckingham, Ottawa County, Q.

Faribault, E. R.:—

a. Iron ochre from East Chester, Lunenburg County, N.S.
b. Stibnite from West Gore, Hants County, N.S.

Ferrier, W. F.:—

a. Quartz crystals from lot 1, con. IX., Madoc, Hastings County, O.
b. Stilpnomelane (var. chalcodite) from lot 12, con. V., Madoc, Hastings County, O.
c. Erythrite from the Cross mine, Madoc Village, Hastings County, O.

Contributions to museum—*Cont.*

d. Limonite (var. bog iron ore) and hæmatite from lot 9, con. XIV., Huntingdon, Hastings County, O.

e. Corundum from lot 14, con. XIV., Carlow, Hastings County, O.

f. Corundum (blue) from lot—, con. IX., Methuen, Peterborough County, O.

g. Corundum from lot 4, con. XVIII., and lot 1, con. XIX., Raglan, Renfrew County, O.

h. Muscovite from the Township of Methuen, Peterborough County, O.

i. Pyroxene crystals from lot 3, con. IV., Herschel, Hastings County, O.

j. Nephelite, odalite cancrinite, zircon, apatite, and biotite from the Township of Dungannon, Hastings County, O.

k. Bismuthinite from lot 34, con. IV., Tudor, Hastings County, O.

McConnell, R. G.:—

Collection of gold and silver ores from the following mines and claims in the Trail Creek, Nelson, Toad Mountain, Slocan and Ainsworth mining districts, West Kootenay, B.C.:—

a. Trail Creek mining district—

Jumbo mine.	Sovereign claim.
Josie mine.	Monte Cristo claim.
Cliff mine.	Deer Park claim.
War Eagle mine.	Union claim.
Crown Point mine.	Nickel Plate mine.
Red Mountain mine.	Commander claim.
Homestake claim.	R. E. Lee claim.
Lily May claim.	April Fool claim.
Sheep Creek Star claim.	Mayflower claim.
Gold Star claim.	Deadwood group.
Le Roi mine.	Iron Horse mine.
Iron Colt claim.	Kootenay-Columbia mine.
Gold Hill claim.	Coxey claim.
Great Western claim.	Heather Bell claim.
Iota claim.	Iron Chief claim.
Apache claim.	Waterloo mine.
Black Hawk claim.	Aaron's Isle claim.
Gladiator claim.	O. K. mine, Sheep Creek.

b. Nelson mining district—

Mersey claim.	Queen Victoria claim.
Elise mine.	Maud S. claim.
Homestake claim.	Arnold claim.
Ben Hassan claim.	Canadian King claim.

North Fork of the Salmon River.

Contributions to museum—*Cont.*

c. Toad Mountain mining district—

Whitewater mine.	Dandy mine.
Grizzly Bear claim.	Silver King mine.
Iroquois claim.	Golden Dale claim.
Starlight claim.	Golden King claim.

d. Slocan mining district—

Arlington mine.	Mollie Hughes' claim.
Dayton claim.	Rambler mine.
Nancy Hanks claim.	Proctor's claim.
Carbonate mine.	Best mine.
Enterprise mine.	Idaho mine.
Utica claim.	Ohio claim.
Reco mine.	Phœnix claim.
Slocan Star mine.	Mountain Chief mine.
Granite Mountain claim.	Evening Star claim.
Antelope mine.	Two Friends mine.
Tamarack claim.	Ruth mine.
Fisher Maiden mine.	Last Chance mine.
Kalispell claim.	Alpha mine.
Texas mine.	Freddie Lee mine.
Currie mine.	Cumberland mine.
Ivanhoe mine.	Daisy claim.
Noble Five mine.	Alameda claim.
Lucky Jim mine.	Noonday mine.
Monitor mine.	Deadman mine.
Beaver mine.	London group.
Alamo mine.	Bluebird mine.
Goodenough mine.	Wellington mine.
Silver Bell mine.	Eureka mine.
Miner Boy claim.	Reid & Robinson claims.
L. H. claim.	Springer Creek.

North Fork of Carpenter Creek.

e. Ainsworth mining district—

King Solomon claim.	Lady of the Lake claim.
Skyline mine.	No. 1 mine.
Blue Bell mine.	Woodberry Creek. (Can. Pac. Co.)

McEvoy, J.:—

Molybdenite and andradite from three miles south-west of Grand Prairie, Yale district, B.C.

Contributions to museum—*Cont.*

(B.)—Received as Presentations :—

Anderson, J. H., Petpeswick Harbour, N.S. :—

Auriferous quartz from the Anderson mine, Lake Catcha gold-district, East Chezzetcook, Halifax County, N.S.

Bache, R. P., Bound Brook, New Jersey U. S. :—

Disseminated graphite from lot 26, range VI., Buckingham, Ottawa County, Q.

Barnum, S., Madoc, Hastings County, O. :—

Sphalerite from lot 1, con. XI., Marmora, Hastings County, O.

Baumgarten, Mrs. H., Ottawa, per W. J. Wilson :—

Quartz crystal and muscovite from mica mine near Lac du Pied des Monts, 18 miles from Murray Bay, Charlevoix County, Q.

Best, James, Bird Creek, Hastings County, O., per A. E. Barlow :—

Corundum crystal from lot 4, con. XVIII., Raglan, Renfrew County, O.

Blue, A., Director of the Ontario Mining Bureau, Toronto, O. :—

Corundum (blue) from lot 14, con. IX., Methuen, Peterborough County, O.

Bostock, H., M.P., Monte Creek Ranch, Ducks, B.C. :—

Obsidian from creek near Martin's, South Thompson River, B.C.

Chambers, R. E., M. E., Bridgeville, N.S., per Dr. H. M. Ami :—

Limonite from the East Branch of East River, Pictou County, N.S.

Claxton, F. J. :—

Amygdaloidal trap with native copper, from about two miles from the line of railway of the Union Collieries Company, and about thirteen miles inland from Union Bay, Vancouver Island, B.C.

Coe, A., Madoc, Hastings County, O., per W. F. Ferrier :—

a. Calcite crystals on hæmatite from lot 9, con. XIV, Madoc, Hastings County, O.

b. Chalcopyrite from lot 25, con. VII, Madoc, Hastings County, O.

Danville Asbestus and Slate Company, Danville Q., per E. D. Ingall :—

a. Crude asbestus, No. 1, from the Jeffrey mine, lot 9, range III, Shipton, Richmond County, Q.

b. Crude asbestus, No. 2.

c. Teased asbestus, No. 1.

Contributions to museum—*Cont*

d. Teased asbestus, No. 2.
e. " Grade C.
f. " " D.
g. " " E.
h. " Asbestic " sand.
i. Three samples of " Asbestic " plastering.

De Beck, G. W., Vancouver, B.C. :—

Auriferous quartz from Takush Harbour, Smith's Inlet, N. of Vancouver Island, B.C. :—

Domville, Lieut.-Col. J., M.P., Rothsay, N.B. :—

Chalcopyrite and bornite from Mineral Vale, Elgin, Albert County, N.B.

Ferrier, W. F., Geological Survey Dept., Ottawa :—

a. Meteorite (pallasite) from Brenham Township, Kiowa County, Kansas, U.S.

b. Anhydrite from lot 4, con. III, North Burgess, Lanark County, O.

c. Whartonite (of Dr. Emmens) from lot 2, con. II, Blezard, District of Nipissing, O.

Fitzgerald, J., Greenview, Hastings County, O., per W. F. Ferrier :—

Corundum (crystal) from lot 4, con. XVIII, Raglan, Renfrew County, O.

Gray, W. M. E., London, England :—

Collection of gold ores from West Australia :—

a. Dark-gray mica schist, carrying iron-pyrites, from the Ivanhoe mine, Hannans.

b. Gray schistose rock, carrying native gold, from Lake View, Hannans.

c. Slightly weathered quartzite, carrying native gold, from Hoffman, fourteen miles north of Niagara.

d. White subtranslucent quartz carrying native gold from Mount Malcolm Proprietary, Mount Margaret district.

e. Weathered sandstone carrying native gold from Cashman's Reward, Forty-two-mile district.

f. An association of white quartz and white kaolin from Cashman's Reward (surface stone), Forty-two-mile district.

g. Banded, white, greenish-gray and grayish-black steatite, carrying native gold from Devon Hill End, Broad Arrow district.

Contributions to museum—*Cont.*

Haley, Allen, M. P., Windsor, N.S. :—

Filiform native silver from No. 1 mine, Ainsworth mining district, West Kootenay, B.C.

Hardman, J. E., C. E., Montreal, Q. :—

Coal from near the junction of Keremeos road with the road from Penticton to Osoyoos, B.C.

Harris, J. M., Sandon, B.C., per Dr. G. M. Dawson :—

Silver ores from the Mollie Gibson lead, Reco mine, and the Arlington mine, Slocan mining district, West Kootenay, B.C.

James, Capt. W. E., Combermere, O., per W. F. Ferrier :—

Corundum (crystal) from lot 4, con. XVIII., Raglan, Renfrew County O.

Jones & Stark, Messrs., Wellington and Nanaimo, B.C., per W. F. Ferrier :—

Molybdenite from the Marguerite, Evangeline and Josephine claims, north side of Mount Buttle, about five miles north of Cowichan Lake, Vancouver Island, B.C.

Lanigan, R., Calumet, Q. :—

Porcelain-ware manufactured from kaolin found on lot 5, range VI., Amherst, Ottawa County, Q.

Low & Blenkhorn, Messrs, Nappan, N. S., per Hugh Fletcher :—

Chalcocite from the farm of Amos Blenkhorn, on the road between Nappan and Maccan, Cumberland County, N.S.

McArthur, D. H., Calabogie, O.

Tremolite (var. asbestus) from lot 22, con. IV., Blythfield, Renfrew County, O.

McAllister, W. B., Ottawa, O., per W. F. Ferrier :—

Quartz crystals from lot 23, range XIII., Eardley, Ottawa County, Q.

McKenzie, H. R., C. E., Sydney, N.S. :—

Soapstone from Landing Cove, north shore of Gabarus Bay, near Louisbourg, Cape Breton County, N.S.

McLellan, A., 117 Metcalfe St., Ottawa :—

Tremolite (var. asbestus) from lot 22, con. IV., Blythfield, Renfrew County, O.

Moffatt, C. P., North Sydney, N.S. :—

Chalcopyrite from George River, Cape Breton County, N.S.

Contributions to museum—*Cont.*

Newby, Frank, Ottawa, O.:—

Tremolite (var. asbestus) from near Calabogie, Renfrew County, O.

North American Graphite Company, Ottawa, O., per H. P. H. Brumell, Manager:—

a. Disseminated graphite from lot 28, range VI., Buckingham, Ottawa County, Q.

b. Vein graphite from the same locality as the preceding.

c. Prepared graphite, for crucible making—Grades L.B., L.C., L.D. and L.G.

d. Prepared graphite, for lubricating—Grades L.B., L.C., L.D., L.L., S.A. and S.A.X.

e. Prepared graphite, for packing—Grades L.D., L.F. and L.M.

f. Prepared graphite, for stove polish and pencils—Grade S.A. and S.A.X.

g. Prepared graphite, for paints—Grade S.A., S.B., P.A., P.C. (gray), P.D. and P.E.

h. Prepared graphite, for electrotyping—Grades E.A., L.L., S.A. and S.A.X.

i. Prepared graphite, for graphite greases—Grades S.A., S.A.X., S.B. and L.L.

Northumberland Stone Company, Shediac, N.B. per Foster Pickard, Manager:—

Sandstone (6 in. cube, dressed) from Buctouche, Kent County, N.B.

Obalski, J., Mining Inspector, province of Quebec, Quebec, Q., per C. W. Willmott:—

Grossularite from P. P. Hall's chromite mine, block A, Coleraine, near Black Lake, Megantic County, Q.

Ogilvie, Wm., Ottawa, O.:—

a. Coal from Coal Creek, Yukon River, N.W.T.

b. Mineral resin, Yukon River, N.W.T.

c. Collection of rocks from the Yukon district, N.W.T.

Reed, Dr. J., Reedsdale, Megantic County, Q.

Bornite from Harvey Hill, Leeds, Megantic County, Q.

Soues, F., Clinton, B. C.:—

a. Auriferous quartz from the Golden Eagle, Golden Cache, and Excelsior claims, Cayoosh Creek, Lillooet district, B.C.

Contributions to museum—*Cont.*

b. Auriferous quartz from the Ida May and Forty Thieves claims, Head Waters of the South Fork of Bridge River, Lillooet district, B.C.

Struthers, Dr. R. B., Sudbury, O., per Dr. H. M. Ami :—
Anthraxolite from lot 9, con. VI, Fairbank, district of Algoma, O.

Sutherland, Hugh, Winnipeg, Man.:—
Silver ore from the Silver Nugget mine, Eight-mile Creek, Slocan Lake, West Kootenay, B.C.

Taylor, J. W., Ottawa, O.:—
Microcline from the Township of Templeton, Ottawa County, Q.

Waterman, W. J., Vancouver, B.C.:—
Radiated quartz from Valdez Island, Seymour Narrows, B.C.

West, Howard :—
Calcite from Wilson Creek, Slocan Lake, West Kootenay, B.C.

Wheeler, A. O., Ottawa, O.:—
Marl from the Fraser River valley, near Mission City, B.C.

Wells and Redpath, Messrs., Kamloops, B.C.:—
Asbestus from the south side of Tulameen River, nearly opposite Bear Creek, Yale district, B.C.

Educationa collections supplied.

" Mr. C. W. Willimott has, for the most part, been engaged 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 :—

1. Collegiate Institute, Seaforth, O.	Consisting of	120	specimens.
2. High School, Calgary, N.W.T.	"	120	"
3. Public School, Hopewell Cape, N.B.	"	80	"
4. Union Mine School, Comox, V.I., B.C.	"	80	"
5. West Kent School, Charlottetown, P.E.I	"	120	"
6. High School, Orillia, O.	"	120	"
7. High School, Summerside, P.E.I.	"	120	"
8. Provincial Normal School, Winnipeg, Man.	"	120	"
9. High School, Oxford, N.S.	"	120	"
10. Granby College, Granby, Q.	"	120	"
11. Public School, Parrsborough, N.S.	"	80	"
12. County Academy, Shelburne, N.S.	"	40	"
13. Public School, Andover, N.B.	"	80	"
14. St. Vincent's School, St. John, N.B	"	80	"
15. Joggins Mine School, Joggins Mines, N.S.	"	80	"
16. Queen's County Academy, Liverpool, N.S.	"	120	"
17. Mont Ste. Marie Convent, Montreal, Q.	"	80	"
18. B. C. School of Mines, Vancouver, B.C.	"	120	"

Educational collections supplied—*Cont.*

19. Cong. des Sœurs de Ste. Croix et des Sept Douleurs, Montreal, Q	Consisting of	80	specimens.
20. High School, Williamstown, O	"	120	"
21. High School, St. Stephen, N.B	"	40	"
22. Polytechnic School of Laval University, Montreal, Q	"	64	"
23. Sacred Heart Academy, London, O	"	80	"
24. Grammar School, Bathurst, N.B	"	120	"
25. Convent Jesus Marie, St. Joseph de Lévis, Q	"	80	"
26. High School, Stellarton, N.S	"	120	"
27. High School, Great Village, N.S	"	80	"
28. Collegiate Institute, Kingston, O	"	120	"
29. High School, Bridgewater, N.S	"	120	"
30. Superior School, Upper Maugerville, N.B	"	80	"
31. McGill College, Montreal, Q	"	8	"
32. University of New Brunswick, Fredericton, N.B.	"	8	"
33. University of Toronto, Toronto, O	"	8	"
34. Queen's University, Kingston, O	"	8	"
35. University of Laval, Quebec, Q	"	8	"
36. School of Mining and Agriculture, Kingston, O	"	8	"
37. Grammar School, Richibucto, N.B	"	120	"
38. Grand Harbour School, Grand Manan, N.B	"	80	"
39. Public Library, St. Catharines, O	"	120	"
40. Laval Business College, St. Vincent de Paul, Q	"	120	"
41. Huron Street Public School, Toronto, O	"	80	"
42. Demill Ladies' College, St. Catharines, O	"	80	"
43. Imperial Institute, London, Eng	"	12	"
44. Morin College, Quebec, Q	"	40	"
45. Public School, Riverside, N.B	"	80	"
46. High School, Tracadie, N.B	"	120	"
47. Hants Border School, Hantsport, N.S	"	80	"
48. Couvent du Sacré Cœur, Ottawa, O	"	80	"
49. High School, Waterford, N.B	"	120	"
50. High School, St. Catharines, O	"	120	"
51. The Academy, Yarmouth, N.S	"	120	"
52. Salem School, Salem, N.S	"	80	"
53. High School, Mitchell, O	"	120	"
54. High School, Markham, O	"	120	"
55. Havergal Ladies' College, Toronto, O	"	120	"
56. District No. 1 School, "The Range," N.B	"	80	"
57. Public School, Jarvis, O	"	80	"
58. Public School, Brandon, Man	"	80	"

"Making a total of 5,164 specimens thus distributed. In addition, specimens of various mineral substances have been supplied by request to several institutions and firms.

Collections made by Mr. Willimott.

"In the early part of the summer Mr. Willimott visited, with the object of procuring further material for the making up of collections and simultaneously, cabinet specimens for the museum—the townships of Hull, Wakefield, Masham, Wright, Maniwaki and Egan, in Wright county, and those of Aldfield, Cawood and Alleyn, in Pontiac county, in the province of Quebec; as likewise the townships of Cameron, Collections made by Mr. Willimott—*Cont.*

Papineau and Calvin, in the district of Nipissing, and those of Griffith, Lyndoch, Raglan and Sebastopol, in Renfrew county, in the province of Ontario.

"In the prosecution of this work he procured, amongst other specimens :—

	Specimens.	Weight.
Albite	24	
Apatite, crystals	150	
Amazon stone	150	
Asbestus	7	
Barite		400 pounds.
Calcite		150 "
Chrysotile	2	
Chalcedony	2	
Corundum	200	
Fluorite	30	
Gneiss		700 "
Graphic granite	2	
Graphite	2	
Grossularite	130	
Hornblende, crystallized		150 "
Limestone, crystalline		300 "
Mica	8	
Mica, crystals	50	
Microcline	3	
Molybdenite, from Aldfield, Hull and Egan	66	
Molybdenite, from Alleyn		100 "
Mountain cork	70	
Pyroxene	30	
Quartz, crystals	130	
Quartz, massive		200 "
Serpentine		450 "
Tourmaline, crystallized	235	
Tremolite		400 "
Wollastonite	100	

"Amongst the minerals collected by Mr. Willimott for the museum, collection, was one which proves on examination to be a rare and interesting species not previously found in Canada. This will be referred to in full in my forthcoming report. Mr. Willimott also made some useful notes in regard to the occurrence of some of the above-mentioned minerals—more especially touching that of the molybdenite.

"In addition to the above minerals, Mr. Willimott has received for making up collections the following from Mr. W. F. Ferrier :—

	Specimens.	Weight.
Andradite	16	
Nephelite, with albite	50	
Corundum, in matrix		100 pounds.
Pyroxene, crystals	200	
Quartz, crystals	380	

LITHOLOGY.

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

"The usual routine work has been carried on during the past year. It has comprised the examination and reporting on numerous miscellaneous minerals and rocks, including interesting series of rock specimens from the cinnabar deposits near Kamloops Lake, British Columbia, and some of the Seine River gneisses collected by Mr. McInnes.

"In the museum, temporary labels have now been placed in all the upright cases of the stratigraphical collection of rocks. A camera for taking micro-photographs with the new Fuess microscope lately acquired, has enabled a number of interesting photographs illustrating the structure of various rocks to be obtained, some of which will be published in forthcoming reports. Museum.

"On the 27th of June I left Ottawa to continue my observations on the corundum deposits of Hastings and Peterborough counties, O., and also to examine the nepheline-syenite localities in the former county for rare minerals. During a portion of the time I made my head-quarters at the camp of Mr. Barlow of this Survey, whose work lay in the vicinity. Field-work.

"The nepheline-syenites of Dungannon township were carefully examined, and fine specimens of sodalite, nepheline, cancrinite, biotite, apatite, hastingsite, etc., were secured. Besides these minerals some rare and interesting species not previously observed were collected and will shortly be described. Minerals collected.

"From Dungannon I went with Mr. Barlow to the pyroxene locality in the township of Herschel, and collected some hundreds of exceedingly fine and perfect crystals. I then went south to Madoc, collecting blende, quartz crystals, hæmatite, erythrite and calcite in the neighbourhood, and drove to the corundum locality in the township of Methuen, Peterborough county.

"The corundum here, as in Hastings, occurs in a coarse pegmatite, distributed rather sparsely throughout the mass and intimately associated with muscovite, in which it is frequently completely embedded. Some of it is of a rich sapphire blue colour, but no material fit for cutting was found. No good crystals were seen, the corundum occurring in irregular rounded masses, having a most curious corroded surface, greatly resembling the rounded and corroded quartz crystals that occur in the bornite at the Harvey Hill mines in the Eastern Townships of Quebec. Corundum.

Lithology—*Cont.*

"I returned to Madoc and went north again to the township of Carlow, where the original corundum locality, near Armstrong's mills, was visited, fine crystals collected and several photographs taken by Mr. Barlow. From Carlow I proceeded to the corundum locality on the farm of Henry Robillard, lots 1 and 2, concession XIX., and 3 and 4, concession XVIII., Raglan township. The occurrence of the corundum here appears to be of much the same character as in Carlow, but some interesting and new facts were observed.

"In the same hill we found syenite, granite and nepheline-syenite occurring in such relations as to leave no doubt in my opinion that we have there a magnificent example of magmatic differentiation of rock types. The corundum occurs impartially distributed throughout the whole of these three types of rock. This particular locality will be fully described in Dr. Adams's and Mr. Barlow's report on the region.

"Spinel, of a bright green colour, in beautifully fresh and well formed octahedrons, was found lining cavities in the corundum; and many other interesting minerals were observed.

"I returned to Ottawa on the 17th of July, and, availing myself of your permission, attended the August meeting of the British Association for the Advancement of Science in Toronto, where I read a paper jointly with Mr. Barlow."

MINING AND MINERAL STATISTICS.

Mineral statistics.

Of the work under his charge, Mr. E. D. Ingall reports as follows:—

"The work of the Section of Mineral Statistics and Mines has been prosecuted throughout the year on much the same lines as heretofore.

"The preparation of the preliminary summary statement of the mineral production of the Dominion for 1896 was completed by the 13th of February of the current year. This is the earliest date yet accomplished, and the pamphlet containing this tabulated statement, together with the explanatory matter, was distributed shortly afterwards.

"On 26th of June, a pamphlet was completed giving in tabular form the production of the various mineral industries of Canada from 1886 to 1896, inclusive. This statement was compiled from the summary tables of mineral production found in the annual reports of the section, revised in accordance with the latest information available and brought to a uniform basis of presentment. This was accompanied by explanatory matter relating to the growth and change of the various industries during the eleven-year period covered. Mineral statistics—*Cont.*

"As much of the detailed information for the detailed statistical report is not available for some months after the close of the year dealt with, it has been found impossible, with present facilities, to complete it and put it through the press till late in the year following that to which it refers. The full report for 1896 is, however, printed and distributed to our exchanges. A commencement has been made toward revising the statistical data for past years contained in this report, with regard to which important information has of late come to hand which was not available in previous years.

"The collection of samples from borings made throughout the Dominion and of records of the same, has, through the kindness of operators, been augmented, and progress has been made in the collection of plans, photographs and other records of mines and mineral deposits. Samples from borings.

"The widespread interest of late aroused in mining matters and in the mineral resources of the Dominion has greatly stimulated inquiry on these points, and the Section has, of course, had to do its share of the largely increased work of the Department due to this cause.

"Of late years, for various reasons, but little time has been available for the personal study by the officers of the Section of the various mineral industries of the country. Thus the technical information available for the report is either fragmentary and somewhat doubtful or obtained indirectly from various sources of varying reliability. An effort was, however, made during the summer to use the little time available, and visits were made to the iron deposit and quarries at Arnprior and to the galena deposits near Galetta in that vicinity. Visits to mines.

"With a view to increasing our knowledge of the graphite industry of Ottawa county, Quebec, I made several trips to the mines in Buckingham township to determine the best lines of procedure to this end. This work was carried out by Mr. A. A. Cole, B.A.Sc., who was occupied several weeks in making the necessary surveys and examinations. As a result of his work detailed plans are now available, showing the distribution of the worked deposits and the extent and relations of the workings, together with notes on their immediate geological surroundings and various other points. It is intended to incorporate these results in the next report and to give thus, not only the statistical data, but also the technical details necessary to a complete description of this industry.

Mineral statistics—*Cont.*

"During the year Mr. A. A. Cole has acted as technical assistant, and in July the staff of the Section was brought to its former strength by the appointment of Mr. J. McLeish, B.A., *vice* Mr. L. L. Brophy, who resigned on March 31st."

PALÆONTOLOGY AND ZOOLOGY.

Palæontology and Zoology.

Mr. Whiteaves submits the following statement of the palæontological and zoological work done in 1897, either by himself personally or under his immediate supervision.

Publications.

"The third part of the third volume of 'Palæozoic Fossils' referred to in the Summary Report of this Department for 1896, was published in April, 1897. It consists of 114 pages, large octavo, and is illustrated by seven full-page lithographic plates and fifteen woodcuts. During its preparation, the authorities of the United States National Museum kindly lent to the writer, for study and comparison, all the fossils in their collection from the Galena-Trenton formation of the Red River valley in Canada. These fossils were identified early in the spring and returned, named, on April 30th.

"A collection of fossils from the Cretaceous rocks of North-west Bay, Vancouver Island, and other localities in British Columbia, has been examined and the species determined, for Mr. Walter Harvey, of Shoal Bay, Thurlow Island, B.C., who has presented many fine and rare specimens to the Museum.

"A paper entitled 'Description of a new genus and species of Cystideans from the Trenton limestone at Ottawa,' was published, with three illustrations, in the number of the 'Canadian Record of Science' issued in June. The genus is of special interest to biologists on account of its close affinity to the Blastoids. Two papers descriptive of other remarkable fossils in the Survey collection were read at the meeting of the British Association for the Advancement of Science in Toronto. One of these is entitled 'Note on a fish tooth from the Upper Arisaig series of Nova Scotia,' and the other 'On some remains of a Sepia-like Cuttle-fish from the Cretaceous rocks of the South Saskatchewan.'

"While attending the meeting of the Royal Society of Canada at Halifax in June, and that of the British Association in August, several public and private palæontological and zoological collections were examined, and a number of specimens of interest secured for the museum of the Survey.

"The second part of the first volume of 'Contributions to Canadian Palæontology' published in 1889, contains an illustrated paper (advance sheets of which were distributed in 1887 and 1888) entitled 'On some fossils from the Hamilton formation of Ontario,' with a list of the species at present known from that formation and province. Since this paper was published, many additional species have been discovered in these rocks by local collectors, and specimens of most of them have been presented to the museum of the Survey, or acquired for it. It has, therefore, been decided to devote the fifth and concluding part of the volume to an illustrated paper consisting of a revision of this local fauna, inclusive and descriptive of the most recent additions thereto. With this object in view and before commencing the manuscript of this paper, a visit was paid to Thedford in May, and the large and important collections of the fossils of that neighbourhood recently made by the Rev. Hector Currie, Mr. G. Kernahan and Mr. N. J. Kearney were carefully examined. At Toronto, Mr. B. E. Walker's collection of the fossils of the Thedford region was also critically examined. Numerous specimens from each of these collections have been borrowed for a further and more exhaustive study, and Mr. Charles Schuchert has most kindly lent the writer 284 specimens of 44 species of fossils, and a list of all the species that he collected at Thedford and Bartlett's Mills, in 1895, for the United States National Museum. Many of the species lent by Mr. Schuchert have not previously been found in Canada, and a few are, apparently, new to science. A preliminary study of the whole of this material has been made and the manuscript of the part of the paper referring to the corals, echinodermata, brachiopoda and pelecypoda, or about one-third of the whole, has been written. It is hoped that the whole of the manuscript, with the plates, will be ready for publication, and the volume finished, next spring.

Palæontology and Zoology—*Cont.*

Hamilton formation, Ontario.

"Since the lamented death of Professor E. D. Cope, in April, the vertebrate fossils from the Belly River and Laramie rocks of Alberta, which had been entrusted to him for study and description, have been returned from Philadelphia. A few of the more fragile of these specimens were somewhat broken in transit, but these have been skilfully mended by Mr. T. C. Weston, who has also mounted several of them, especially two unique skulls of a Dinosaur (*Lœlaps incrassatus*, Cope), for exhibition in the museum.

Cretaceous vertebrate fossils.

"In addition to the series of vertebrate fossils from the Red Deer River collected by Mr. Lambe, and the bones and teeth of Mastodons from two localities in Ontario collected by Dr. Ami, which are referred to in their reports, several interesting collections of fossils have been acquired during the past year, either by donation or purchase, and in

Palæontology and Zoology—*Cont.* most cases as the result of correspondence or of personal interviews with the collectors.

Additions in zoology. "The additions to the zoological collections in the museum have been quite as numerous as in previous years, as will be seen in the list of contributions to the museum, in which they are fully particularized. The skins of the adult male northern fur-seal and two pups, and of the northern sea-lion and cub, from the Pribyloff Islands, which were referred to in last year's Summary Report as having been received from Mr. James M. Macoun, have been mounted at the Ward Natural Science Establishment at Rochester, N.Y. The group of the three fur-seals makes a striking and attractive exhibit, but the sea-lion is unfortunately too large to be brought into the museum.

"The official correspondence has been about as usual (a little more than 200 letters). The duties of Acting Director have been performed for about five weeks, during the Director's absence in British Columbia.

Work by Dr. H. M. Ami. "Dr. Ami has continued the work of determining palæontological collections, principally from the eastern provinces of the Dominion, besides giving some time to the preparation and display of specimens in the museum.

"Lists of fossils from numerous localities in the Ottawa palæozoic basin and in the valley of the St. Lawrence, between Brockville and Montreal, have been prepared and added to those referred to on page 126 of the Summary Report for 1896, all of which are to accompany the reports by Dr. Ells on the areas comprised in Ottawa City, Perth and Pembroke sheets (Nos. 119, 120, 122 of Quebec and Ontario). These lists were prepared from collections made by Dr. Ells and the late Mr. N. J. Giroux in 1896. Dr. Ami also assisted Dr. Ells in ascertaining the precise geological horizons of certain much faulted and disturbed fossiliferous limestones in the vicinity of Ottawa.

"He has also continued the work of determining a large number of fossils collected by Mr. Hugh Fletcher, Mr. T. C. Weston, Mr. J. A. Robert, and by himself, last season, in Colchester, Pictou and Antigonish counties. With a view to ascertaining the exact age of the sedimentary formations of that part of Nova Scotia, the report and geological maps of which areas are being prepared for publication by Mr. Fletcher, the greater portion of the specimens have been examined and preliminary lists of the species prepared.

Field-work in Nova Scotia. "On the first of June Dr. Ami received instructions to proceed to Nova Scotia to continue the work of the two previous seasons and 'obtain local series or lists of fossils from as many places as possible in the so-called Devonian belt of the southern parts of Pictou and Colchester counties;' likewise 'to visit such parts of the province to the west as might be found desirable in the course of Mr. Fletcher's mapping work, with possible reference to the taxonomic position of the New Glasgow conglomerates or their equivalents,' etc. From the 1st of June to the 10th of August he visited numerous localities in the Middle and West River valleys of Pictou county, along the valleys of the Salmon and Black rivers and Calvary Brook, in the numerous cuttings afforded by the railway from Union station to West River station. Special attention was paid to the highly fossiliferous shales of Avonport, Horton and Trenholm Brook, in order to ascertain the relations which the Horton series of Sir Wm. Dawson bears to the fossiliferous rocks of Riverdale and other localities of so-called Devonian age. From these Horton beds a large and interesting collection of fossils was obtained.

Palæontology and Zoology—*Cont.*

Pictou county

"In Antigonish county, he also spent some time obtaining material both from the undoubted Silurian formations of the Arisaig shore and from the supposed Devonian series of McAra's Brook. From several localities in this brook better material was obtained than on any previous occasion. It is hoped that this will serve to fix more definitely the age of these rocks and to enable the proper geological colouring to be given to the maps of this part of the province, now awaiting publication.

Antigonish county.

"Big Island Merigomish, and King Head were visited with a view of ascertaining the exact age of the coal-seam cropping out north of the lobster factory, but the palæontological evidence obtained in these places was very meagre and unsatisfactory.

"The Cumberland coal basin and the relations of the Millstone Grit and the productive Coal Measures and of the Upper Carboniferous or Permo-Carboniferous, to one another, occupied a considerable portion of his time. Collections of fossils were made at Spicer's Cove, West Cove, Pudsey's Point, Sand River Cove, Shulie, Joggins and Fish Cove, in the Joggins Mines district, as well as at Leamington, in South Brook, Dixon's Mills and Salt Springs mines, in the Springhill mines region. The shales of Spicer's Cove contain a flora apparently akin to that of rocks which are referred by Dr. Ells to the Millstone Grit. This flora, however, has a decided resemblance to that of the Coal Measures. In no part of the district did he find types which are indicative of Permian age.

Cumberland county.

"In this work Dr. Ami was ably assisted by Mr. Lee Russell, of the Provincial Normal School, Truro, N.S., and by Mr. M. H. McLeod—

Palæontology and Zoology—*Cont.*

Mr. Hugh Fletcher's assistant. He desires to convey thanks also to Prof. Coldwell, Prof. Tufts, and to Mr. Harold Tufts, all of Wolfville, N.S., for assistance furnished whilst in their neighbourhood.

"He has prepared preliminary lists of the fossils from these localities which will help to determine the exact palæontological and stratigraphical relations of the various members of the disturbed and doubtful series of rock formations of the counties of eastern Nova Scotia. When in Halifax, Montreal and St. John, N.B., Dr. Ami obtained access to the palæontological collections from Nova Scotia in the museums of those places, and secured lists of fossils which help to throw further light upon this difficult problem. In connection with the work a standard section should be made, and he suggests that a careful examination might be undertaken of the exact sequence of the fossils in Sir Wm. Logan's great section of Carboniferous strata at the Joggins shore. Also a series of collections of fossils should be made from Folley, Economy, Parrsboro', Five Islands, Shubenacadie, Tenycape and Walton, in Nova Scotia, and from St. John, Mispec, Albert county and other localities in New Brunswick.

"In connection with the work in Nova Scotia the following points may be noted:—

Notes on the work done.

"(1) No fossils were obtained in the New Glasgow conglomerate of Pictou county.

"(2) In the rocks overlying the New Glasgow conglomerate along the eastern bank of the East River, between New Glasgow and Trenton, in Rear Brook quarry, and along the left bank of Smelt Brook above the bridge at the Trenton steel works, certain black Carboniferous and highly fossiliferous shales occur, associated with soft, gray, and more or less fine-grained sandy shales and sandstones also fossiliferous. The evidence afforded by the fossil flora and fauna of this series points to the Carboniferous rather than to the Permian age of the rocks in question. No typical Permian forms have yet been obtained from these beds, but land plants and aquatic animals collected indicate the Carboniferous Period.

"(3) The nearest approach to Permian is found in the strata of Cape John and vicinity, where large branches of the genus *Walchia* and fronds of *Pecopteris* occur. These have a Permian facies, but the genera mentioned might occur in Upper Carboniferous rocks. The term Permo-Carboniferous, already used by the Survey, seems quite applicable to the shales and sandstones of Cape John and other localities.

"(4) The fossiliferous sandstones and shales of the Union and Riversdale regions in Colchester and Pictou counties, are seen to lie unconformably beneath the fossiliferous marine limestones, sandstones and shales of Lower Carboniferous age. They hold plants and animals which in their broad general characters resemble those of the eastern American Carboniferous—if we leave out of consideration the types which occur in the 'fern-ledges' of Lancaster county in New Brunswick, described and regarded as Devonian. The fossils which show this affinity to types of Carboniferous age include, besides the presence of a protolimuloid crustacean closely allied to *Prestwichia* and erect trees of doubtful affinities, such genera as: *Calamites*, *Asterophyllites*, *Alethopteris*, *Sphenopteris*, *Cyclopteris*, *Cordaites*, *Spirorbis*, *Naiadites*, (*Anthracomya*), *Lepidodendron*, *Leaia*, *Carbonia*, *Estheria*, *etc*. All these have been found in the Riversdale and Union rocks, and the following species are common to these rocks and those of Lancaster county, New Brunswick: *Cyclopteris (Aneimites) Acadica*, *Lepidodendron corrugatum*, *Stigmaria ficoides*, var., *Cordaites Robbii*, (sometimes with numerous specimens of *Spirorbis* covering the surface of the leaves), besides closely related forms belonging to the genera *Calamites*, *Asterophyllites*, *Alethopteris* and *Sphenopteris*. From this it would appear that the strata of Union and Riversdale may be regarded as equivalent to those in Lancaster county, which have been described and held to be of Devonian age. Palæontology and Zoology—*Cont.*

"Some Ostracods from the rocks above referred to have been sent to Prof. T. Rupert Jones, and fragments of crustacea and fishes to Dr. Henry Woodward and Mr. A. Smith Woodward, of the British Museum; who have furnished important information in regard to them.

"In the museum, a large number of boxes containing local series and lists of fossils has been placed in the drawers below the cases, and a catalogue of these has been prepared. Two cases of fossils from the Manitoba Devonian areas have been arranged during the year. To the collection containing duplicate specimens for educational and distribution purposes, material has been added from time to time. Additions of species to the museum collection have been recorded and entered in a catalogue of Canadian fossils in course of preparation. Work in the museum.

"Dr. Ami also reports that he has kept the records and additions to the ethnological collection and has spent some time in obtaining exact information regarding the objects of Indian manufacture recently obtained from the Department of Indian Affairs.

"On the 21st of August he was instructed to proceed to Leamington, in Essex county, Ont., and to Marburg, in Norfolk county, Ont., to investigate recent discoveries of elephantine remains at these places. Mastodon remains in Ontario.

Palæontology and Zoology—*Cont.*

Nearly six weeks were spent in this work. He made notes on the mode of occurrence of the remains, and on the characters of the deposits in which they were found, and obtained, not only numerous bones and teeth, with portions of the skulls, of two or more specimens of Mastodon, but also specimens of fossil wood and molluscan fossils occurring with the remains, which throw some light on the climatic conditions of the period when these animals existed in Ontario. As far as is known the exact mode of occurrence of Mastodon remains in Western Ontario has not been previously noted.

Cambro-Silurian outliers

"In connection with the geology of the district comprised in sheet No. 131, Ontario, Lake Nipissing sheet, he has examined a small but important collection of fossils from Mattawa, which appears to represent the most westerly outlier of Ordovician strata in the Ottawa Valley. The list of fossils from this locality will appear in Mr. Barlow's report on the geology of that region. In order to more effectively complete the study of the fossil fauna of the Lake Temiscaming outlier, sheet No. 138 of the Ontario series, a box of fossil remains obtained by officers of the Geological Survey during Sir Wm. Logan's administration, was examined and a list of the species therein prepared to be incorporated in the report on the fossils of the district.

"Collections of fossils for educational institutions in Canada are in course of preparation, and seventy-five specimens of fossil Brachiopoda from the Island of Anticosti have been forwarded to Prof. James Hall, of Albany, N.Y., in exchange for specimens received.

Report on museums.

"By request of the Director, and with his assistance, Dr. Ami has prepared a 'Report upon the state of the principal museums in Canada and Newfoundland.' This report, which was read before The General Conference Committee of the British Association for the Advancement of Science during its meeting in August last at Toronto, has subsequently been printed *in extenso*. It is essentially a digest of the contents of thirty-one museums in Canada, together with notes on fifty private collections.

"On several occasions he has been called upon to examine and report upon materials obtained in the course of boring operations in the Palæozoic rocks of various localities in Ontario, with special reference to the occurrence of gas, oil or salt in the strata penetrated. These reports were handed to the Director from time to time.

Report by Prof. Lapworth.

"Prof. Charles Lapworth, of Mason Science College, England, the well-known authority on graptolites, has completed the task of identifying a large number of specimens sent him since 1885, and has sent a MS. report on the graptolites from many localities in Canada, from the Atlantic to the Pacific. The specimens upon which this report is based were returned in the spring.

Palæontology and Zoology—*Cont.*

"The following papers were prepared by Dr. Ami during the past year, in addition to his report on Canadian museums :—

"'Notes on some of the fossil organic remains in the geological formations and outliers of the Ottawa Palæozoic Basin.' Royal Soc. Can., 2nd series, vol. II., sec. IV., pp. 151-158. 'Synopsis of the Geology of Montreal,' being part of British Medical Association Souvenir Guide. 'Contribution to the Palæontology of the Post-Pliocene Deposits of the Ottawa Valley.' Ottawa Naturalist, vol. XI., No. 1, pp. 20-26.

Work by Mr. L. M. Lambe.

"Mr. L. M. Lambe completed the revision of the Palæozoic tabulate corals of Canada, to which reference was made in the Summary Report of 1896, and the manuscript was prepared for the printer at the end of February. The drawings thought necessary for the proper illustration of the structural details of the corals were made by Mr. Lambe, and have been reproduced, forming in all five octavo plates. Late in February, in continuation of his study of Canadian Palæozoic corals, work on the *Rugosa* was begun and continued until the middle of July. There are now known in Canada about twenty-four genera and over one hundred species of corals of this group.

Collections made in the North-west.

"In July, Mr. Lambe was directed to proceed to the North-west Territories, with the double object of inspecting and reporting upon the experimental borings in progress there and of collecting further fossil remains from the Laramie and Belly River formations in the vicinity of Red Deer River. In compliance with these instructions, Mr. Lambe left Ottawa on July 23rd for Red Deer, Alberta, from which place it was proposed to descend the river by boat and thus reach some of the best exposures of these formations. Red Deer was reached on July 29th, and, with two men engaged there, a start was made on the morning of July 31st.

"Progress down the river was rendered comparatively easy, as there was a fair amount of water in the stream, and the current was moderately strong. The mouth of the Red Deer River, where it debouches into the south branch of the Saskatchewan River, was reached on August 31st. Continuing down the South Saskatchewan River, Saskatchewan Landing, distant about three hundred and eighty-five miles from Red Deer by water, was reached on September 3rd. Here the fossils collected, aggregating in all over eleven hundred pounds in weight, were packed in boxes and transported by wagon south by the Battleford trail to Swift Current, a distance of twenty-seven miles, whence they

Palæontology and Zoology—*Cont.*

were shipped to Ottawa by rail. It was found later, on being unpacked, that none of the fossils, nearly all of which were fragile and some of considerable weight and size, had suffered from their long journey.

"The Red Deer River, below Red Deer, is swift, with an average fall of about five feet to the mile, and for about forty miles below the village is practically a succession of short rapids. From Tail Creek to the Rosebud River, the current averages a little over two miles an hour. In the lower part of the river the current is about one and three-quarters mile an hour. Between Dead Lodge Cañon and the mouth, progress was often much impeded by the prevalence of sand-bars, over which the boat, now weighed down by its load of specimens and drawing about eleven inches of water, had to be constantly dragged. On the South Saskatchewan River, using two pairs of oars and assisted by a favourable wind, as much as forty miles was made in one day.

"All the rocks exposed on either side of the river, as far as a point a couple of miles below Willow Creek, belong to the Laramie formation and consist, for the most part, of sandstones and clay-shales. Beyond this the Pierre rocks underlying the Laramie, make their appearance in the bottom of the valley, and are continuous for a distance of about thirty-three miles, to a point three or four miles below Bull Pound Creek, where those of the Belly River series underlying the Pierre are met with.

"The primary object of the expedition being the collecting of reptilian remains, especially those of dinosaurs, that were known to occur in the rocks of the Laramie and Belly River formations, special search was made for bones in all the rock-exposures seen as the course of the river was followed downward. The intervals between camps varied much, and depended entirely on the richness of the beds in fossil remains. When it was found desirable, a stay of two or three days was made at one locality, or the camp was then removed across the river, or only a mile or two down stream.

"On leaving Swift Current, Mr. Lambe proceeded to Edmonton and thence to Victoria, Alberta, in connection with the boring operations there in progress under contract with the government.

"Ottawa was reached on October 2nd.

Dinosaurian remains.

"It would be premature to offer any descriptive account of the fossil organic remains collected, more especially as it is hoped that further collections may be made, which will elucidate the relations of the dinosaurian bones, of which the greater part of the material consists. The eventual comparison of the remains from the Laramie and Belly

River formations—two clearly defined series between which the marine Pierre formation is interposed—will undoubtedly afford matter of much interest."

The following is a list of specimens collected by or received from officers of the Survey, during the year 1897 :— Contributions to museum.

Dr. R. Bell :—

Walrus skull from Baffin Land.
Ninety fossils from Akpatok Island.
Six objects of Eskimo manufacture.
Forty-six birds' eggs from Hudson Bay.

Professor Macoun :—

Thirty-four sets of birds' eggs from Alberta, collected by W. Spreadborough.

James Macoun :—

Nest and eggs of the Lapland Longspur and Gray-necked Finch, and eggs of five other species of birds, from St. Paul's Island, Behring Sea.

J. B. Tyrrell :—

432 fossils from the Cambro-Silurian and Devonian rocks of northern Manitoba, and fifty specimens of *Anodonta Simpsoniana* and *Unio luteolus* from Lake Manitoba.
Stone knife obtained from José Mercredi, Fond du Lac, Lake Athabasca, in 1892.
Two fragments of pottery from Ile à la Crosse, Churchill River, collected in 1892.
Four spear heads from Cree Lake, Stone and Churchill rivers, collected in 1892.

A. P. Low :—

Two specimens of the Ivory Gull, shot in the ice off Sandwich Bay, Labrador, June 12, 1897.

L. M. Lambe :—

A series of reptilian and plant remains from the Belly River and Laramie formations of the Red Deer River, Alberta.
Two stone mauls of Indian manufacture from the Red Deer River.

W. McInnes :—

A few obscure fossils (loose) from the Lake of the Woods and Eagle Lake, O.

Contributions to museum—*Cont.*

Dr. H. M. Ami :—

About 2,000 fossils from Pictou, Colchester and Cumberland counties, N. S.

400 specimens of fossil plants, fish remains, *etc.*, from Avonport, Horton Beach and Trenholm Brook, King's County, N.S.

Portions of the skeleton of two specimens of the Mastodon from Essex and Norfolk counties, O.

336 chipped flints, 144 arrow-heads, four adzes, three whetstones and two gouges, of Indian manufacture, from the township of Woodhouse, Norfolk county, O.

Dr. Ami, L. M. Lambe and W. J. Wilson :—

A number of Pleistocene fossils from Besserer's Grove, near Ottawa.

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

By presentation :—

(A.—*Palæontology*).

Colonel C. C. Grant, Hamilton, O. :—

Numerous fossils from the Medina, Clinton and Niagara formations, near Hamilton.

B. E. Lyster :—

Several fossil plants from the Tertiary rocks at Vancouver, B.C.

J. B. Hobson :—

Portion of a bone from the Cariboo Hydraulic mine, B.C.

Thomas Armstrong, Harwood Plains, O. :—

Specimen of *Columnaria Halli*, Nicholson, from the Black River limestone of March township, Carleton County, O.

Rev. Hector Currie, Thedford, O. :—

Twenty-five fossils from the Hamilton formation at Thedford and Bartletts Mills.

G. Kernahan, Thedford, O. :—

Fifty fossils from the same formation and localities.

R. Macintosh, Thedford, O. :—

Five fossils from the Hamilton shales at Thedford.

Colonel F. Ruttan, Winnipeg (per J. B. Tyrrell) :—

Five fossils from the Hudson River formation at Little Stony Mountain, Manitoba.

W. H. Robson, Lethbridge, Alberta (per J. B. Tyrrell) :— Contributions to museum—*Cont.*

100 fossils from the Hudson River formation at Stony Mountain, Man., from the Silurian rocks at Stonewall, Man., and from the Cretaceous rocks of Alberta.

W. Townley, Stony Mountain, Manitoba (per J. B. Tyrrell) :—

Seven fossils from the Hudson River formation at Stony Mountain.

John Gunn, Stonewall, Manitoba (per J. B. Tyrrell) :—

Specimen of a supposed new species of *Gyroceras* from the Silurian rocks at Stonewall.

Donald Gunn, Stonewall, Manitoba (per J. B. Tyrrell) :—

Specimen of an *Orthoceras* from Stonewall.

Frank Newby, Ottawa :—

Three fossils from the Guelph formation at Elora.

W. G. Otto, Vars, Russell County, O.:—

Specimen of an *Orthoceras* in a slab of limestone dug up at Vars.

Rev. W. Patterson, M.A., Leamington, O.:—

Eight fossils from the Corniferous limestone of Essex County, O.

Victor W. Lyon, Jeffersonville, Indiana, U.S.A. :—

One hundred and eighty-seven specimens of seventy-two species of fossils from the Devonian formation, and nine specimens of three species from the Niagara formation, of Clarke County, Indiana.

S. W. Wilkins, Ottawa :—

Six species of fossils from the Cretaceous rocks of the Belly River district.

(B.—*Zoology*).

Sir William Henry Flower, K.C.B., &c., Director Nat. Hist. Dep., British Museum :—

Skull of Bull Gaur (*Bos gaurus*) from India.
Skull of Indian Buffalo (*Bos bubalus*).

Prof. D'Arcy W. Thompson, Univ. Coll., Dundee, Scotland :—

One egg of the Great Black-backed Gull, two eggs of the Glaucous Gull, one egg of the Kittiwake, and one egg of the Dovekie, all from Disco, Greenland ; and one egg of the Kittiwake from Davis Strait.

Contributions to museum—*Cont.*

Rev. C. J. Young, Lansdowne, O. :—

Specimen of Brunnichs Murre, shot on the St. Lawrence at Rockport, O.

Three eggs of Cooper's Hawk, three of the Florida Gallinule, and three of the Red-winged Blackbird, all taken in eastern Ontario.

T. J. Egan, Halifax, N.S.:—

Two specimens of the Black Rat *(Mus rattus)* caught near Halifax.

Two specimens of the Red Phalarope *(Crymophilus fulicarius).*

Dr. C. F. Newcombe, Victoria, B.C.:—

Ten specimens of three species of marine shells from British Columbia, not previously represented in the museum.

Walter Harvey, Thurlow, B.C.:—

Four specimens of a rare marine mollusc (*Volutharpa ampullacea*) from Shoal Bay, B.C.

J. H. Fleming, Toronto :—

Egg of the Black-footed Penguin (*Spheniscus demersus*).

Set of four eggs of the Chickadee (*Parus atricapillus*) from the Parry Sound district.

F. A. Saunders, Ottawa :—

Skins of 220 Canadian birds and of five Canadian mammals.

R. H. Hunter, Ottawa :—

Two eggs of the Night Hawk found on the roof of a house in Gilmour St.

W. B. Dawson, Ottawa :—

Small land shells from St. Paul Island, Gulf of St. Lawrence.

W. T. Lawless, Ottawa :—

Adult female Murre (*Uria troile*) caught in the ice at Kettle Island, Ottawa River, Dec. 12, 1897.

John Giles, Mimico, O.:—

Curious variety of the House Sparrow, shot at Mimico.

Dr. James Fletcher, Ottawa :—

Specimen of a sponge (*Clathria delicata*, Lambe) from Squirrel Creek, Prince Edward Island.

G. B. Boucher, Fort Chimo, Labrador (per A. P. Low) :—

Three eggs of the Gyr Falcon and three of the Semipalmated Plover.

G. R. White, Ottawa :— Contributions to museum—*Cont.*

Seven mounted photographs of the nest and eggs of Canadian birds, in their natural surroundings.

(*C.—Ethnology*).

From the Department of Indian Affairs :—

A collection of objects of Indian manufacture from the coast of British Columbia and the North-west Territories.

Commander Wakeham, Ottawa :—

Harpoon, spear, duck dart, waterproof skin and two floats, from the shores of Hudson Strait.

W. H. Porter, Fort Erie, O. :—

Nineteen specimens of arrow-heads, spear-heads, and other stone implements from Fort Erie.

Malcolm McKinnon, Thedford, O.:—

Three flint arrow-heads from Thedford.

T. C. Weston, Ottawa :—

Paint bag from an Indian grave in the N. W. T.

C. N. Challand (per Dr. H. M. Ami) :—

Spear-head from lot 15, concession V., township of Woodhouse, Norfolk County.

Christopher Nelson, Marburg, O. (per Dr. H. M. Ami) :—

Stone amulet or ornament from lot 3, concession V., township of Walpole, county of Haldimand.

Frank McCall, Simcoe, O. (per Dr. H. M. Ami) :—

Five arrow and spear-heads from lot 1, concession V., township of Woodhouse, county of Norfolk.

By purchase :—

(A.—*Palæontology*).

Tusks and other remains of a Mastodon found by Mr. Challand at Marburg, Norfolk County, O.

Twenty-three rare species of fossils from the Cretaceous rocks at Hornby, Denman and Vancouver islands, B.C.

Three rare and almost unique crinoids, and one portion of a ventromedian plate of a *Coccosteus*-like fish, from the Hamilton formation of Ontario.

Contributions to museum—*Cont.*

Numerous specimens of fossil plants and fresh water shells, mostly Unionidæ, from the interglacial deposits near Toronto.

About 200 specimens of the rarer fossils of the limestones and shales of the Lévis formation at St. Joseph de Lévis, Q.

(B.—*Zoology*).

Specimen of the Golden Eagle, shot near Woodbridge, York County, O, in November, 1897.

Ruff and Reeve, shot on Toronto Island by Mr. H. Humphrey, in May, 1877.

Set of (two) eggs of the Bald Eagle, taken at Sheet Harbour, near Halifax, N.S.

Two eggs of the Osprey, taken at Porter's Lake, near Halifax.

Two eggs of the Great Black-backed Gull, from Grand Lake, N.S.

Two eggs of the Raven, from Truro, N.S.

Set of (four) eggs of the Black-throated Green Warbler, from Miller's Woods, near Halifax.

A small collection of rare recent shells.

Set of (two) eggs of the Bald Eagle, taken in the north-east point of Raza Island, at the entrance of Toba Inlet, B.C., in May, 1897.

Sets of eggs of ten species of birds and a single egg of Leach's Petrel, all from Nova Scotia.

Specimen of the Lesser Snow Goose, from Portage la Prairie, Manitoba.

Set of (three) eggs of the Duck Hawk, two eggs of Richardson's Merlin, one egg of the Prairie Falcon, and two eggs of the Long-billed Curlew, all from Alberta.

Sepiostaires of three recent species of *Sepia*, for comparison with remains of Sepiadæ from the Cretaceous rocks of the South Saskatchewan.

(C.—*Ethnology*).

Large baked clay pot of Indian manufacture, found in the township of Eardley, Q.

Natural History.

Professor J. Macoun makes the following report on the work done by him or under his immediate control, during the year 1897 :—

Work during winter.

" Between the date of my last report and my departure for the field on June 1st, I was, owing to my assistant being engaged on other work, able to do little more than attend to the routine work of my office and classify and arrange the natural history collections made during the previous season.

Natural history—*Cont.*

" During the past eight years I have not only been collecting and studying the flora of western Canada, but have been investigating the fauna as well. A part of the results of my botanical work has already been published, and the large collections of botanical specimens made have been mounted and placed in the herbarium, so that this is now very rich in western plants, and when the time comes for the publication of a flora of the western provinces, we have all the necessary material on hand.

Explorations of previous years.

"During the seasons of 1894, 1895 and 1896, I worked up, in the field, the natural history of the prairie region between Winnipeg and the foot-hills of the Rocky Mountains. In 1889, 1890 and 1891, I studied the fauna and flora of the Rocky Mountains, and of that part of British Columbia lying along the line of the Canadian Pacific Railway. In 1893, I worked on Vancouver Island. The only portion of the southern part of western Canada thus remaining unvisited, was the region between the prairie and the summit of the Rocky Mountains and this section you authorized me to examine last summer.

Assistance in field-work.

" In all the years mentioned above, I have had Mr. William Spreadborough for my field assistant. Besides having unrivalled powers of observation, he is an accomplished taxidermist, and these qualifications have enabled him to render valuable assistance in systematically working up both the fauna and flora of the regions we have visited together. Having in view from the first the advisability of writing a complete catalogue of Canadian birds, I thought it wise to have collections and observations made early in the spring, so that something might be learned of their migration-routes. This scheme has been carried out by Mr. Spreadborough. He was stationed in the spring of 1892 at Indian Head, in 1895 at Moosejaw, in 1894 at Medicine Hat, in 1897 at Edmonton, in 1891 at Banff, in 1890 at Revelstoke, in 1889 at Hastings, B.C., and in 1893 at Victoria, Vancouver Island. It will thus be seen that the range in longitude of the western birds ought now to be pretty well known. The summers being generally spent in moving through the districts in the vicinity of the above stations, a complete knowledge of the birds that breed in the region in question has also been obtained. Collections of eggs and skins were also made every year.

Catalogue of birds.

"It has now become possible to prepare a catalogue of the birds of the whole Dominion, that will include notes on their migration,

Natural history—*Cont.*

summer haunts, nests, eggs and other interesting matters. The first part of this catalogue is now almost ready.

"Large collections of the smaller mammals have been made, and a catalogue of the species, giving their approximate ranges, could now be produced, but owing to the diversity in local forms, years must elapse before an exhaustive enumeration can be made. We know definitely, however, the range of the greater number, and from the material now in hand, a preliminary report might be prepared at any time.

"Besides plants, birds and mammals, collections have also been made of the reptilian fauna, and so far as was possible of the smaller fishes.

Field-work.

"Having your instructions to complete my examination of the foot-hill country south of Calgary, Alberta, I left Ottawa for Calgary on June 1st, last, and was able to commence work on the 6th of that month. Taking Calgary as a base, I began a list of the plants occurring there and made collections of all the species in flower at that time. When this was done, I was asked to examine into certain cases of cattle poisoning that had occurred at Jumping Pound and other points, causing great alarm among the ranchers. I reached Jumping Pound on June 11th, and on the afternoon of the same day went to look at some of the dead cattle and discover if possible the cause of death. There had been eighteen deaths at that date. After an examination of the flora, I found there was only one plant that could cause death by poisoning. This was a tall-growing larkspur (*Delphinium scopulorum*), which is common in all the foot-hill country from the Highwood River to the Arctic Circle. So that there could be no doubt about the matter, I took a rancher with me and followed the cattle-tracks into the woods, where we found dead cattle and the remains of partially eaten plants. The contents of the stomachs showed the stringy outside bark of the stems of larkspur. With these facts before me, I suggested to those interested that they should keep their cattle out of the woods in the early spring. No trouble is to be feared after the middle of June, when grass becomes plentiful.

Poisoned cattle.

Work on Elbow River.

"On July 19th, I returned to Calgary, intending to go south to Macleod, and was there joined by Mr. Spreadborough, who had been at Edmonton since early in April, making observations on birds and collecting their skins and those of small mammals. When I reached Calgary, part of the town was under water, in consequence of the phenomenall heavy rains which had occurred. All the bridges between Calgary and Macleod were carried away, and there seemed little chance of our being able to go south for some weeks. On considering the work to be done, I saw that could I reach the head of the Elbow River I would do just as well as if I went to the source of Highwood River, so I joined the party of Mr. A. O. Wheeler, a Dominion land surveyor, who was at that time going into the foot-hills with a large staff.

Natural history—*Cont.*

"From June 21st to July 24th, Mr. Spreadborough and I had our head-quarters in Mr. Wheeler's camp, and made excursions with pack-horses or on foot, as occasion demanded. On June 29th, we took pack-horses and ascended Bragg's Creek, the north branch of the Elbow River, to its source, and camped at an altitude of over 6000 feet. During the next five days we made excursions from our camp to numerous points up to 8000 feet, and made extensive collections. As we were camped only a little over 1000 feet below the timber-line, we were able to study the fauna and flora above the timber-line and to note the transitions due to altitude.

Character of flora.

"Only three species of plants passed from the plains to the highest summits, and all three extend far beyond the Arctic Circle being at home on the shores of the Arctic Sea. These plants are: *Delphinium scopulorum* (Larkspur), *Anemone multifida* (cut-leaved anemone), and *Anemone hirsutissima* (prairie 'crocus'). Most of the 208 forms seen above 6000 feet were boreal or far northern species, but many of them were common in the marshes and thickets of the foot-hills. Dry situations, even if exposed to cold winds, produced prairie plants, just as bogs and marshes produce arctic plants in the eastern provinces.

"The bulk of the species were of northern origin, and the passage from the prairie to the mountain summits was like that to be met with if one had walked north from Edmonton to the Arctic Sea. A few real alpine species were, however, found on Moose Mountain above 7000 feet, such as *Arabis Lyallii*, *Claytonia megarrhiza*, *Aplopappus Brandegii*, *Townsendia Parryi*, *Rhododendron albiflorum*, *Stenanthium occidentale*. All these seemed to be those characteristic of mountain regions further south, and are not found much further to the northward.

Distribution of small mammals.

"We had good opportunities of studying the smaller mammals and found that they were quite local in their habits, but in all cases they liked to be near water. The only form of the prairie and foot-hill region that reached an altitude of 7000 feet was the pouched gopher or 'mole' as called by the residents of the country. This animal is universally distributed over the prairie region, but prefers the rich black earth on the sides of ravines in the south and on the borders of poplar

Natural history—*Cont.*

thickets to the north. A complete series of skins, taken at Edmonton, Moose Mountain at an altitude of 7000 feet, along the Milk River, Alberta, and at Indian Head, Assiniboia, show that we have but one form of this species. It was the same with the Spermophiles. No matter where Franklin's, Richardson's or the thirteen-striped species were seen, they never varied. It was not so with the squirrels and chipmunks. These varied as we left the plains, so that the higher we ascended the more distinct the forms became and the easier to differentiate.

"None of the prairie birds breed in the mountains, but such birds as the White-crowned Sparrow, the Pipet and the Gray-necked Finch were breeding above the timber-line, and on the extreme summits the White-tailed Ptarmigan seemed quite at home.

"Our mountain work was done between the first and second series of great rain storms, and on July 5th, in a terrible storm, we left our camp for the plain. When we saw the mountains again they were buried in snow which remained for a week. On the morning of the 7th, Mr. Spreadborough went up the Elbow River thirty-one miles, and camped above the mouth of the Fisher Branch, where he had the mountains all around him. I joined him on the 12th, having walked over the pack-trail from our lower camp. Many interesting things were picked up and additional facts regarding distribution were recorded. Four days were spent collecting and exploring above the timber-line here and many additions were made to our collections. As usual we found Parry's Marmot and the Little Pika on the very summit of the mountains and always dwelling in colonies.

Work at Crow Nest Pass.

"We returned to Calgary on July 19th, and after packing up our specimens started for Macleod on the 24th. One day was spent there, supplies were procured and a team was hired to take us to Crow Nest Lake, seventy-two miles off. As we were ahead of the railway parties, we found the road in very poor condition after the heavy rains of the preceding months. The water in the streams was still very high, but we made all the crossings safely and reached the lake on the 28th. Our tent was soon pitched and work commenced, and while I occupied myself chiefly with botany, Mr. Spreadborough attended to the fauna. In both branches of our work we found a marked change from the species seen at the source of the Elbow River. It would be apparent to the most casual observer that here the climatic conditions are different from those of the mountains further north. Our first trip was to the summit of the mountain north of Crow Nest Lake, and from this altitude we could take in without difficulty all surrounding mountains and the district characterized by yourself as consisting of 'rough hills.' It now became apparent to me why this region had such a peculiar flora. To the west, no mountains were visible, but far to the north up Michel Creek and Elk River snowy peaks were to be seen. To the south a large mountain rose from the lake, but later examination showed that it stood alone and was perfectly dry to its summit, which is 8600 feet above the sea. To the east, twelve miles off, was Turtle Mountain, and beyond was the open treeless prairie. Here, then, was the source of the continual winds at Macleod.

Natural history—*Cont.*

"The peculiarly western species found in Crow Nest Pass, and along the North and South Kootenay passes were now accounted for and the remarkable extension of such plants as *Balsamorhiza sagittata* and *Fritillaria pudica* and others far out on the south-western prairies was explained. Owing to the breaking up of the mountain ridges south of the Livingstone Range, the dry and warm winds from south-eastern British Columbia and Idaho have a clear sweep across the low summits and through the passes, giving both a climate and vegetation akin to that of a region much farther south.

Western and south-western plants.

"During our stay at Crow Nest Pass, we ascended the mountains in the vicinity and found them all barren at their summits and wind-swept. Indeed at the altitude of over 8000 feet on August 4th, the air was hot and the sun's rays almost unbearable, yet a mile away, facing the north, we saw quantities of snow and a small glacier. An excursion made to that place later, showed a long exposed slope to the west and north-west, and the snow on the northern exposures was the remains of the winter drifts formed by the constant winds from the west. During the five weeks we were in the pass we never saw clouds move from any point but the west. Often strong winds blew into the pass from other directions, but they did not reach nor affect the high clouds. With the dryness of the mountains, the flora took on a corresponding character, and all the new forms which were discovered belonged to the southern mountains, but were here not found at so high an altitude as further south. Amongst these were valuable medicinal plants such as *Osmorhiza occidentalis* and *Ferula dissoluta.* The mountains were so dry that the usual alpine cruciferous and saxifragaceous plants were altogether wanting.

"Later examinations showed that all the waters of the higher mountains here entered rents in the strata, those of the north side being discharged by a large stream issuing from the mountain-side and flowing almost directly into Crow Nest Lake. An excursion

Natural history—*Cont.*

was made on August 9th to the snow-field and glacier seen in the recesses of the high mountain to the south of the lake. After ascending the lake in a small boat, we climbed around the western shoulder of the mountain and ascended the stream that enters the head of the lake. Four hours of climbing showed the glacier lying before us on the south, and about a mile further on we found the greater part of the water issuing from a cave in the mountain-side about 2000 feet below the summit. Shortly after, we were surprised to see an opening right through the mountain to the south and west of the glacier. This opening was near the summit, and an arch of unknown thickness was formed by the rock over it.

Mountain south of Crow Nest Lake.

The Gap.

"After completing our examination of the region about Crow Nest Lake, we moved on August 11th twelve miles east to the 'Gap,' close to the sulphur spring under Turtle Mountain. Between that date and the 22nd, we climbed all the mountains round and penetrated into the hills, making collections of plants and trapping small mammals. Our work was completed by the 22nd, when we packed up and returned to Macleod. The day after we arrived there we went on to Calgary, where after our specimens had been arranged for shipment to Ottawa I dismissed my assistant and went up to Banff, there meeting the visiting members of the British Association. On September 2nd I started for Ottawa and arrived there on the 6th.

Results of heavy rains.

"The heavy rains of June and July amply fulfilled my forecast of 1895, the drought was broken, as all the lakes and ponds in the foot-hills were again filled with water, and on the line of the Crow Nest Pass Railway, ponds that the wagon-road had gone through in 1896 were found with six feet of water in 1897. I am informed that in October the ducks came back to the long deserted ponds and seemed to be as plentiful as they were ten years ago. Grass in the foot-hills and on the prairie was luxuriant.

Determination of plants.

"The increased interest that is now being taken in botany in every part of the Dominion is very encouraging, but at the same time it adds very largely to our duties, as scarcely a day passes that specimens do not arrive for determination. This consumes much of our time. In large parcels alone, we named, during the year, nearly 2000 species of plants. Of these 650 species came from the Department of Agriculture, British Columbia. The collections made by Mr. Low, Dr. Bell and myself last summer will be worked up by my assistant Mr. J. M. Macoun this winter, and this will occupy most of his time. My own time for the remainder of the winter will be required to complete my work on the birds of Canada.

"My work on the Hepaticæ and Lichens has progressed so far that another season in the eastern provinces, where these plants reach their greatest development, will enable me to complete Part VII. of the catalogue of Canadian plants.

Natural history—*Cont.*

"Owing to the fact that I have had no regular office assistant during the past year, a smaller number of plants than usual has been mounted and placed in the herbarium. For the same reason, a comparatively small number of duplicates has been distributed and very few exchanges were made.

Herbarium work.

"Three thousand three hundred and ninety-six sheets of specimens were mounted for the herbarium as follows:—

Number of plants mounted.

Canadian	2,086
Foreign	472
Cryptogams	838
Total	3,396

"Two thousand seven hundred and thirty-four sheets of specimens were distributed, partly to public institutions, partly to private individuals in exchange for other specimens.

Number distributed.

"The principal universities and other public institutions to which specimens were sent are:—

Harvard University	130
Missouri Botanic Gardens	120
United States National Museum	174
Botanical Museum, Copenhagen	288
Kew Gardens	180
Columbia College	198
Catholic University, Washington	308
University of Minnesota	113
British Museum	73
Botanical Museum, Stockholm	125
Agricultural College, Michigan	70

Dr. James Fletcher, F.R.S.C., Entomologist and Botanist to the Experimental Farm, has kindly continued his services as honorary curator of the entomological collections belonging to the Geological Survey, and reports as follows on these:—

Report by Dr. Fletcher

"I have the honour to report that the entomological collections of the Geological Survey Department are in a good state of preservation. Few additions have been made during the past year. With the exception of two collections from Dr. Robert Bell—one of Coleoptera, made in 1887 at Temagami Lake; the other, a collection of Lepidoptera, made in Baffin Land and the islands north of Hudson Bay—no other insects have been collected by the officers of the Survey during the past season. Among Dr. Bell's insects were a few of great rarity. Two specimens of *Chionobas Taygete* were particularly acceptable, as this species was not previously represented in the collection. The collection of insects for the Banff museum has been much increased in value through the energy of Mr. N. B. Sanson, the curator, who during the summer collected no less than thirty different species of diurnal Lepidoptera. Specimens of these are now being spread to be placed in this collection so that the species represented may be shown from actual specimens taken in the Rocky Mountain Park at Banff. A few specimens also have been kindly given for this collection by Mr. W. H. Danby, taken at Rossland, B.C., and Mr. C. De Blois Green, taken in the Okanagan Valley, B.C."

MAPS.

Maps.

Mr. James White, geographer and chief draughtsman, reports as follows on the mapping work and related subjects :—

"During the past year Mr. C. O. Senécal has compiled portions of the West Kootenay, Manitou and Sydney Coal-field sheets and has autographed maps Nos. 619 and 621. Mr. L. N. Richard has traced Sheets 126 and 129, Ontario, and 50, 56, 57 and 58, Nova Scotia, for the engraver, and has drawn a map of Western Nova Scotia for photo-lithography. Mr. W. J. Wilson has compiled and reduced material for the map of the Dominion. Mr. O. E. Prudhomme has also been employed on the Dominion map and in making reductions for the new edition of the Yukon sheets. Mr. J. F. E. Johnston has compiled and drawn the greater portion of Sheet 121, Ontario and Quebec. Mr. W. M. Ogilvie was employed on general draughting work from June 9th to August 19th, when he was detached for field-work as assistant to Mr. W. T. Jennings, C.E. He rejoined the staff 20th December. Mr. E. D. Bolton was employed on general draughting from January 18th to April 30th.

"During the year, nineteen new maps and a second edition of the 'Northern portion of the Lake of the Woods' map have been published. Twenty new maps and a second edition of the three Yukon sheets are now being engraved or photo-lithographed. The stones for the 'black' of sheets 42 to 48 of the Nova Scotia series have been engraved, but their publication has been delayed, pending the completion of the geological work. The unusual demand, owing to the gold discoveries, having exhausted the edition of the 'Northern portion of the Lake of the Woods' and 'Yukon' maps, a second edition of the former, revised and corrected to date, was issued in April last, and a similar edition of the Yukon maps is now in progress and will be ready shortly.

"Owing to the pressure of other work, the progress of the new map of the Dominion has been much delayed, but it will, probably, now be completed within a few months. Reductions for the northern portion of this map were supplied to the Department of Railways and Canals to assist in the correction of the new edition of the map of that department. Maps—*Cont.*

"As Mr. Giroux's illness and death had left his work in the townships of Hawkesbury and Lochiel incomplete, I made in September last, the surveys required for the portion included in Sheet 121, and also surveyed a few roads in the township of Loughborough, for the Frontenac map.

"An enumeration of the maps published during the past year, or in course of preparation, is appended herewith.

Maps Printed in 1897.

		Area in square miles.
620	British Columbia—Part of Trail Creek Mining Division—West Kootenay District.—Scale 1 mile to 1 inch..........	208
594	Athabasca and Peace River—Sheet I—Scale 10 miles to 1 inch.....	39,700
595	" " " —Sheet II— " "	39,700
596	" " " —Sheet III— " "	41,000
597	North-west Territories—Country between Lake Athabasca and Churchill River—Scale 25 miles to 1 inch.........	137,100
603	North-west Territories—Doobaunt and Kazan Rivers and North-west Coast of Hudson Bay—Scale 25 miles to 1 inch................ .	250,000
619	North-west Territories—Map of Sledge Routes, 1893 and 1894, Fort Churchill to Nelson River—Scale 25 miles to 1 inch.............	25,400
621	North-west Territories—Diagram showing three positions successively occupied by the Centre of the Keewatin Glacier—Scale 100 miles to 1 inch	405,000
227	Western Ontario—Sheet 1—Northern part of the Lake of the Woods (2nd edition)—Scale 2 miles to 1 inch...........................	3,456
570	Ontario—Sheet No. 125—French River Sheet—Scale 4 miles to 1 inch.....................	3,456
606	Ontario—Sheet No. 131—Lake Nipissing Sheet—Scale 4 miles to 1 inch..	3,456
599	Ontario and Quebec—Sheet No. 138—Lake Temiscaming Sheet—Scale 4 miles to 1 inch.....	3,456
590	Quebec—Portions of Joliette, Argenteuil, Terrebonne and Montcalm Counties—Scale 4 miles to 1 inch.	3,350
585	Labrador Peninsula—South-west Sheet—Scale 25 miles to 1 inch...	251,100
586	" " —South-east Sheet " " "	251,100
587	" " —North-west Sheet " " "	251,100
588	" " —North-east Sheet " " "	251,100
592	Nova Scotia—Sheet No. 40—Sheet Harbour Sheet—Scale 1 mile to 1 inch	216
607	Nova Scotia—Sheet No. 41—Fifteen-mile Stream Sheet—Scale 1 1 mile to 1 inch........	216
611	Nova Scotia—Sheet 51 (and 52)—Ship Harbour Sheet—Scale 1 mile to 1 inch..........	

Maps—*Cont.*

Maps, Engraving or in Press.

		Area in square miles.
	Dominion of Canada, 2 sheets, each 28″ x 34″, including the Dominion from the Atlantic to the Pacific and from the International Boundary to Hudson Strait and Great Bear Lake.	
604	British Columbia—Shuswap Sheet—Scale 4 miles to 1 inch..........	6,400
605	Ontario—Sheet No. 126—Manitoulin Island Sheet—Scale 4 miles to 1 inch..........	3,456
630	Ontario—Sheet No. 129—Missisauga Sheet—Scale 4 miles to 1 inch..	3,456
626	Ontario—Map showing the occurrences of Iron Ores and other minerals in portions of the Counties of Frontenac, Lanark, Leeds, and Renfrew—Scale 2 miles to 1 inch..........	1,700
631	Quebec—Lièvre River and Templeton Phosphate District—Sheet 1—Scale 40 chains to 1 inch..........	120
632	Quebec—Lièvre River and Templeton Phosphate District—Sheet 2—Scale 40 chains to 1 inch..........	100
593	Nova Scotia—Sheet No. 42—Trafalgar Sheet—Scale 1 mile to 1 inch	216
598	Nova Scotia—Sheet No. 43—Stellarton Sheet—Scale 1 mile to 1 inch	216
600	Nova Scotia—Sheet No. 44—New Glasgow Sheet—Scale 1 mile to 1 inch..........	216
608	Nova Scotia—Sheet No. 45—Toney River Sheet—Scale 1 mile to 1 inch..........	216
609	Nova Scotia—Sheet No. 46—Pictou Sheet—Scale 1 mile to 1 inch....	216
610	Nova Scotia—Sheet No. 47—Westville Sheet—Scale 1 mile to 1 inch.	216
633	Nova Scotia—Sheet No. 48—Eastville Sheet—Scale 1 mile to 1 inch..	216
634	Nova Scotia—Sheet No. 49—Musquodoboit Sheet—Scale 1 mile to 1 inch..........	216
624	Nova Scotia—Sheet No. 50—Moose River Sheet—Scale 1 mile to 1 inch..........	216
635	Nova Scotia—Sheet No. 56—Shubenacadie Sheet—Scale 1 mile to 1 inch..........	216
636	Nova Scotia—Sheet No. 57—Truro Sheet—Scale 1 mile to 1 inch.....	216
637	Nova Scotia—Sheet No. 58—Earltown Sheet—Scale 1 mile to 1 inch.	216

Maps, Compilation Completed.

Manitoba—Lake Winnipeg Sheet—Scale 8 miles to 1 inch..........	43,600
Nova Scotia—Sheet No. 53—Lawrencetown Sheet—Scale 1 mile to 1 inch.	216
Nova Scotia—Map of Western Nova Scotia—Scale 8 miles to 1 inch......	12,830
Nova Scotia—Plans of Killag, Salmon River, Caribou, Goldenville and Oldham mining districts—Scale 500 feet to 1 inch..........	

Maps, Compilation Incomplete..

British Columbia—West Kootenay Sheet—Scale 4 miles to 1 inch........	6,400
Western Ontario—Sheet No. 4—Manitou Sheet—Scale 4 miles to 1 inch..	3,456
Quebec and Ontario—Sheet No. 121—Grenville Sheet—Scale 4 miles to 1 inch..........	3,456
Quebec—North-west Sheet of "Eastern Townships" Map—Scale 4 miles to 1 inch..........	7,200
New Brunswick—Sheet 1 N.W.—Fredericton Sheet—Surface Geology—Scale 4 miles to 1 inch..........	3,456
New Brunswick—Sheet 2 S. W.—Andover Sheet—Surface Geology—Scale 4 miles to 1 inch..........	3,456
Nova Scotia—Sheet No. 133—Cape Dauphin Sheet—Scale 1 mile to 1 inch	216
" " —Sheet No. 134—Sydney Sheet—Scale 1 mile to 1 inch.......	216
" " —Sheet No. 135—Glace Bay Sheet—Scale 1 mile to 1 inch...	216
" " —Sheets Nos. 59 to 65, 76, 82, 100 and 101—Scale 1 mile to 1 inch	2,376
" " —Sheets 54, 55, 66, 67, 68, 69—Scale 1 mile to 1 inch.........	1,296

LIBRARY.

Dr. Thorburn, librarian, reports that during the year ended December 31, 1897, there were distributed 9927 copies of the Survey publications, comprising reports, special reports and maps. Of these 7690 were distributed in Canada, the remainder, 2237, were sent as exchanges to other countries. Library and Publications.

In addition to the above, the sales of publications during the year were 5843, for which $981.82 has been received.

The number of publications received as exchange, was 2758, and the number purchased was eighty-five volumes, besides thirty-three periodicals subscribed for.

The number of letters dealing with library matters sent out was 1551, and in addition there were 749 acknowledgments.

The number of letters received was 1168 besides 1228 acknowledgments.

The number of volumes bound during the year was 135. It is estimated that there are now in the library about 12,000 volumes besides a large number of pamphlets.

NOTE.—It may be stated that the books in the library can be consulted during office hours by those who wish to obtain information on scientific subjects.

VISITORS TO MUSEUM.

The number of visitors registering during the year 1897 has been 32,357, being a slight increase over that for 1896, and the highest yet attained. Visitors to Museum.

STAFF, APPROPRIATION, EXPENDITURE AND CORRESPONDENCE.

The strength of the staff at present employed is forty-nine. Staff.

In May last Mr. R. W. Brock was appointed to the vacancy in the technical class, caused by the death of Mr. N. J. Giroux.

Appropriation and expenditure.

The funds available for the work, including appropriation for boring in Alberta, and the expenditure of the department during the fiscal year ended 30th June, 1897, were:—

—	Grant.	Expenditure.
	$ cts.	$ cts.
Civil list appropriation	50,675 00	....
Geological Survey appropriation	60,000 00	....
Boring appropriation	7,000 00	....
Civil list salaries	....	49,983 31
Exploration and survey	....	19,066 91
Wages of temporary employees	....	9,199 43
Boring operations	....	7,000 00
Printing and lithography	....	19,652 81
Purchase of books and instruments	....	1,176 08
" chemicals and chemical apparatus	....	212 39
" specimens	....	378 73
Stationery, mapping materials and Queen's Printer	....	1,445 52
Incidental and other expenses	....	1,879 14
Advances to explorers on account of 1897-98	....	16,250 00
		126,244 32
Less—Paid in 1895-96 on account of 1896-97	....	9,261 56
		116,982 76
Unexpended balance civil list appropriation	....	691 69
" Geological Survey appropriation	....	55
	117,675 00	117,675 00

The correspondence of the Department shows a total of 9160 letters sent, and 8803 received.

I have the honour to be, sir,

Your obedient servant,

GEORGE M. DAWSON,

Deputy Head and Director.

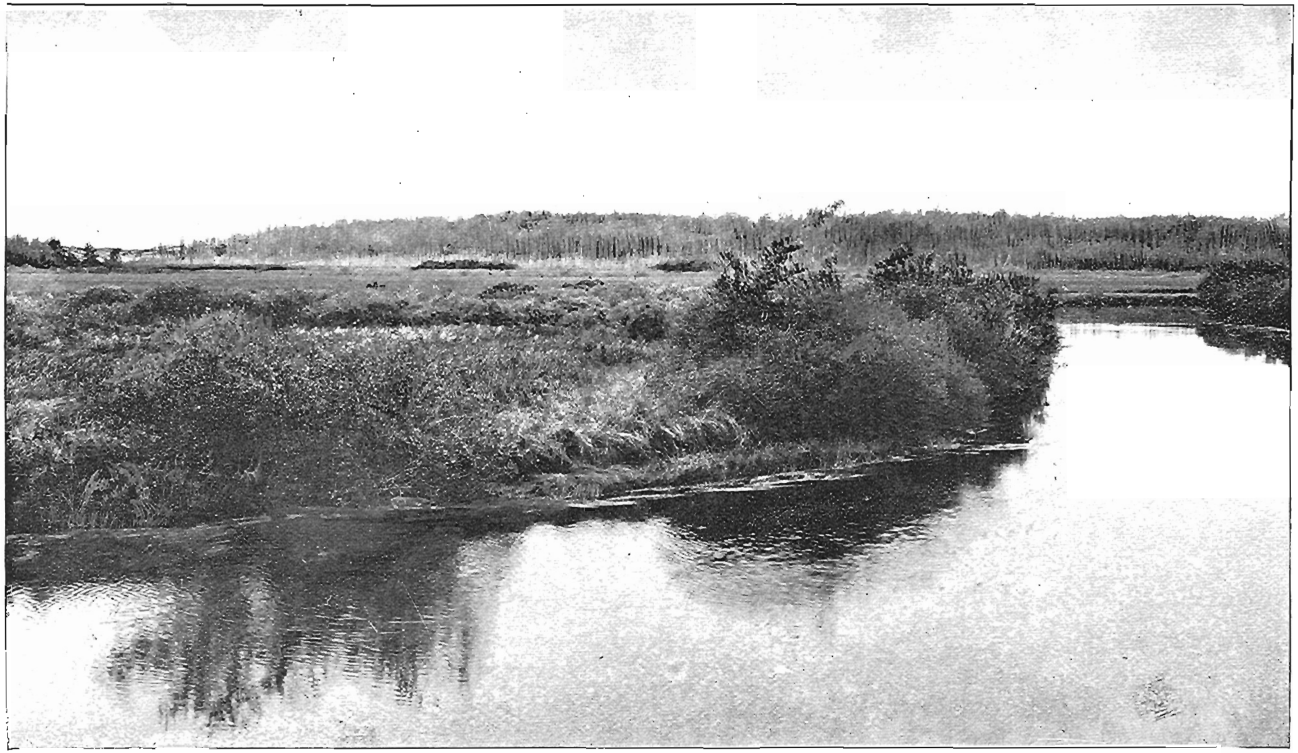


Photo. by W. McInnes.

VIEW LOOKING NORTH FROM NEAR THE HEAD-WATERS OF THE MATTAWA RIVER.

GEOLOGICAL SURVEY OF CANADA

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

REPORT

ON THE

GEOLOGY

OF THE AREA COVERED BY THE

SEINE RIVER AND LAKE SHEBANDOWAN MAP-SHEETS

COMPRISING PORTIONS OF

RAINY RIVER AND THUNDER BAY DISTRICTS, ONTARIO

BY

WILLIAM McINNES, B.A.

OTTAWA

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

1899

No. 678.

To G. M. Dawson, C.M.G., LL.D., F.R.S.,
Director Geological Survey of Canada.

Sir,—I have the honour to submit herewith a brief report upon that part of the Districts of Rainy River and Thunder Bay which is covered by the two geological map-sheets known as the Seine River sheet (No. 6) and the Shebandowan sheet (No. 9). The work upon these sheets was done by the late W. H. C. Smith and myself, with the able assistance of Mr. W. Lawson on most of the Seine River work.

I have the honour to be, Sir,
Your obedient servant,

W. McINNES.

NOTE.—*The bearings throughout this report are given with reference to the true meridian.*

REPORT

ON THE

GEOLOGY

ON THE AREA COVERED BY THE

SEINE RIVER AND LAKE SHEBANDOWAN MAP-SHEETS

BY

WILLIAM McINNES, B.A.

INTRODUCTION.

The greater part of the geological and topographical work in connection with the Seine River sheet was done by the late W. H. C. Smith, of this Survey, whose sad death before the work was completed necessitated the compilation of both geology and topography largely from his note books.

Field-work by late W. H. C. Smith.

Although it is believed that these notes have been for the most part correctly interpreted, yet they must of necessity lose something of their value from not being written up by their author. Valuable work was also done by William Lawson, B.A., who was employed as assistant geologist during the greater part of the time spent upon that sheet. The work upon the Shebandowan sheet and a part of that upon the Seine River sheet was done by myself, assisted at various times by Mr. T. H. Wiggins, B.A., Mr. A. Cushing, B.A., Mr. A. P. Bull, B.A., and Mr. Lawson.

Work by W. Lawson.

Owing to the want of any topographical map of the region that was at all correct, it was found necessary to make independent surveys of practically all the lakes and streams of any size in the entire district. In the compilation of this work the line of the Canadian Pacific Railway and the meridians and base-lines run by Mr. Niven of the Ontario

Want of topographical information

Crown Lands Department were found most useful as tie-lines, and other surveys were adopted wherever they could be made use of. All the important routes through the district were surveyed either by transit and Rochon micrometer telescope or by compass and micrometer, and the smaller lakes lying off the main lines were put in by compass and boat-log. The portages on all important lines were chained. Although extreme accuracy cannot be claimed for these methods, they unite expedition with reasonable accuracy in a way which seemed to best serve the purposes required. Without specifying individual cases, which would occupy too much space, I may be allowed to say that our thanks for many courtesies are due to the various mine managers encountered, to the officials of the Canadian Pacific Railway, the officers of the Hudson's Bay Company and to very many others whose kindness has helped along the work.

Thanks due for assistance given.

TOPOGRAPHY AND GENERAL DESCRIPTION OF THE DISTRICT.

Area covered.

The area treated of in the present Report comprises a tract of 3456 square miles, lying to the west of Thunder Bay, Lake Superior. It may be roughly described as extending from Port Arthur on the east to Rainy Lake on the west, and from the Canadian Pacific Railway on the north, southwards to a few miles south of the township of Moss. The eastern half lies in the District of Thunder Bay and the western half in the District of Rainy River, the boundary line between the two nearly coinciding with the line of division between the Shebandowan and Seine River geological sheets.

Topography.

Elevation.

The general elevation of the whole district, with the exception of its south-eastern corner, where it slopes down towards Thunder Bay, is between thirteen hundred and sixteen hundred feet above sea-level or from seven hundred to a thousand feet above Lake Superior. Its topographical features can be almost surely predicated from its geology. The greater part is occupied by Archæan rocks, with only a small area in the south-east corner where the flat-lying Animikie rocks overlap. The area occupied by the older rocks is characterized by low, rounded hills with the softened outlines which the Archæan everywhere, usually presents, while the region covered by the Animikie rocks shows table-topped hills and escarpments with perpendicular faces and sharply angular outlines. Almost everywhere about the height-of-land, extend broad expanses of muskeg in which the various rivers take their rise and from whose abundant water-supply they are, at very short distances from their sources, augmented to streams of considerable volume. Small lakes are very numerous and, with their connecting streams, make the exploration of the district comparatively easy, by providing canoe-routes in almost all directions through it. These, though not always very desirable routes of travel, yet render passage possible through large tracts which without their aid could be explored only at great expense of both time and money.

Small lakes abundant.

Cultivated Area.

The region generally is still uncultivated. In the south-eastern portion however, in the townships lying to the west of the towns of Port Arthur and Fort William, farming is successfully carried on, special attention being devoted to root-crops. Beyond these townships the inhabitants are confined to the employees of the Canadian Pacific Railway located at small stations along the line, a little settlement of mill hands at Savanne, the miners employed on the Sawbill Lake properties and scattered bands of Ojibway Indians who make a precarious living by hunting and fishing eked out by a very limited cultivation of potatoes on their reserves.

Cultivated area small.

Country sparsely settled

Indian Reserves.

There are four of these Government reserves for Indians within the district under consideration, situated at Sturgeon Falls, at Island Falls, at the junction of the Fire-steel and Seine rivers, and on the west side of Lac des Mille Lacs. Of these the first and last only are permanently occupied by Indians. The reserve at Sturgeon Falls is situated on the both banks of the Seine River and embraces a large area of good land, but merely a narrow-strip along the immediate bank of the river is cleared and only small patches of this are cultivated in a desultory way by the Indians.

Indian reserves.

The reserve at the junction of the Fire-steel and Seine rivers, though lying in an area of good land is not permanently occupied by the Indians and is not cultivated by them.

On Lac des Mille Lacs the reserve is also situated on good farming land at Poplar Point, on the west shore of the lake, seven miles from Savanne station, on the Canadian Pacific Railway. A large clearing was made here under Government supervision, and some instruction was given the Indians in agriculture, but at the present time only a small

Land suitable for farming.

field is kept annually under cultivation, and it is only at the time of the yearly treaty-payment that the Indians are found in any numbers on their reserve. For the remainder of the year they are widely scattered over the country, during the winter hunting and trapping, and during the summer encamped on some lake which affords the best prospect of a supply of food. Fish, caught chiefly with nets, form the staple diet of the Indians during the greater part of the year. In the early autumn there is a general migration to the lakes, that furnish wild rice, where there is the double advantage of plenty of rice for soup and an abundance of ducks of various kinds which gather about the rice beds. There are no Indian schools in the district, though Indians who can both read and write are met with. These have been educated at the mission at Fort William, or at the school at Lac Seul, or have been instructed by friends who have enjoyed the advantages of one of these schools.

Fish.

Indians not progressive.

The outlook for the future of the Indians of this district does not seem to be a very bright one. They are slow to avail themselves of the advantages offered by the Government towards their settlement as agriculturists, preferring to gain a precarious livelihood by hunting and trapping to settling down to steady work upon their reserves. The vices of civilization they acquire with ready aptitude, but are too indolent and improvident to care to bear any of its burdens.

Principal Rivers.

Principal rivers.

The largest rivers within the region of the map-sheets are the Seine and the Kaministiquia, the first belonging to the Hudson Bay watershed, and the last to the St. Lawrence. Their head-waters, known as the Savanne River and the Dog River respectively, overlap and at a number of points approach within a mile or less of one another. They are both navigable by canoes almost to their sources, as their head-waters lie in a muskeg-covered area which supplies them with a good volume of water even a few miles from their sources. Falls and rapids are numerous on both rivers capable of affording good water-powers all along their courses, excepting those parts lying in the muskeg area near their sources. These two streams with their tributaries drain almost the whole of the area covered by the map-sheets. The Quetico and Pickerel rivers drain the area immediately to the north of Hunters Island; the Pipestone, a limited area south of Seine River, in the western part of the Seine River sheet; the Turtle River, an area in the north-west and the head-waters of the English River, a few square miles lying about Scotch Lakes.

Quetico and Pickerel rivers

Lakes.

The largest lakes in the district are Lac des Mille Lacs with an area of ninety-six square miles, Dog Lake with an area of fifty-seven square miles, White Otter Lake thirty-five square miles, Shebandowan Lake twenty-five square miles, Greenwater Lake fourteen and Pickerel Lake thirteen square miles. The depths of these lakes is generally great as compared with their size. The greatest depths reached in a number of soundings in these lakes is as follows:— Areas of larger lakes.

	Feet.
Steep Rock Lake	240
Dog Lake	221
Sturgeon Lake	210
White Otter Lake	166
Quetico Lake	120
Batchewanung Lake	114
Clearwater Lake West	100
French Lake	78
Kasakokwog Lake	80
Crystal Lake	60

The largest lake, Lac des Mille Lacs, is comparatively shallow, its general depth being not more than thirty feet.

Waterfalls.

Throughout the whole region there is a well-marked accordance between the general course of the waterways and the strike of the rocks, this strike representing not original bedding, but planes of schistosity and shearing. The general character of the water-courses is that of series of lakes connected by short rapids and falls and even where lake-expansions are absent and the streams preserve their river-like character they still present an alternation of long stretches of sluggish current and short rapids and falls. A few of these falls are notable. The falls of Kakabeka on the Kaministiquia River, with a height of 119 feet, possess a natural scenic beauty seldom excelled and are economically of interest as affording a very fine and easily accessible water-power. On the same river just below Dog Lake there is a descent of about 350 in a series of rapids and falls which would also afford a magnificent water-power should occasion arise for its utilization. The Seine River throughout its length presents a series of falls which would be of value for power. Notable among these are Sturgeon Falls, Calm Falls at the head of Nonwatin Lake, Steep Falls, at the head of Steep Rock Lake, Lynx-head Falls and Island Falls all of which are sheer falls and some of considerable height, the highest, Steep Falls

Streams follow strike of rocks.

Falls.

having a perpendicular pitch of about forty-five feet. In addition to these there are on almost all the rivers in the district falls which could be utilized for power should a demand for this arise.

Elevations not high.

There are no high elevations anywhere within the district. The highest region is that about the height-of-land on the north side of the Canadian Pacific Railway, between the waters flowing into the Atlantic Ocean by the great lakes and the St. Lawrence River and those flowing into Hudson Bay by Rainy Lake, Lake of the Woods and Lake Winnipeg. The low rounded hills in this vicinity rise to heights of between 1600 and 1700 feet above sea-level and the general level along the height-of-land is between 1500 and 1600 feet.

Northern and Southern areas compared.

Marked contrast between vegetation of northern and southern areas.

Throughout the district a marked contrast is noticeable between the northern and central and southern parts in respect to the relative luxuriance and variety of their vegetation. The northern areas are largely expanses of flat, swampy land with low rounded hills of gneiss. The vegetation is comparatively stunted and many of the forest trees growing freely in the southern area, particularly along the river valleys, are entirely absent in the northern region. The maple, elm and ash are instances of these. The section through which the Canadian Pacific Railway passes is a good sample of the general character of the northern area and an inspection of this gives no true impression as to the scenic beauties or agricultural possibilities of the other part of the region.

Land suitable for agriculture

Throughout its southern and central parts are many very charming lakes and extensive areas of land quite susceptible of cultivation, though the rigour of the climate will always act to some extent as a bar to its settlement by agriculturists. The large muskeg areas of the north seem to be very generally due to extensive impermeable clay beds which underlie the surface soil and prevent the natural drainage of these sections. The influence of these large swamps must be very considerable in lowering the general temperature of all the surrounding country.

In the townships lying along the Kaministiquia River and between it and Thunder Bay, general farming is engaged in with good success, and there are numerous areas further inland which only await means of transportation and a market to convert them into equally successful agricultural communities.

Wild Animals.

Game and fur-bearing animals

Of the larger wild animals occurring in the district, moose and caribou are the most important for food. Moose are plentiful in certain parts of the region, particularly in the valleys of the Atekokan and Little Turtle River, in the country lying to the south of Shebandowan Lake and along the upper stretches of the Matawin River. Caribou range all over the area and are fairly plentiful. Red deer are only occasionally met with and are confined to the southern part. Among the fur-bearing animals are black bears, which are rather numerous, beaver, otter, fox, martin, mink, lynx and skunk. All of these are trapped by the Indians during the winter months when the fur is in condition, and the sale of the skins furnishes them with almost their only means of trading with the outside world. Wolves, which follow the red deer generally, are scarce.

Ducks in great variety are plentiful, and many of them nest in the district.

Fish abundant.

In most of the clear-water lakes gray lake-trout are abundant, and jackfish or pike are almost universally present in both lakes and streams. Brook trout are confined to the waters flowing into Lake Superior, and occur only in the smaller streams flowing into Thunder Bay. Doré or wall-eyed pike, known locally as pickerel, are found in most of the lakes, and whitefish in many. Sturgeon are caught in some of the lakes bordering Hunters Island, and ascend the Seine River to Sturgeon Falls, where they are taken by the Indians with the spear.

Forest Growth.

List of forest trees.

The principal forest trees of the district, arranged simply in order of their respective abundance, are :

Banksian Pine	*Pinus Banksiana.*
Black Spruce	*Abies niger.*
Balsam Spruce	*Abies balsamifera.*
White Spruce	*Abies alba.*
Poplar	*Populus tremuloides* and *P. grandidentata.*
White Birch	*Betula papyracea.*
Pine	*Pinus alba* and *P. resinosa.*
Cedar	*Thuya occidentalis.*
Tamarack	*Larix Americana.*
Ash	*Fraxinus sambucifolia.*
Balsam Poplar	*Populus balsamifera.*
Elm	*Ulmus Americana.*
Maple	*Acer rubrum.*
Oak	*Quercus macrocarpa.*
Yellow Birch	*Betula lutea.*

The original forest trees have been burnt off over large tracts, and here, in addition to many of the forms mentioned above, are found mountain ash, wild cherry, sumac, and many smaller shrubs and trees. Along the water-courses are found alder, red osier, dwarf birch, &c.

Trees suitable for pulp-wood.

The trees of sufficient size for merchantable timber, have been for the most part either burned by forest fires or cut away, but there remain large areas covered by trees suitable for pulp-wood.

Routes of Travel.

Canoe-route from Lake Superior to Lake Winnipeg.

One of the main canoe-routes between Lake Superior and Lake Winnipeg which formed a connecting link between east and west for the northern half of the continent before the building of the Canadian Pacific Railway, passes through this region, and consequently descriptions of the general character of the country and brief allusions to its geology are common in the writings of the early travellers. Prior to the construction of the wagon road known as the Dawson road, between Port Arthur and the foot of Lake Shebandowan in 1870, one of the main waters to the west, an alternative one to that by Pigeon River and the Boundary Lakes, followed the course of the Kaministiquia River to its source in Dog Lake and the Dog River upwards for twenty miles to Prairie Brook. This small stream and a series of lakes with connecting portages were followed to the Savanne River and that river to Lac des Mille Lacs. Crossing Lac des Mille Lacs the route followed Baril Bay and portage to Baril Lake and this lake and Brulé portage to Windigoostigwan Lake. From the extreme western end of this lake French portage led to French Lake, which connected by river with Pickerel Lake, whence Pine portage led to Doré Lake and Deux Rivières portage and two small lakes and streams connected this lake with the larger body of water known as Sturgeon Lake. The route then followed the Maligne River, Lac la Croix and the Namakan River and lake to Rainy Lake. After the building of the Dawson road, in 1870, the part of the route by the Kaministiquia River and Dog Lake was abandoned and a forty-one mile portage along the wagon road from Port Arthur to the foot of Lake Shebandowan was substituted. From Shebandowan Lake a portage of three-quarters of a mile led to Kashaboiwe Lake, whence by a portage of a mile Lac des Mille Lacs was reached at its south-eastern end. From Lac des Mille Lacs westward the old route indicated above was followed to Rainy Lake. Although it seems at the present day almost absurd that the idea should have been entertained that the commerce between east and west could be carried over this route, yet it served a useful purpose for a time and when its abandonment was inevitable it rendered valuable service in facilitating the construction of the Canadian Pacific Railway. Indeed without this route

Part of route abandoned in 1870.

Facilitated construction of Canadian Pacific Railway.

for the carriage of men and supplies the building of the road would have been a much more arduous undertaking. In the days of its greatest activity between the years 1873 and 1878, all the principal portages were made by means of horses and wagons kept on the ground for that purpose and the lakes were traversed by steam tow-boats with barges for freight.

GEOLOGY.

Summary.

The Geological formations represented in the region covered by this Report are as follows, in descending order :— Geology.

Surface deposits of glacial and lacustrine origin.
Animikie.
Steep Rock Series.
Keewatin.
Coutchiching.
Laurentian.

The most widely distributed of these is the Laurentian which occupies more than three-fourths of the entire area. The Keewatin is next in extent, covering the greater part of the remaining one-fourth, with but limited local areas of Coutchiching, Steep Rock Series and Animikie. Areas occupied by different formations.

It is proposed to consider these geological formations in the reverse order of that followed in the above enumeration and to describe as briefly as possible their relations to each other in so far as it has been found possible to determine these. In the main, the conditions found by Dr. A. C. Lawson in the Rainy River region have been found to hold good for this region, and his admirable description* of the relations between the series there will apply generally here also.

LAURENTIAN.

The Laurentian preserves everywhere in this region the same general aspect. It is made up of granite-gneisses which vary in the presence or absence of hornblende and in the distinctness of their foliation, but which are recognizable as Laurentian gneisses wherever seen. The typical rock of the great Laurentian areas, away from the contact of other formations, is a biotite-granite-gneiss made up of quartz, orthoclase, plagioclase and biotite, generally distinctly foliated and banded with General aspect of Laurentian homogeneous.

* Annual Report, Geol. Surv. Can., vol. III (N.S.), 1887-88, part F.

finer and coarser layers. The last-named characteristic is not, however, always present; great areas occur where the gneiss remains quite uniform and lacks altogether the banded structure above referred to; nor is the distinct foliation a constant feature; in the central portions of large areas, particularly in that occurring on the Seine River sheet, about White Otter Lake, this foliation is often very obscure or even altogether absent, and the rock becomes a non-foliated biotite-granite The non-foliated, central portion merges gradually, at varying distances from the edge of the area, into well-marked gneiss, the latter evidently a phase of the granite produced by stress and incipient flowage.

Subdivision of Laurentian difficult.

The division of the Laurentian classed on the accompanying maps as hornblende-gneiss, though in the main made up of granitoid-gneisses composed of quartz, orthoclase and hornblende, embraces locally areas of quartz-diorite which it has not been found possible to separate from the main mass. These vary in colour from bright red to dull greenish-white and are composed of quartz, plagioclase, orthoclase and hornblende, or, in many cases chlorite, an alteration product of biotite. These chloritic plagioclase rocks are so involved in the field with the hornblende-granite and gneisses that the whole have been included under one classification. The plagioclase phase seems to be largely confined to the marginal, sheared and crushed areas bordering the Keewatin bands and is notably developed in the area lying to the north of Steep Rock Lake, about Moose Lake both north and south of that lake, and at the edge of the Greenwater Lake and Shebandowan Lake areas. In most cases these quartz-diorites and quartz-mica-diorites have all the general characters of granites, and would probably in almost every case be so classed in the field, their dioritic character being recognizable only on microscopic examination of thin sections, when the felspar is found to be largely plagioclase with, generally, however, a proportion of orthoclase, the relative amount of each felspar varying so as to constitute true granites on the one hand and diorites on the other.

Microscopical examination necessary to determine rocks.

Thin section No. 10, from the small lake south of Steep Rock Lake and between Lake Margaret and the Atikokan River, and No. 11 from the Seine River above Steep Rock Lake are typical of the plagioclase type of these rocks.

Quartz-mica-diorite.

No. 10 is described by Mr. Ferrier as "a quartz-mica-diorite consisting chiefly of plagioclase and quartz, the plagioclase greatly decomposed and the quartz much granulated. Plagioclase filled with little scales of sericite. Bisilicates originally present now almost all altered to chlorite, but both biotite and hornblende were apparently there," and No. 11 as a "quartz-mica-diorite, exceedingly shattered and crushed and considerably altered, sericite largely developed. Minerals present—quartz, plagioclase, biotite, hornblende, chlorite, etc. Very similar to No. 10."

Hornblende-granite-gneiss.

From the same area, about six miles east of the last, thin section No. 30 is thus described by Mr. Dresser: "In the thin section this rock is seen to consist chiefly of felspar, a little of which is twinned, quartz, chlorite and calcite. Orthoclase is in fairly well-defined grains separated by a mosaic of quartz grains. Its decomposition is shown in many places by numerous crystals or small areas of mica (probably sericite) whose longer axes are generally parallel to one or other of the crystallographic axes of the orthoclase. It is not easy to determine the relative proportions of the two felspars but both are evidently present. The quartz shows distinct strain shadows in a few of the larger grains, but more of it is in finer grains, often with an advanced cataclastic structure. The chlorite and calcite are probably decomposition products of the primary hornblende. The gneissic structure of the rock is clearly shown. It is a hornblende-granite-gneiss."

Alteration rocks makes determination difficult.

This hornblendic series grades, generally insensibly, into the biotite-carrying granites and gneisses, forming almost everywhere a more or less broad band intervening between the biotite-gneisses and the Keewatin belts. Approaching the Keewatin the hornblende-granites are generally extensively altered, including in their composition apparently material derived from the basic Keewatin rocks. The principal areas of these rocks which occur in the region under consideration comprise that lying to the east of Steep Rock Lake and those south of Greenwater Lake. The former area forms the termination of a broad tongue of the Laurentian enclosed on both sides by Keewatin belts. Without doubt there are included in it rocks which were originally Keewatin, The extreme deformation which these have undergone and their intimate infolding with the granite-gneisses has rendered it impracticable, without much more detailed work than it has been found possible to devote to the region, to separate them. In this set of rocks occur many of the gold-bearing lodes of the Sawbill region.

Area south of Greenwater chiefly hornblende-granite-gneiss.

In the area south of Greenwater, the incorporation of material from the basic series is not so observable. The rocks are in the main hornblende-granite-gneisses with some biotite, and shew the extremely mashed and altered forms of the Moose Lake area only close to the contact with the Keewatin; they, however, often contain plagioclase and in some cases in a preponderating degree. On Shelter Island, which lies near the edge of the gneiss area, the rocks gener ally exposed are strikingly red in colour from the large proportion of bright red felspar. They appear in the field to be bright red, hornblende-granitoid-gneisses, without distinct foliation. Specimen No. 9, from this locality, Mr. Ferrier describes as a quartz-mica-diorite; chief constituents plagioclase, microcline, chlorite derived from mica and hornblende (?), titanite, epidote, apatite, a little iron ore largely altered to leucoxene.

Granites changing to diorites near contact with Keewatin.

This rock appears to be of the character of granodiorite or tonalite. Felspar stained a deep-red colour. As in other areas of the granitoid rock in the district, there are here, in the zone nearest to the contact with the Keewatin, rocks showing plagioclase and orthoclase in different proportions, probably every gradation occurring from true granites to diorites. Specimen No. 5 is from the same gneiss area near the contact on Grouse Lake, about eight miles to the south-west of the last noted locality. It has the appearance, in the field, of a rather soft, massive, red and green crystaline felsite merging into a hornblende-granite. It is described as a crushed and granulated granite gneiss, the granulated material consisting chiefly of quartz, orthoclase, microcline, plagioclase, titanite, hornblende, mica, etc., microcline, as would be expected in such an extremely crushed rock, is exceedingly abundant, chlorite and epidote are abundantly scattered through the rock and crystals of pyrite are plentiful. The parallel arrangement of constituent grains is marked; mica and hornblende chloritized.

Probable small area of Keewatin schists on Whitefish Lake.

On the Shebandowan sheet, the Laurentian gneisses have been represented as extending to the extreme north-eastern edge of the map. Although they were seen only for about eight miles north of the extreme northern bay of Dog Lake, their further extension was inferred from the continuous section exposed on Rivière des Iles where they strike a few degrees north of east and extend far beyond the edge of the sheet, to Lac des Iles. Accounts since received from Indian traders, who have travelled through that district, and who describe certain rocks occurring on Whitefish Lake as slates or schists, make it quite probable. however, that a band of Keewatin schists may come in here, though it must be limited in extent. The section seen on Boulder Brook rather encourages this view, as the Laurentian gneisses exposed along its course become fine black biotite-gneisses not unlike those which elsewhere often characterize the approach to a contact with Keewatin schists. At the north end of Lac des Iles, associated with the regular Laurentian biotite-gneisses, are certain massive hornblende rocks and rocks made up of a triclinic felspar and biotite mica, with sometimes a little quartz. These also characterize a departure from the Laurentian type of rocks, showing that Keewatin rocks probably come in further north.

Drift found along the upper courses of Dog River, west of the head Lac des Isles consisted partly of the débris of Nipigon rocks, red clay-stone-porphyries etc., probably indicating that the edge of the overlapping Nepigon series is at no very great distance to the north-east, as these rocks are friable in character and will not bear transportation for any great distance without disintegration. Drift from Nipigon rocks on upper part of Dog River.

The smaller lenticular area of gneisses and granite occurring on Shebandowan Lake, though isolated, is probably of the same age as the greater gneiss areas. It is referred to more particularly on another page in this report.

The still smaller bosses of granite occurring in Moss Township, at Round Lake, at Peewatai Lake and south of Dog Lake, though presenting some differences lithologically from the gneisses generally, are probably also of the same age.

The small areas of granite occurring on the west shore of Nonwatin Lake, two small areas on Lake Margaret, two on the east shore of Steep Rock Lake, two on the east shore of Lac des Mille Lacs, and two south-east of Osmaire Lake, are either continuous with the main Laurentian areas which they adjoin or are evidently offshoots from these areas. The granitic intrusives occurring in limited exposures at Harold Lake, at Gabawy Lake and on Whiskey Jack Lake, though their entirely isolated positions in the midst of Keewatin belts prevents any certain statement as to their affinity, yet show the same relations to the inclosing Keewatin and probably belong to the same period of intrusion as the gneisses generally.

COUTCHICHING.

The Coutchiching of Lawson, in its extension eastward through the area covered by the Seine River sheet, changes gradually to a set of rocks which, on the Shebandowan sheet and throughout the easterly three-quarters of the Seine River sheet, have been mapped as Laurentian gneisses. They have been so mapped in these localities because the coarse, biotite-gneisses which cut and are interlaminated with the fine black biotite-gneisses resembling Coutchiching, greatly preponderate in volume. In the Rainy Lake Coutchiching, no intrusion of these rocks has been observed, but the aspect and relations of the Coutchiching, as seen in its eastern extension there, makes it probable that the granites are present at no very great distance below, and that the Eastward extension of Coutchiching changing to Laurentian gneisses.

Granitic intrusions frequent

extreme gneissic form of these rocks is due to this proximity. For, going eastward we find that intrusions of coarse white pegmatite-like granite-gneiss become more and more frequent, and the proportion of fine black biotite-gneiss and hornblende-gneiss or schist correspondingly decreased in volume, until a point is reached where the coarser gneiss so largely predominates as to lead to the mapping of that portion as Laurentian.

The prevailing aspect of the rocks in this easterly section is that of stratiform fine and coarse gneisses with, however, everywhere evidence that the coarser variety is intrusive through the finer, cutting it and contorting it in a striking way and inclosing detached blocks. The finer gneiss is identical with the Coutchiching series of Rainy Lake in all its general characteristics and probably represents the eastward extension of these rocks. At many other parts of the district, however, the schists of the Keewatin, as they approach a contact with the Laurentian, assume a character exactly similar to these gneisses and to the Coutchiching and form a belt, from a few yards to over a mile in width, that cannot lithologically be distinguished from parts of the Coutchiching.

KEEWATIN.

Description of Keewatin rocks of the district.

The Keewatin, as exposed in the district under consideration, is made up of a number of rock-types varying from extremely basic, igneous masses and their derived schists, to acid quartz porphyries and the schists produced by their shearing. With these are associated quartzites in a more or less altered condition and slaty bands which seem to have been originally argillites. The basic diorites and diabases and the green schists derived from them, form by far the largest volume in the series and occur in great thickness, how great has not been determined. Over large areas the deformation and shearing has produced a uniform schistosity in these rocks, which conforms to the trend of the formation and also to the foliation of the Laurentian which flanks them. This schistose structure, excepting very locally, is characteristic of the Keewatin everywhere. It presents every gradation in degree, from its first obscure indication in massive igneous rocks to the extreme fissility shewn by many of the nacreous schists. Beds of conglomerate, sandstone and argillaceous slate, of limited extent, are also found, but are very local in their distribution and do not form any considerable proportion of the whole volume.

Explanation of colouring on map-sheets.

On the accompanying geological map-sheets, two lithological divisions of the Keewatin are distinguished by different colouring. These divisions are not intended to convey the idea that in the one are included only the basic diorites, diabases and schists, and in the other only the rocks named in the margin as pertaining to that division; but rather that these are the prevailing rocks in each case. The basic green schists and diorites occur everywhere throughout the Keewatin of the district, but in the portions particularly coloured as being characterized by them, they form the great bulk of the strata, with only occasional exposures belonging to the other division, while in the other division they occur only as occasional exposures. There are two main bands of the Keewatin traversing the district which run approximately east-and-west. The most northerly of these comes into the area from Rainy Lake, on the west, and is an extension easterly of the rocks of that age mapped by Lawson in the Rainy Lake sheet. It forms a broad belt entering eastwards from Rainy Lake up the valleys of the Seine and Atikokan rivers as far as Steep Rock Lake where it bifurcates, one fork continues easterly and terminates in the extensive area of low, swampy land lying between the eastern shore of Lac des Mille Lacs and the Canadian Pacific Railway. The other fork bears away to the north-east, by way of Clearwater Lake, to and beyond the Fire-steel River, where it, terminates about five miles to the north-east of the railway. The more southerly Keewatin belt comes into the area of the map-sheets from the south in the vicinity of the township of Moss and sweeps eastward in a broad belt, in which lies Shebandowan Lake and river and which terminates only near the shores of Thunder Bay where it is overlapped by flat-lying Animikie and Keewenawan strata.

District traversed by two main bands of Keewatin.

Smaller isolated areas of Keewatin rocks which have apparently been infolded with the Laurentian, occur at Trout Lake, north-east of Kasbaboiwe Lake and on Dog Lake. These hold the same general relation to the inclosing Laurentian as do the larger Keewatin belts.

Smaller areas.

There can be no doubt that the Keewatin here includes rocks which differ widely in age. This is made evident by the conglomerates met with with here and there throughout the area, which contain as pebbles rocks similar to many of those of Keewatin age, including quartzites, quartzose felsites, quartz-porphyries and various basic diorites and hornblende-schists. It is also indicated by the widely divergent character of the rocks making up this division in different parts of the field. A series of rocks which occurs along the Shebandowan River and extends south-wards over part of the township of Connell and to the west of that township, presents points of lithological dissimilarity to the rocks of the Keewatin generally occurring throughout the district. They are generally less altered and hold belts of conglomerate with pebbles

Keewatin on Shebandowan River lithologically different.

chiefly of cherty, black slate, banded chert, and black and white, pyritous quartzite, with many small pieces of black slate scattered through the matrix. The paste is for the most part schistose, but in certain layers quite sandy. The conglomerate is overlain by heavy beds of a quartzite which weathers yellowish with dark-rusty spots. Associated with these rocks there occur belts of jaspillite and iron ores, the iron ore occurring as both magnetite and hæmatite and interbanded with jasper and chert. Though presenting points of difference from the Keewatin further west, most of these differences are due merely to a less degree of metamorphism, and as the iron-bearing member can be easily recognized and traced westwards, outcropping at intervals, from Kaministiquia station to and beyond Greenwater Lake, there seems to be no room for doubt that the belt is continuous between those two points. Notwithstanding points of divergence from the other Keewatin belts in the district, there is so great a general resemblance between them and so close a concordance in their relations with the Laurentian that they are considered to belong to that division.

Thickness of the Series.

Thickness of Keewatin series not known.

No attempt is made to calculate the thickness of the Keewatin as exposed in the area under consideration as it is considered that any such computation would be visionary in the extreme. Though the original lines of deposition may here and there coincide with the cleavage which affects the region generally, this is so local in occurrence that no structure can be built upon it. The only areas within the boundaries of these map-sheets which afford the data necessary to the computation of the thickness of the strata, are the Animikie area in the south-east corner and the Steep Rock area. In the former of these the strata are but gently undulating in structure and in the other, though complicated folding has taken place and a general cleavage has been induced, the great diversity in the beds and their ready recognition along the strike, make it possible to arrive at a good approximation to the absolute thickness and succession. Both of these series of rocks overlie the Keewatin unconformably, though the Steep Rock series has been involved in part of the folding to which the Keewatin has been subjected.

Areas which afford some data.

STEEP ROCK SERIES.

Steep Rock Series

On the accompanying map a series of rocks occurring about Steep Rock Lake is defined by a separate colour. They have been classified with the Keewatin as forming the upper division of that series, although they are believed to be of later age than the great bulk of the Keewatin strata. About Steep Rock Lake they occupy a well-defined basin, the edges of which along its northern and eastern sides are defined closely by the shores of the lake. To the north-west and south, the series is cut off by faults which bring it into direct contact with the older rocks. A few isolated exposures of rocks believed to form part of this series have been noted on the Seine River below the lake. They are of such small extent and are so intricately infolded with the rest of the Keewatin that a separation of them has not been attempted. Messrs. H. L. Smythe* and W. H. Smith,† both of whom studied the series in some detail, agree in describing the series as unconformably overlying the rest of the Archæan. The name Steep Rock series has been proposed by the former of these writers for this set of rocks, and in the absence of any means of correlating them with any formation of known age it seems advisable to retain this name. The structure of the series can be fairly well made out, and in the following description free use has been made of the papers above referred to, as the conclusions arrived at were borne out very fully by my own observations.

Origin of name.

The Keewatin rocks as they occur in the country mapped include a great thickness of strata occupying a position between the granitoid gneisses and the Animikie rocks which are provisionally considered as lowest Cambrian. It is probable therefore that there is included under that division series of rocks of different ages, but which, through subsequent folding, have become so involved with each other that their subdivision would require the working out of the region in very great detail. That the series seen about Steep Rock Lake can be so divided from the rest of the Keewatin both on stratigraphical and lithological grounds is certain, and it seems almost equally certain that it is older than the Cambrian as represented by the Animikie beds of Thunder Bay, as the lithological differences between the two are very marked and the folding and crushing which has affected the Steep Rock series so markedly does not seen to have taken place after the Animikie was laid down as the flat-lying strata of this formation are quite unaffected by it. They are consequently considered to occupy a position below the Cambrian and above the great bulk of the Keewatin. A description of the various horizons into which the series is most readily visible, will give a good idea of its composition and emphasize

Probably older than Cambrian.

* Structural Geology of Steep Rock Lake, Ontario. American Journal of Science, vol. XLII, pp. 317-331.

† The Archæan Rocks west of Lake Superior. Bull. Geol. Soc. of Am. vol. IV pp. 333-348.

Description of horizons.

the lithological discordance between it and the underlying and the newer series. It is in the main summarized from Smythe.

I.—Fine conglomerate of closely-packed small quartz-grains, holding occasional rounded and water-worn quartz pebbles sometimes 3 or 4 inches in diameter and with an interbedded layer of limestone. This formation is represented in East Bay by beds of quartz pebbles, none larger than buckshot, alternating with layers of massive quartzite. Estimated thickness 430 feet.

II.—Dark to light bluish-gray, banded limestone with thin cherty seams, the upper part a breccia with fragments of limestone and trap in a calcareous matrix, the basal beds frequently massive, siliceous and pyritous. From 300 to 700 feet.

III.—Soft, fissile, dull-green, pyritiferous volcanic ash, with occasional pebbles of limestone, and containing, near the base, bands of jasper and iron ore. Maximum thickness about 600 feet.

IV.—Interbedded, coarse, greenish-gray diorite of plagioclase and hornblende, locally sheared to form layers of green schist. Maximum thickness probably 1000 feet.

V.—Very calcareous green schist with seams of finely crystalline limestone. About 600 feet.

VI.—Conglomerate, varying from a hydromica schist with clastic grains of quartz to a coarse conglomerate with pebbles of quartz and granite. Maximum thickness about 100 feet.

VII.—Light, gray-green, close-textured diorite or diabase, weathering light-brown, varying in structure from coarsely crystalline and massive to fine, banded and schistose. Including also a band of about 20 feet of graphitic-schist. About 1400 feet.

VIII.—Agglomerate, of inclusions or elongated fragments with rounded outlines, resembling the type rock of formation IV varying in size from very small to 5 or 6 inches in longest diameter, contained in a matrix of the same material occurring as a light, greenish-gray fissile schist. About 300 feet.

IX.—Fine-grained clay-slate with light and dark-gray bands. Thickness unknown.

Probable explanation of stratigraphy.

The stratigraphy of the series is most easily explained by considering the present condition to have been produced by from two distinct periods of folding. The first of these from a N.E.–S.W. stress, probably folded the rocks into a series of simple folds at right angles to this direction. The later folding, which produced results which are so marked over the whole district, has masked almost altogether the evidences of the former folding. This first folding is probably responsible for the curious tongues of Keewatin which run off into the granitoid gneisses at various points, sometimes for long distances, as for instance at Beaver River and Dovetail Lake, and the corresponding tongues of gneiss, well exemplified at Beaver Lake.

These tongues were probably left at the close of the first period of folding as long narrow synclinal folds, inclosed partially by the corresponding sides of anticlinal folds of the underlying rocks. Subsequent denudation planed off the tops of the inclosing folds and left the tongues alone remaining as we now find them. The regional cleavage and crushing caused by the second period of stress has left its record over the whole district, and the cleavage induced by it passes from the Archæan rocks on each side right across the rocks of the Steep Rock series.

ANIMIKIE.

Animikie.

The Animikie rocks which occupy a limited area in the south-eastern corner of the region, overly unconformably the Archæan rocks wherever they have been seen in contact. From their stratigraphical relations to the overlying formations further east on Lake Superior, they are believed to represent the lower beds of the Cambrian. No evidence as to their age is afforded in their exposure in the district under consideration, excepting that given by their unconformity on the Keewatin and Laurentian and consequent more recent deposition than these. Exposures are not frequent as the greater part of the land supposed to be underlain by these rocks is covered by a thick mantle of drift. A few isolated exposures, however, and their occurrence a little distance to the south in more continuous outcroppings, makes it fairly certain that these rocks underlie the area so coloured on the accompanying map.

Relations of Animikie and Archæan rocks.

The immediate overlap of the Animikie rocks on the Archæan was not seen within the sheet, but their stratigraphical relations to one another are nevertheless well indicated. The Animikie beds are everywhere horizontal or nearly so and the Archæan rocks are as universally nearly vertical. The relations of the two are clearly seen at Kakabeka Falls on the Kaministiquia River just south of the boundary of the Shebandowan sheet. Here the fall is over a cliff-face of black, earthy-looking, carbonaceous Animikie shales, lying almost horizontal, and the gorge below is cut through the same rocks for a distance of nearly a mile. The actual contact is not seen, a gully intervening between the two series of rocks at the line. On the river just above, however, the Archæan rocks are well exposed. Granitoid gneisses and green, chloritic, hornblende-schists strike N. 80° E. with a dip to the north of 60° to 65°. The unconformity between the two admits of little doubt, and the surface aspect of the older rocks is such as to indicate a time-break of long duration.

Unconformity found at Duncan mine.

The unconformity between the two is again exhibited at the Duncan or Shuniah-Wiatchu mine, about a mile south of the edge of the Animikie under consideration. Mr. W. M. Courtis, M.E., * reports that the shaft here passed through the following strata in descending order, starting below a flat sheet of surface diabase :

	Feet.
Black slate	40
Dark green slate with masses of chert, red above and gray at base	300
Soft, carbonaceous, black slate	80
Calcareous band containing much iron ; arenaceous band in flinty, black slate ; jasper-slate band	20
Chert with bands of dolomite	27
Keewatin diorite, etc	

CORRELATION.

Comparison of Archæan with series elsewhere described.

But little can be attempted in the way of correlating the various formations of this district with those described in great detail by various observers in the region south of the International Boundary. There can, however, be made a few correlations which are at least very probable.

In the case of the Laurentian of this district there can be no doubt that it forms part of the "basement complex" of the region to the south ; although there the Coutchiching and part of the Keewatin are by the U. S. geologists generally regarded as also referable to the same "basement complex." The relations made out over the district under consideration do not seem to warrant this inclusion, as shown on another page, the Coutchiching seems rather to be an extremely altered facies of Keewatin and the gneisses and granites appear to bear the same

* Trans. Am. Inst. M.E., vol. XV. p. 671.

relation to every part of the Keewatin, i.e. they are intrusive with regard to all portions of that formation with which they have been found in contact.

Lower Marquette probably equivalent to Keewatin.

As already pointed out, by Van Hise and others, there is strong enough lithological similarity between the iron-bearing belt of the Matawin and that of the Lower Marquette and correlated series, to make it extremely probable that the two are synchronous in age. This being so, the Keewatin of this district generally must be looked upon as probably equivalent to the Lower Marquette of the United States Geologists; the Upper Marquette being possibly represented by the Animikie.

Eastern and Western Regions Compared.

Area here described continuous with that of Rainy Lake.

The region under consideration is continuous with that so well described by Dr. A. C. Lawson in his report on the Geology of the Rainy Lake Region,* and the general geological features of the two regions are similar. The Laurentian in the two areas is quite the same both lithologically and structurally. The thin sections which he describes illustrating the petrography of the system might have been taken from the eastern region, so closely do the two resemble one another. In the western area, Dr. Lawson found it possible to subdivide the Keewatin more minutely into lithological groups than we have been able to do in the eastern area. This is partly due to the character of the country, which, in the Rainy Lake region, lent itself more readily to detailed examination, but is principally owing to an apparently greater uniformity in these rocks in the eastern section and to their being generally in a more highly altered condition.

Differences in structure of Laurentian areas.

A striking feature in the mode of occurrence of the two sets of rocks in the Rainy Lake region is the occurrence of the Laurentian, in irregularly ovoid areas, entirely surrounded by belts of Keewatin rocks. In the Seine River and Shebandowan areas, this feature is not present. The Keewatin occurs rather as long bands, infolded with the Laurentian and conforming in strike to the foliation of the gneiss. These bands are often continuous for long distances, terminating in long, narrow arms which are gradually lost in the gneiss. The Seine River band, which was traced by Dr. Lawson right across the Rainy Lake sheet, has been followed continuously to near the ninetieth meridian of west longitude, a distance of over one hundred and eighty miles. This band varies considerably in width, in some places reaching a thickness of over twelve miles and in others narrowing down to under three miles.

* Annual Report, Geol. Surv. Can., vol. III (N.S.), 1887-88.

Relations of the Coutchiching.

Another point of difference between the eastern and western areas is the absence in the former of tracts of Coutchiching that can be separated from the Keewatin. Though there are local occurrences of fine gneisses and mica-schists quite similar to Coutchiching rocks, these are but phases of the Keewatin, apparently due to a more complete alteration along zones contiguous to the intrusive gneisses. The disappearance of the broad area of these rocks which comes upon the Seine River sheet from Rainy Lake, by their absorption into the mass of the Laurentian along their strike, is referred to on another page.

CONTACTS DESCRIBED.

Conditions at contacts of Laurentian and Keewatin.

Following the various lines of contact between the Laurentian and Keewatin, it is found that the conditions characterizing any one line of contact are remarkably constant all along its course, but that the line of contact on one side of a Laurentian or Keewatin area may differ quite widely from that on the other side. As illustrative of this, we may take up briefly the different lines of contact and examine points along their course where an opportunity to investigate them has been found.

Section on the Kaministiquia.

In examining the northern edge of the southern Keewatin area, the first good section across the line of contact is that afforded by the Kaministiquia River. Here the Keewatin schists seem to pass into the Laurentian gneisses by a gradual progression; the schists becoming by degrees more and more gneissic from the development of mica in them and by the interbanding with them of layers of coarser gneiss until they become quite characteristic Laurentian strata. This is the contact best seen by all the earlier explorers, as it lies on the regular line of travel between east and west, and to it is due probably their general opinion that the relation between the Huronian and Laurentian here was that of a conformable sequence. Following the contact westward, the next point where a good section is seen is at Buda station on the Canadian Pacific Railway, and here the same conditions are found to prevail.

At Buda station.

Section at Narrows of Kashaboiwe Lake.

At the Narrows at the foot of Kashaboiwe Lake, an excellent section is exposed which is referred to at greater length on another page; the contact phenomena are again of a similar character. The same relations between the two sets of rocks are found at the crossing of Crayfish River and on the Government road to the Huronian mine, at both of which points good sections are seen. On the east side of McKenzie Lake, just beyond the southern limit of the map, though the actual contact was not seen, the exposures of fine black gneiss enclosed in the prevailing coarser white biotite-gneiss, were of quite the same character as those seen at the various other points, noted above, where good sections were examined.

Contact line at north end of Kashaboiwe Lake.

The next extended line of contact to the north of the last, is that of the northern edge of the Kashaboiwe or central gneiss area with the Keewatin belt of Lac des Mille Lacs. At the north end of Kashaboiwe Lake, where the two series are found in direct contact, the contact is a sharp one, the Laurentian cutting the schists in a striking manner and sending off arms and stringers into them, the zone thus affected being, however, quite narrow. The same conditions are found at the contact on the south shore of Bolton Bay, and again, further west, at Baril Bay, where the contact might be called an indentated one. Although in a general way similar to those described above, this contact has probably been affected by a great fault which has somewhat changed the relationship of the two series. At Elbow Lake, there is the same well marked intrusive contact, with but a narrow zone of the schists penetrated by apophyses of the gneiss. Still further westward, the next two points at which sections were made across the contact, were examined by Mr. Smith, who seems to have found about the same set of conditions. At Pine Lake, however, where the Coutchiching takes the place of the Laurentian, the contact is found to be of an entirely different character; no sharp line of demarcation between Keewatin and Coutchiching is possible, there is simply a gradual change, continuing for a distance across the strike of over two miles, where the hard, massive, quartzite-like strata of the Keewatin become more and more micaceous and schistose up to a point where they are true biotite-gneisses.

Different conditions at Pine Lake.

Northern side of Lac des Mille Lacs Keewatin belt.

On the northern side of the Lac des Mille Lacs belt of Keewatin, the contact preserves the same uniformity in character from the above-named lake, (where the commingling of the two series in a broad contact zone makes the location of a definite line of division often difficult), westward to Moose and Sawbill lakes. The gneisses are evidently intrusive along this line, but the character of the contact phenomena is quite distinct from that of the two already described. All along this contact, there is a broad belt where the gneisses seem to have absorbed and incorporated the Keewatin strata, producing a set of nondescript, massive, granitoid rocks which it is often difficult to assign to either one or other of the two series. They are generally so deformed that it is difficult to make out their original composition or genesis.

Southern edge of great Laurentian area.

The southern edge of the great northern area of Laurentian, from Pyramid Lake westward, is again generally clearly intrusive in its relations to the Keewatin. The line of contact can be closely placed wherever exposures are to be seen as the contact zone along which the one set of rocks is markedly affected by the other is quite narrow. The conditions which are found along this line are similar in a general way to those existing along the Bolton Bay and Elbow Lake contact, the gneisses cutting the schists sharply and sending arms and apophyses into them.

Contact an irruptive one.

The nature of this contact of the southern rim of the northern area of Laurentian gneisses with the Keewatin belt which borders it, is along its whole length, wherever opportunity is afforded of observing it, is one of irruption. The evidences of this are many. The gneisses which, almost everywhere along this southern edge, become more basic in composition as the contact is approached, changing from typical biotite granite-gneisses to hornblende-gneisses, hornblende-syenites and hornblende granites, cut the Keewatin rocks quite after the manner of intrusive masses. They send into it long arms, sometimes of a size capable of representation on the accompanying maps, as at Beaver Lake and south of Steep Rock Lake, but more often in narrow apophyses which the small scale of the maps prevents being shown. Blocks and masses of the Keewatin strata are included in a manner which establishes beyond doubt the viscid condition of the gneisses at the time the blocks were included in them.

Gneissic intrusions.

From Lac des Mille Lacs, also, where the contact can be well observed on the many islands and deeply indented shore-line, westerly to Rainy Lake, the same evidences of intrusion are characteristic of the gneisses; they present the appearance of an intrusive, semi-viscous mass which cuts strata that at the time of the intrusion were quite solid. It is true that, locally, instances of quite an opposite set of conditions are to be found, notably on Lac des Mille Lacs and Beaver Lake, where, at more than one point, the diorites and diabases, apparently of the Keewatin belt, are the intruding rocks and send dykes into the gneisses, which are also included in the form of angular and semi-angular blocks and masses in the basic rocks. Phenomena of this sort are, however, only local, and do not represent the general conditions obtaining along the contact. These occurrences probably always represent later dykes which cut both series of rocks. In some cases this is readily observable, and where it is not and the diorites seem to form part of the Keewatin, the explanation seems to be, that, even in these cases the intrusions are of the later age, but their almost absolute identity in character with the diorites of the Keewatin makes their recognition difficult.

Instances where the conditions are reversed.

Diorites of two periods at Pine Point.

An example of this is seen at Pine Point, Lac des Mille Lacs, where a later dyke of diorite cuts the older diorite of the Keewatin. The contact between the latter and the gneiss is of the intrusive character so generally found. It is illustrated by specimens exhibiting the two rocks in contact, which Mr. A. E. Barlow, kindly examined. Of the first Mr. Barlow says :—"The hand specimen shews a contact between a dark, greenish diorite and a very pale, pink-granite. The granite near its junction with the diorite is very much finer grained, while the diorite exhibits no such change in texture. Under the microscope, this contact is seen to be sharp, but somewhat ragged, and portions of the individuals of hornblende composing the diorite have become incorporated in the granite. The diorite is composed essentially of hornblende and plagioclase, the former being by far the most abundant constituent. The hornblende forms a more or less intricate felt-work of imperfectly developed crystals of a bright green colour. It is trichroic—$\mathfrak{a}$, light yellow, $\mathfrak{b}$, greenish $\mathfrak{c}$, bluish. Absorption $\mathfrak{c} > \mathfrak{b} > \mathfrak{a}$. The plagioclase has been converted into an aggregate composed principally of zoisite and epidote. This so-called saussurite alteration is usually so complete as to destroy all evidence of the polysynthetic twinning, although in certain cases the twinning lamellæ may still be seen. Sphene (titanite) is an abundant constituent, occurs in grains or irregular areas composed of an aggregate of these grains, reddish-brown in colour, strongly pleochroic, brown, yellow to almost colourless, and has probably resulted from the alteration of ilmenite, as opaque nuclei of titanic iron still remain.

The older diorite described.

"The granite is composed chiefly of orthoclase, plagioclase, quartz and biotite. The orthoclase is more or less grey and turbid owing to the development of minute scales of kaolin or muscovite. There are evidently two varieties of plagioclase present. The more basic variety has been partially saussuritized, but there has not been sufficient development of epidote, zoisite and muscovite to completely mask the twinning lamellæ, which may still be readily seen. The more acidic variety is usually very fresh and often exhibits two sets of polysynthetic twinning lamellæ intersecting nearly at right angles. Biotite is only sparingly present and has undergone either partial or complete alteration to chlorite. A good deal of epidote is present, light-yellow in colour and shewing the characteristic pleochroism, yellow to nearly colourless, rough relief and brilliant chromatic polarization. Zoisite is also present in rather large amount. The epidote occurs in irregularly angular individuals and aggregates without regular boundaries, also in small grains and fragments and is often seen imbedded in the chloritized biotite. A good deal of the epidote and zoisite at least has resulted from the decomposition of the felspar. The finer grained portion of the granite near the contact contains minute fragments of

Lithological character of granite in contact with diorite.

Granite near actual contact.

hornblende which have doubtless been derived from the diorite. These contain numerous needle-like crystals of rutile, intergrown in the form of net-shaped groups known as sagenite webs, the meshes of such sagenite webs being 60° and 120°. The granite also contains some good sized prismatic crystals and more or less rounded grains of rutile, of a deep-brown colour, almost opaque, but which, in strong transmitted light, appear of a deep, blood-red colour. These are especially abundant near the junction, but at a short distance they are either very scarce or wholly absent. The quartz is clear and colourless, but is usually somewhat dusty owing to the presence of numerous fluid cavities with and without fluid bubbles. The quartz shows only very limited evidence of pressure. Apatite is present and a very small amount of titanic iron ore which was detected by its partial alteration to leucoxene. A limited amount of granophyre was noticed. The difference in texture of the granite near the line of junction and the incorporation of fragments of hornblende in the vicinity seems to indicate that the granite is younger than the diorite."

Contact between hornblende-schist and granite near Pine Point.

At another point on this contact, near by, the diorite becomes a hornblende-schist, probably from pressure and shearing. Mr. Barlow also examined a specimen taken from this point.—"The hand specimen shows a contact between a gray granite and a dark, grayish-green hornblende-schist. Small interlaminated veins of quartz traverse the hornblende-schist in the immediate vicinity of its contact with the granite and have evidently been introduced simultaneously with the irruption of the granite. The thin section crosses the contact and exhibits a portion of both rocks.

The granite.

"The granite is composed of quartz with the usual inclusions, orthoclase and a much smaller proportion of plagioclase, both of which have undergone extensive decomposition, and biotite which is now wholly converted into chlorite showing the characteristic, dull-blue polarization. Sphene (titanite) is tolerably abundant and occurs in small, wedge-shaped crystals and irregular grains, light reddish-brown in colour and strongly pleochroic. Epidote is also present and a deep-brown mineral surrounded by a rim of epidote, probably allanite. Some short stout prisms of zircon were observed, with pyramidal terminations, of a pale wine-colour, feebly pleochroic and showing characteristic strong relief and brilliant red and green interference colours between crossed nicols. Both the sphene and zircon are often contained in the chloritized biotite.

The hornblende-schist.

The hornblende-schist is composed of hornblende and felspar, the latter having been converted into saussurite. The hornblende occurs in elongated fragments and imperfect crystals which have a very perfect parallel alignment. It is bright-green in colour and trichroic.

Epidote is tolerably abundant as a product of decomposition. Very little quartz was noticed. Brown pleochroic 'halos' generally surround the grains and crystals of sphene which are imbedded in the hornblende near the line of junction between the two rocks."

The usual alteration of the granite is observed as is shown by a specimen collected from what is seen clearly in the field to be the granite side of the contact. Mr. Ferrier describes it as a quartz-mica-diorite, exceedingly crushed and decomposed, consisting chiefly of quartz and plagioclase with decomposed, chloritized mica and hornblende; plagioclase all saussuritized; epidote, sericite etc., abundant as products of alteration; extreme granulation, stretching and undulatory extinction of quartz. Alteration of the granite.

In contrast with the markedly intrusive character of the contact of the northern area of gneiss with the Keewatin, is the nature of the contact along the southern edge of the central or Kashaboiwe area of gneiss already referred to. Owing to the nature of the country through which the line of contact passes, the observations of the actual contact have been fewer in number than in the case of the northern area, but where opportunities for an examination have been found, the phenomena are those of a gradual passage of the one set of rocks into the other. At the southern end of Kashaboiwe Lake, where a good section is exposed, there is no actual line of contact which can be defined on the ground. Here the gneisses of Kashaboiwe Lake, which are coarse biotite-granite-gneiss with bands of fine, black biotite-gneiss, pass gradually into quartz-schist; or rather, the quartz-schists, by the addition of mica, gradually become fine biotite-gneisses. Southern edge of central gneiss area. At south end Kashaboiwe Lake.

Reference to the phenomena occurring at the contact along the northern side of the Keewatin belt of Lac des Mille Lacs, will again show a noticeable contrast between that and the southern contact of the same belt. In the first-named case, the contact conditions extend over a belt about four miles in width, the rocks of the two series being, over that distance, intermingled to such a degree as to render it difficult to fix the exact line of junction, while in the latter the rocks of one series are quite unaffected by proximity to the other at distances of about one hundred yards from the actual contact. Differences in character of contact.

Still another and very distinct form of contact between the gneisses and the Keewatin rocks, is seen along some parts of the southern edge of the central gneiss belt, the northern edge of which we have just been considering. Here there is apparently a gradual passage of the one set of rocks into the other, but the form which the passage takes is of an entirely different character from either of the others considered. Starting from the gneiss belt, at some distance from the contact, and proceeding southwards across the strike we get coarse, white, granitoid gneisses, composed of quartz, felspar and biotite and some hornblende, with bands of fine, almost black, biotite-gneiss interlaminated and occurring as broken bands and include, drawn-out fragments in the coarse gneiss. The coarse gneiss and the fine bands by degrees change their relative importance until the latter occurs as the prevailing rock with the coarse white gneiss as bands in it. *Pari passu*, the fine black gneiss loses its mica, and gradually also its gneissic character, until, when the bands of coarse gneiss have become inconsiderable in size and number, the fine bands have assumed the aspect of an altered felspathic sandstone of purplish colour, in which mica has been developed. Continuing southwards, the coarse gneiss entirely disappears, and the fine, hard, purplish felspathic quartzite is continuous, becoming less and less micaceous until it appears as a quartzite with no mica or with mica only sparingly scattered through it in fine specks. Closely following the disappearance of the coarse gneiss bands, the quartzite or greywacké developes a schistose structure and forms a belt of banded, felspathic schist two miles in width, that gives place to green chloritic schists, which, with areas of massive diorite rocks, form the main body of the Keewatin belt.

Faults.

Faults seldom recognizable.

That this area has been affected by many faults, there is little doubt; though these are so masked by the extreme alteration and folding of the strata that they are seldom recognizable. A line of displacement seems to be pretty clearly indicated which runs in a north-west and south-east direction through Boot and Baril bays of Lac des Mille Lacs and along the east shore of Greenwater Lake.

Displacement affecting Keewatin at Lac des Mille Lacs.

The amount of displacement is more than two miles. It is most clearly seen where the Keewatin belt of Lac des Mille Lacs is affected by it. The actual line of fault cannot be seen, as the strata all along the line followed by the fault-plane are intermixed in great confusion. The line of contact between the green schists and gneisses along the fault is a serrated one, with long tongues of each rock running into the mass of the other, along the planes of foliation and cleavage which are nearly at right angles to the line of faulting, The whole aspect of the rocks along the contact, goes to shew that folding and shearing on a grand scale has affected them subsequently to the faulting.

Amount of displacement.

The belt of Keewatin which crosses Lac des Mille Lacs, preserves a very regular trend throughout its course, with only minor flexures of the

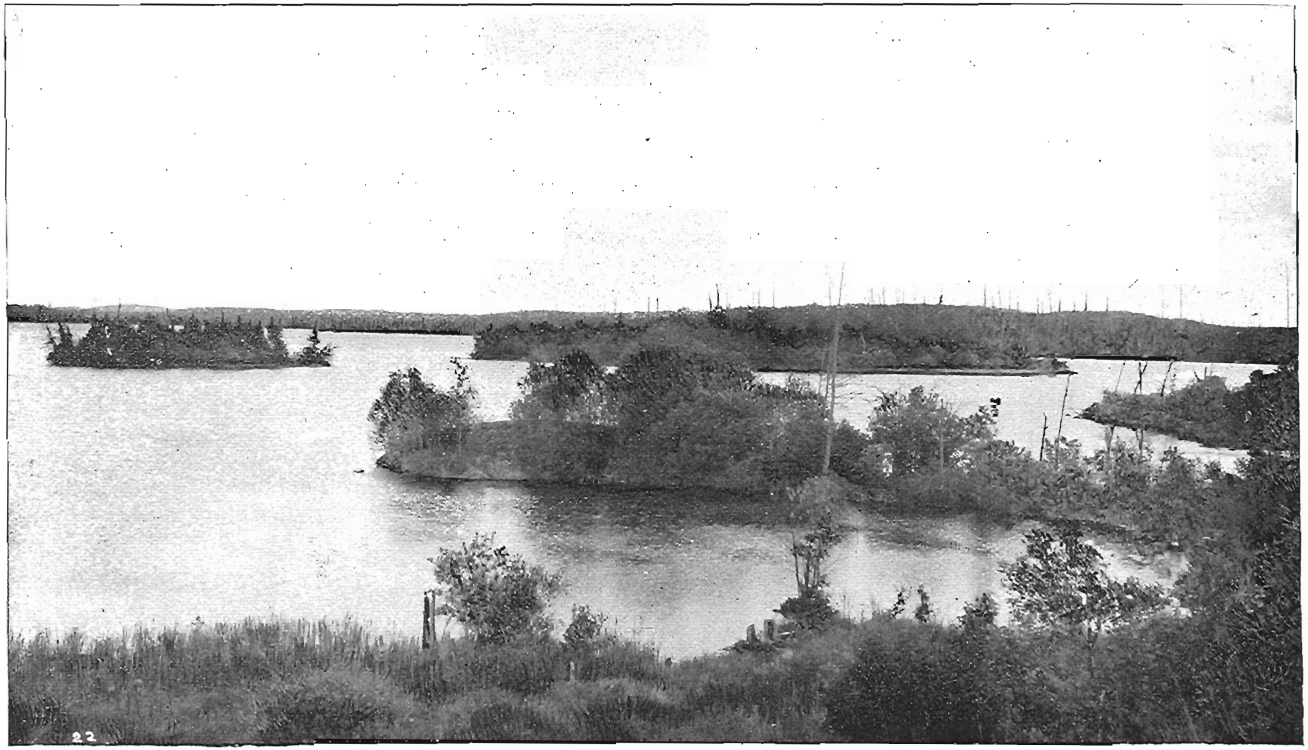


Photo. by W. McInnes.

PORTAGE BAY, SOUTH END OF LAC DES MILLE LACS.

strata, and the presence of a fault where indicated is inferred from the abrupt displacement of the belt at the point where the fault would cross. East of the line, the belt is found to have a position two miles or more to the south of its position to the west of the line, while it still preserves the same character and strike. Following the supposed line of faulting south-easterly, it would cut the next Keewatin band at the crossing of Crayfish River, and here, though the limited number of exposures afforded by the river traverse do not so clearly indicate a break, yet there is evidence that the band, at the point where the line of dislocation would strike across it, take a more southerly position within a short distance along its strike.

Displacement at Greenwater Lake.

At Greenwater Lake, again, the position of the southern edge of the Keewatin belt on the eastern side of the lake is some six miles south of its position on the western side.

Fault at Dog Lake.

A fault where the amount of dislocation is much less in amount, not more than one mile, is seen to have affected the strata on Dog Lake. This becomes evident where a small band of Keewatin crosses the lake about its centre. The band is well exposed on both shores of the lake and the strike of the rocks well marked. Produced on its strike from the western shore, the band would reach the eastern shore about a mile north of its actual position. This abrupt change in position can only be explained by a fault or by an extremely sharp double fold and of these alternatives the fault seems to be the more probable. Here, as in all other parts of the region, the line of fault is quite unrecognizable except where the Keewatin band is affected by it. In the Laurentian area, the uniformity in the character of the rocks and the absence of well marked bands prevent its recognition. It is most probable that very many other lines of faulting occur throughout the district, but, owing to the conditions described above, it is only in very exceptional cases that they can be recognized, practically only when they cross a Keewatin band.

LOCALITIES PARTICULARLY DESCRIBED.

In the following pages, some of the more striking localities in the district are described in greater detail and their geology will be more particularly referred to. For this purpose some of the large lakes, a few of the principal rivers and canoe routes are taken, as affording the best geological sections.

Lac des Mille Lacs.

Description of Lac des Mille Lacs.

Lac des Mille Lacs is the largest body of water in the area mapped between Rainy Lake and Lake Superior. It has a very irregular outline is generally shallow and studded with islands, and covers an area, exclusive of islands, of ninety-six square miles. Its name, which dates back to the days of the early French voyageurs, is doubtless descriptive of the island feature of the lake which has the effect of apparently dividing it up into innumerable small bodies of water, by limiting the views from any point to the waters bounded by the encircling islands. Owing to the swampy nature of the land drained by the rivers flowing into it, the water of the lake carries much organic material which gives it a deep yellowish tinge. The Savanne River, which flows into the lake at Port Savanne, now Savanne station on the Canadian Pacific Railway, and which is the principal tributary, has two main branches that rise near the height-of-land dividing these waters from those flowing into Lake Superior by the Kaministiquia River. It empties from its north-western corner by the Seine River, the waters of which flow into Hudson Bay by way of Rainy Lake, Lake of the Woods and Lake Winnipeg. The shores are generally rocky with little surface soil. In places, however, and particularly along the shore occupied by the Indian reserve, there is a coating of considerable depth of stratified sand and clay which forms cut-banks from five to twenty-five feet in height. Some of the smaller islands opposite the reserve serve as burial places for the Indians, who, though sometimes interring their dead in graves dug in the ground and covered with poles, seem to prefer placing the body, sewn up in a covering of birch-bark, on a scaffold erected between the trunks of trees on some island where it is safe from the attacks of wild beasts. Pike and whitefish are the principal food fish of the lake and they occur in considerable quantity. The greater part of the forest growth has been burned off and the remaining portions are principally Banksian pine, with, however, a few tracts of limited extent of white and red pine.

Savanne River.

Outflow by Seine River.

Character of shores.

Laurentian and Keewatin areas.

The northern part of the lake lies in the Laurentian and the southern part in the Keewatin, the contact between the two cutting it nearly in half. The Laurentian about the shores has a general trend of about N. 70° E. but in places is very irregular, striking at the Indian reserve but little east of north, and on Broad Point varying to east and even ten to fifteen degrees south of east. The eastern shore affords a good section across both series of rocks, the Laurentian consisting mainly of well-foliated granite-gneiss composed of quartz, felspar and biotite with mica and hornblende often present in addition, particularly as the contact of these rocks with the Keewatin is approached. The line of contact as fixed upon the accompanying map, occurs near the northern edge of a band or contact zone made up of an intimate commingling of the rocks of the two series. The diorites of the Keewatin are invaded

Line of contact.

by small areas of granite and felsite and apparently often merge insensibly into the felsites and granites. They become quartz-diorite and are cut by many small veins of quartz which often holds molybdenite. One large vein about five feet in width was noted but was not observed to carry any valuable minerals.

Interbanded with the diorites and granitoid rocks near the contact zone, are quartzites, which gradully increase in proportionate volume going southwards, from occasional exposures intimately intermixed with the granitoid rocks to a point where they become the prevailing rock and the granitoid rocks are entirely absent. The quartzites in their turn pass into felspathic quartz-schists, fine-banded and striking uniformly in a direction N. 70° E. or parallel to the trend of the belt. The dip is everywhere high, varying from vertical to 70° to 80° in either direction. The chloritic, hornblendic diorites and diabases, with limited areas of pyritous black slate and of an agglomerate or breccia of diorite fragments cemented by a schistose paste of the same material, have a width of about four miles. The quartzites and quartz-schists together have about the same width across their strike. As this strike does not necessarily have any relation to planes of bedding, no inference as to original thickness can safely be made upon it.

Interbanded quartzites at contact.

Bolton Bay which follows the strike of the rocks westerly for six miles, shows almost continuous exposures of the same felspathic quartzite and felspathic, quartz-schists. Near the head of the bay the shore is occupied for about two miles by banded crystalline felsite with narrow layers of felspar and chert. Where the shore-line bends furthest south, at a little bay and brook, interbanded schist and coarse gneiss occur, the gneiss running into the schist along the planes of cleavage in long arms, from a few inches to twenty feet in width. The hill just to the south is made up of gneiss similar to that seen all about Kashaboiwe Lake.

Exposures on Bolton Bay.

Where this line of contact cuts the north end of North-east Bay on Kashaboiwe Lake, the relations of the two rocks are precisely similar, and a good opportunity of observing them is afforded by the bare hills which rise steeply from the water's edge all about the head of the bay. Here long arms or apophyses of red granitoid gneiss and of a pegmatite-like rock made up of coarsely crystalline orthoclase and quartz, with the quartz sometimes only sparingly present, extend into the Keewatin in the form of interlaminated bands, generally following the planes of cleavage of the schists, but in places cutting the schists in large irregularly shaped masses. Following the same line of contact westerly,

Other points on contact line.

it is next seen on Baril Bay, and there the same conditions, in a general way, prevail, though the relations of the two series are somewhat complicated and masked by the crossing of a fault at that point. The same apparent interbanding of the two series is seen. Arms of the gneiss are intruded along the planes of cleavage of the schists so as to present the appearance of alternating beds of each series. The Keewatin rocks are represented mainly by diorites with schists apparently derived from them.

Shebandowan Lake.

Shebandowan Lake.

Shebandowan Lake is a long narrow body of water divided by constrictions into three subdivisions, forming an upper, a middle and a lower lake. Its total length is about twenty-five miles and its average width about three-quarters of a mile. It formed one of the links on the old Dawson route, a wagon road forty-four miles long connecting it with Port Arthur. To improve the navigation, by flooding out the slight rapids at the narrows, a dam was built which raised the water about two feet and a half. Although the dam has since fallen into decay its effects are still seen in the belt of dead trees which encircles the lake.

Generally characterized by Keewatin rocks.

Keewatin rocks are exposed everywhere about the shores of the lake excepting on part of the south side of Middle Lake and the north side of Lower Lake where granitoid gneiss is exposed. This area of gneiss is spindle-shaped and about ten miles long by four wide. It is entirely enclosed in Keewatin rocks with which its relations are those of an intrusive mass. The contact of these rocks with the enclosing Keewatin are very similar to that seen on Lac des Mille Lacs. There is the same close intermingling of the two sets of rocks forming a broad zone along the contact where the rocks are generally granitic in form but are made up largely of material apparently derived from

Contact zone.

the Keewatin. This contact zone merges almost imperceptibly, on one side, into quite typical hornblende-gneisses and on the other into Keewatin schists and diorites. Among the granitic rocks of this belt there are many which have all the field characteristics of granites but which under the microscope are seen to be quartz-diorites, though always containing a percentage of orthoclase.

The granite-gneisses.

The regular granite-gneisses of the area, as far as they have been examined, are found to contain plagioclase as well as orthoclase and there seems to be every gradation in the relative proportion of these felspars. Mr. Ferrier describes two of these rocks, examined in thin section, as follows :—"Specimen No. 1, from an island in Middle Lake. Crushed and sheared hornblende-granite, made up of quartz, orthoclase, plagioclase, hornblende, biotite (the two latter altered to chlorite), sericite, iron ores and calcite. The rock is greatly crushed and decomposed, the quartz granulated, the felspar largely altered and filled with little scales of sericite, calcite etc. Both biotite and hornblende are almost completely altered to chlorite, and there has been deposition of secondary iron ores." Petrographical characters.

"Specimen No, 2, from the narrows between the Middle and Lower Lakes. A quartz-mica-diorite (?), made up of quartz, plagioclase, orthoclase, hornblende, biotite, titanite, apatite, iron ore, with chlorite, sericite, epidote and iron ores as secondary products, This is one of the transition rocks between granite and diorite. Orthoclase, or at least unstriated felspar, is present in the section, but plagioclase certainly preponderates; quartz is abundant and well granulated; plagioclase is the predominant felspar and is much decomposed, the individuals being filled with granules of epidote, scales of sericite, etc.; both hornblende and biotite are much altered to chlorite, the former intimately associated with the titanite; titanite in large, deep-brown, pleochroic, irregular masses and crystals is abundant; iron ore is not abundant, a few grains apparently associated with leucóxene, probably ilmenite."

Small masses of Keewatin which have apparently been caught up by the intruding mass of granitoid rock, occur sometimes at a considerable distance from the edge of the mass. An instance of this is found on the west shore of the lower narrows, where an ash rock forms the immediate tip of the point, cut off less than a chain back by the granitoid rock. Mr. Ferrier describes it as—"Specimen No. 6. A clastic, ash-rock, quite calcareous, effervescing freely with dilute hydrochloric acid; shews a fragment of tourmaline." Included masses of Keewatin.

Approaching the contact from the east, along the north shore of the lake, felspathic, quartzose schists are exposed just west of Swamp River, dipping N. $< 80°$ to vertical. These are succeeded by white-weathering, soft, fissile hydromica schists which gradually become quite granitoid in structure and merge into granitoid gneisses with obscure schistose cleavage and show chlorite films along the cleavage planes. It is difficult here to find exactly the line of separation between the two sets of rocks owing to their composite character throughout the contact zone. There seems to be little doubt that most of these crushed and sheared rocks have been derived from granites, though some have been sheared to form typical schists and others have been crushed so that they show under the microscope a clastic structure. A good Crushed rock near contact along north shore.

Microscopical character.

example of this facies of the rock is seen on a small island in the lower lake, where the rock shows to the eye a fine greenish groundmass of quartz and felspar, specked with blebs of clear quartz and with crystals of pyrite. Under the microscope it shows a clastic structure very strikingly. Mr. Ferrier, who examined the rock in thin section, describes it as a clastic rock made up of granitic débris, the material being derived from granite or quartz-porphyry fragments of quartz, plagioclase, orthoclase, titanite, biotite, (?) etc. It comprises much secondary epidote in subangular fragments; paste of a fine-grained material consisting of the same minerals.

Contact on south side of gneiss lens.

On the south side of this lens of gneiss the contact is generally sharper, the Keewatin quartzose felsite, felspathic schists and diorites being penetrated for shorter distances by arms and stringers of granite. A very hard, coarsely crystalline diorite showing felspar in irregular pieces sometimes half an inch in diameter, which are probably crushed crystals, occurs near the contact on the south shore of Lower Lake. It is penetrated by arms of the granite. Examined in thin section, Mr. Ferrier describes it as—"Specimen No. 4. An altered basic, eruptive diorite (possibly derived from a diabase), exceedingly decomposed; essentially composed of hornblende and plagioclase both almost entirely decomposed, the former to chlorite and the latter to saussuritic material. Ilmenite is quite plentiful with leucoxene. Twinning in the hornblende individuals is exceedingly common, two twinned individuals being frequently twinned with each other. The hand specimen has a porphyritic appearance."

Western extremity of gneiss.

The gneiss area tapers at each end to a long point; at the western extremity, where the rocks are well exposed on Loch Erne, they consist of red hornblende-granites which probably are composed partly of plagioclase and which merge in places into red crystalline felsites. These clearly cut the Keewatin diorites and felspathic schists and enclose them in the form of angular blocks and masses. On the north-east shore, a ledge of felspathic schist is cut by large veins or arms of the granite which sends out smaller veins along the lamination-planes of the schist and encloses fragments and blocks of it, the whole forming in places a regular breccia. At the western end of the lake only Keewatin rocks are seen, the granites having entirely disappeared or being represented only by narrow veins cutting the schists.

Greenwater Lake.

Greenwater Lake.

Greenwater Lake is a very beautiful sheet of transparently clear water with a semicircular length of nine and a half miles and an average width of about a mile and a half. It lies to the south of Upper Lake Shebandowan into which it flows by a small clear stream with a total length, including two small lake-expansions, of a mile and a half. It may be reached from Lake Shebandowan by the stream and lakes just referred to, by making two short portages of five chains and twelve chains respectively, or by a direct portage into its most easterly bay from the western end of Upper Lake Shebandowan, two miles south of the end of Kashaboiwe portage. By this route the lake can be reached most directly, though it involves a portage of forty-five chains, which is not, however, exceptionally rough or difficult.

This lake-basin is an exception in the district, in which most of the lakes show a preference for the Keewatin areas. Its northern shore, which forms an almost exactly regular arc of a circle, is defined by the southern edge of the belt of Keewatin that occupies the country northwards to the Kashaboiwe Lake, and the lake itself lies almost wholly in the granitoid gneiss. The whole southern shore is formed of this gneiss as well as many of the projecting points along the northern shore. The feature is an interesting one, for, all along this shore of the lake, the jutting headlands are occupied by the granite-gneiss, with smooth and well rounded surfaces that extend back from the shore for but short distances, in some cases for but a few feet, when they abut abruptly against the dioritic rocks of the Keewatin, which are in contrast with the gneisses, and are abrupt and but little worn. The same relationship between the granitoid rocks and the diorites is seen on another small lake south of Shebandowan known as Peewatai Lake, referred to elsewhere in the Report. This lake is occupied in a similar manner by intrusive granites which form the lake-basin, but show only on the tips of the points and abut against sheer walls of diorite. A gneissic lake-basin.

The strike of the Keewatin schists immediately to the north of Greenwater Lake, conforms very closely to the trend of the shore-line, being evidently defined by the edge of the gneiss area in which the basin of the lake lies. The operation of the same causes which throughout the district generally have led to the occurrence of lakes and river valleys along the belts of Keewatin, has here produced apparently opposite results, though in both cases the softer rocks, yielding more readily to demanding agencies, have been scooped out into basins. In the two cases under consideration the Keewatin rocks in contact with the gneisses are hard diorites which have shewn themselves to be more resistent even than the granitoid rocks. Keewatin schists here more resistant.

The prevailing rocks of the Keewatin, as exposed all along the north shore of the lake inside of the fringe of gneiss are diorites and horn- Prevailing rocks.

Iron ores.

blende-schists, the latter having associated with them bands of magnetic iron ore. Specimens from a point on the east shore two miles and a half from the southern end of the lake were submitted to Dr. Hoffmann, for analysis. He describes it as follows.—" A very fine-grained, almost compact, schistose magnetite from Greenwater Lake, district of Thunder Bay, Ont.,—collected by Mr. McInnes, 4th October, 1891,—has been examined by Mr. F. G. Wait, and found to contain:

Metallic iron	52·82 per cent.
Insoluble matter	22·31 "
Titanic acid	None.

A good iron ore."

This belt shows similar ores at various points in its extension towards the Matawin River and also on its probable westerly extension south of Moss township.

Specimens of the ore from this part of the belt collected by Mr. H. B. Proudfoot, P.L.S. were also submitted by me to Dr. Hoffmann for examination. Upon them he reports as follows :—

" Specimen No. 1, labelled.—Two miles south-west of intersection of south boundary of Moss Township with Round Lake River (Crooked River), District of Thunder Bay.

" Specimen No 2, labelled.—From south of Moss Township (one mile and a half west of No. 1.) District of Thunder Bay.

" Specimen No. 3, labelled.—From south of Moss Township (north of No. 2.) District of Thunder Bay.

"The material consisted in all instances of very fine crystalline, massive magnetite.

Analysis gave for :—

	1.	2.	3.
Metallic iron	42·57	42·64	51·30 per cent.
Insoluble matter	38·45	38·63	26·99
Titanic acid	None	None	None

The insoluble matter consisted of quartz and actinolite."

Magnetite and quartzite-schist.

In the case of the specimens collected by myself from Greenwater Lake, these do not represent average samples from the whole band, but rather selected samples from the richer-looking portions. The ore occurs in a band about twenty feet in width, with a general strike N.40° W., but very much folded and crumpled, the magnetite forming narrow bands in a quartzite actinolite-schist inclosed on either side by hard, fine- to medium-grained diorites. A belt with similar iron ore occurs on Dakota Lake, six miles east of the Greenwater locality, but the bands of magnetite are here narrower.

Peewatai Lake.

Peewatai Lake basin in granite.

The basin in which Peewatai Lake lies has been hollowed out of the granite entirely, the inclosing diorites coming only to the shore-line. In lithological character and structure, this small area is quite different from the gneiss area of Shebandowan Lake to the north and from the larger area which approaches within a few miles of it on the south, but is quite similar to the granitic area of One Island Lake, north of the township of Ware. The granite is very uniform in character wherever examined throughout the area. It is a non-foliated, coarse, red granite, porphyritic with large crystals of red orthoclase felspar in a groundmass of semi-vitreous quartz and hornblende.

Diorites of south shore

Only at one place on the lake is the granite seen in actual contact with the diorite, and here there is a gradual change from typical diorite into typical granite. Approaching the contact from the diorite side, the rock becomes gradually more and more felsitic and shews great blotches of felspar, becoming finally a regular crystalline felsite, which in a short distance itself merges into the ordinary porphyritic granite of the area. All along the south side of the lake, diorites occupy the shore, with the exception of the little jutting points that project into the lake, which are formed of granite. Nowhere along this shore are the two rocks seen in actual contact, as a gully occurs between each granitic point and the mural escarpment of diorite rising behind it.

The diorite has generally a slaty cleavage, and is, in certain layers quite cherty and holds calcite and iron-pyrites with occasional bands of very lean magnetic iron ore.

Granite passing to felsite.

At the eastern end of the lake, though the actual contact is not seen, the granite loses its distinctly granitoid character, and becomes a quartzose crystalline felsite similar to that described as marking the contact at the western end of the lake. Although differing very much in character from the great mass of the Laurentian gneiss of the district, nothing has been observed with reference to the relationship of this area or of that north of Ware township to the rocks surrounding them, that would indicate that they differ in origin in any material way from the gneisses of the Laurentian areas.

Crayfish River and Lakes.

Crayfish River.

Keewatin schists.

A good set of exposures of the rocks along the contact between the Laurentian area of Kashaboiwe Lake and the Keewatin belt of Shebandowan is afforded by the Crayfish River and lakes. The river, from its mouth at the head of the south-west bay of Kashaboiwe Lake for a distance of six miles up stream follows the Keewatin belt. Near the mouth are exposures of gray mica-schists, similar to those occurring at the narrows on Kashaboiwe Lake, striking N. 64° E. with a vertical dip. Highly calcareous, felspathic, slate-like schists, considerably contorted but with a general strike N. 74° E. and dipping at a high angle to the south, come in just above the first rapid three miles from the mouth. These are followed by occasional ledges of blue-gray, felspathic, slate-like schists, striking N. 85° E., which continue to the falls, where little altered, blue, slate-like schists come in. The same rocks and harder felspathic quartzites continue up stream, gradually becoming more gneissic by the addition of mica, and showing bands of coarse white mica-gneiss, to the next fall, where coarse, mica-gneisses are exposed. These gneisses are quite similar to those of the Laurentian area excepting the presence in them of green chlorite films that probably represent comminuted material from the schists, which they have incorporated. From this point outwards the gneisses are continuous, with, for some distance back from the contact, occasional belts of the schists interbanded. All along the south shore are mica-gneisses with the decided purple tints characteristic of the near approach to a contact with the Keewatin. A bay which extends southwards, at a distance of about a mile and a half from the foot of the lake, runs into the Keewatin belt and shows exposures of hard, fine, blue-gray, felspathic greywacké which changes by the addition of mica into mica-gneiss, fine-grained and purple in colour.

Gneissic rocks.

Rocks near Crayfish Lakes.

The rocks occurring about the Crayfish Lakes and extending up the river to the crossing of the Huronian Mine road, are gneisses of the type seen in the belt that crosses Kashaboiwe and Dog lakes, of which they represent the westerly extension. They show everywhere an alteration of coarse white gneiss and fine dark-gray biotite-gneiss in stratiform layers, and differ very materially in their general aspect and mode of occurence from the gneisses that form the larger Laurentian areas of the district. They, however, merge into it on one hand, and in certain contacts, notably on the Kaministiquia River, at the narrows on Kashaboiwe Lake and in the lakes under consideration, gradually merge on the other hand into the Keewatin. When approaching the contact with the Keewatin from this belt of gneiss, the dark-gray, fine

Relations to Laurentian and Keewatin.

gneiss gradually becomes harder and occurs in broader bands in the coarser white gneiss, losing its mica by degrees and at the same time taking on a purple colour. This change continues until the fine gneiss becomes a hard felspathic quartzite, purplish-gray in colour, with specks of mica and closely resembling an altered felspathic sandstone.

This change from one set of rocks to the other is, in places, so gradual that the tendency, in fixing the line of contact between the two, is to vary its position considerably according to the side from which it is approached. A gradual passage.

These phenomena seem to indicate that the bands of fine gneiss which give this belt of gneisses its stratiform appearance, are really highly metamorphosed Keewatin schists. It is interesting to note that this belt followed westerly along its strike passes into the Coutchiching of Rainy Lake by the gradual disappearance of the bands of coarse gneiss. Dr. Lawson suggested the probability that the Coutchiching was a highly altered sedimentary series, and Dr. Coleman has, by microscopic examination of thin sections of these rocks, shown their deviation from sediments, or at least has shown that they have the characteristics of sedimentary rocks. The conclusion would seem to be that there is no break between Keewatin and Coutchiching and that the latter is really only an extremely altered phase of the former. Connection of Keewatin and Coutchiching.

Round Lake and Kawawiagamak River.

Round Lake which cuts the eastern boundary of Moss township lies in the Keewatin almost entirely, though small areas of intrusive granitic rock occur about its shores, one of which is of sufficient extent to be represented on the map. Along the portage-route from Shebandowan Lake, the rocks exposed are chiefly Keewatin diorites, varying from quite fine-grained, with a slaty structure developed in them, to coarse and somewhat granitoid in structure and cut by veins of granite On the lake itself the rocks are chiefly of the quartz-porphyry type. Along the north shore, from the end of the portage to the north-west corner, exposures are frequent of red crystalline felsites with areas of diorite, schist and vesicular diabase which is cut and invaded by apophyses of granite. At the extreme north-west corner, a small intrusive mass, made up of biotite granite-gneiss and red hornblende-granite, is probably an outlier from the larger area of these rocks which occurs at Jackfish Lake, or may be continuous with that area. The granite area of the east shore, represented on the map, is made up of fine-grained, red, biotite-granite and more coarsely crystalline, Round Lake. Quartz-porphyry. Intrusive granite mass.

red syenite composed of felspar, apparently orthoclase, and biotite. Both are without foliation. The boundaries of the mass away from the lake shores are largely conjectural. Elsewhere about Round Lake the quartz-porphyry type of rocks prevails with limited exposures of diorite and felspathic schist. A somewhat felspathic, quartzose massive rock, resembling an altered quartzite, shows broad bands charged with pyrite and chalcopyrite which are probably zones of shearing where the sulphurets have been deposited in much the same manner as vein matter.

Pyritous band.

Section on Huronian road.

Northwards from Round Lake, a section across this belt of Keewatin to the southern edge of the gneiss, is afforded by the road leading from the Huronian Mine. The exposures along the road are, for the most part, felspathic schists, varying to greywacké-like massive felsite at a point about a mile and a half from the northern edge of the belt. A felspathic schist not unlike those exposed generally shows in certain layers a conglomerate structure. The matrix is schistose and holds semi-angular pebbles of quartz and of a felspathic quartzite not unlike the material forming the paste, though harder. In places this closely resembles a true conglomerate, though not everywhere, as sometimes the pebbles suggest by their arrangement broken bands, the fragments of which have been drawn apart and surrounded by the softer parts. The contact with the gneiss is one of gradual change, the schists becoming more micaceous and gneissic by almost imperceptible degrees.

Conglomerates.

Kawawiagamak River.

All along the Kawawiagamak River, from Round Lake to the low land near its mouth, the rock exposures are highly felspathic in character and are for the most part variations of the quartz-porphyry and crystalline types often altered to quartz-felsite-schists and sericite-schists, with a general strike about N. 40° E. At the small grassy lake opposite Jackfish Lake, somewhat schistose chloritic diorites are associated with felspathic schists striking N. 44° E. and with a massive, red crystalline rock with green blotches, resembling in the field a crystalline felsite. Under the microscope, in thin section, it proved to be exceedingly crushed and altered, but is described by Mr. Ferrier as a diorite, though somewhat porphyritic. The same type of rock, varying from a diorite to a crystalline felsite, often quite schistose in structure, continues to the third portage, where a soft green schist is associated with massive red quartz-porphyry. This rock was examined in thin section by Mr. Ferrier who found it very similar to one described by him in Dr. Dawson's Kamloops Report, 1894.* It is a porphyry passing into a porphyrite.

Massive porphyry.

* Annual Report, Geol. Surv. Can., vol. VII. (N.S.) p. 397 B.

The rocks everywhere continue to present alternations of diorite, green schists and massive felsites and quartz-porphyries, to the last portage, the strike swinging more to the north until it becomes N. 29° E. At the long rapid just above the last portage but one, a knotted, felspathic, sericitic schistose rock occurs, which in its more massive phase was found to be a shattered and squeezed quartz, porphyrite with epidote plentifully developed in it. The last exposures before reaching Konepiminanikok Lake, though still, apparently, belonging to the same set of rocks, show parallel films of chlorite or hornblende. Between this and the lake there is a broad stretch of low land showing no exposures. On the lake, the first exposures seen are granites and granite-gneisses which contain both hornblende and biotite. Although a connection with the Keewatin belt of Saganaga and Saganagons lakes has not been traced, it seems very probable from the strike of these rocks along Kawawiagamak River that the two belts will be found to be continuous. Exposures on lower part of river.

Dog Lake.

Dog Lake takes its name from the huge effigy of a dog outlined in sand, which is still to be traced on the high terrace, over which the portage to the lake passes. This is said by the Indians to have been left by the Sioux when they abandoned this section of the country for the west, as a lasting reminder to the Ojibways of their scorn for them. Dog Lake.

The old pre-glacial outlet of the lake seems to have been to the east of the present river through a channel now entirely drift-filled. The Kaministiquia from its outflow from the lake for a distance of about four miles, is rough in the extreme and shows a series of most picturesque falls and rapids. Pre-glacial outlet.

The main falls, known as the Great Dog Falls, consist of three principal pitches closely following one another, and have a total height of over a hundred feet. They occur at a point on the river four miles below the lake and three-quarters of a mile above Little Dog Lake, from which a striking view of them may be had. Great Dog Falls.

The lake lies in a general north-and-south direction, with a long bay stretching away ten miles and a half to the east. Its greatest length is sixteen miles, and its average width two miles and a half. The depth of water is very considerable, in proportion to the size of the lake. A series of soundings along lines indicated on the map gave depths varying from one hundred and seventy to two hundred and sixteen feet over General character of the lake.

considerable areas ; indeed, the uniformity of the bottom was rather remarkable, as soundings at intervals of a quarter of a mile, over a distance of three miles or more, showed a variation in depth of only a few feet on either side of two hundred and ten feet. In form the lake is very irregular with a coast-line indented by many bays of all shapes and sizes, which run into the land often for considerable distances, leaving between them jutting points of gneissic rock. These bays and points have little or no relation either to the strike of the rocks or to the direction of glaciation, but seem to have been governed in their formation by the occurrence of original hollows down which streams flowed, and which now form the deep bays of the lake. The only exception to the rule that the brooks come in by way of the various bays about the lake is the main Dog River, which has carried down enough sediment to largely silt up its bay, forming a considerable area of alluvial land about its mouth with a long spit extending out into the lake.

Cause of bays.

Shores.

The immediate shores are generally comparatively flat. Low, rounded and glaciated hills of gneiss, that form points and rise to heights of from fifty to one hundred feet, alternate with sand and gravel beaches, that almost everywhere characterize the coves, and which extend back for some distance as low, drift-covered flats, before rising to the moderate height of the general level of the surrounding country.

Dog River.

Dog River, the principal feeder of the lake, and really the head-waters of the Kaministiquia River, has cut out for itself a meandering channel through its drift-filled valley. From Coldwater Brook to the mouth, the valley is broad and flat and the river winds about with a very crooked course, the banks of fine sand rising from fifteen to twenty feet above the ordinary summer level of the river. But few rock exposures are found, isolated knobs of well-foliated, biotite-gneiss with a general strike N. 60° E. projecting at intervals through the drift coating. Similar conditions prevail on Rivière des Iles for many miles up from the mouth, the same fine sand forming cut-banks underlaid by stiff blue clay. The rock exposures are chiefly biotite-gneisses, in places becoming very fine-grained and not unlike those commonly occurring at the contact with Keewatin schists.

Rivière des Iles.

Kashaboiwe Lake.

Kashaboiwe Lake.

Kashaboiwe Lake, which lies between Lac des Mille Lacs and Shebandowan Lake, flows into the latter by a stream a mile and a half in length, with rapids and falls having an aggregate descent of about thirty feet. Almost the whole of the lake is occupied by gneissic rocks, the northern boundary of the band touching the north end of the lake, and the southern boundary crossing at the narrows within half a mile of its southern end. Coarse, reddish biotite-gneiss is the prevailing rock, with interbanded fine, dark biotite-gneiss, which occurs as well-marked bands from a few inches to several feet in width, and as bands abruptly terminated and often broken and forming blocks enclosed in the coarser gneiss, the blocks drawn out into long tails along the planes of foliation. Biotite-gneisses.

At the head of the north-east bay, the contact between the gneisses and the Keewatin crosses about half a mile from the extreme north end. The granitoid gneisses are here seen in direct contact with slaty, felspathic and quartzose schists of the Keewatin. The contact is evidently an intrusive one as respects the granite-gneisses. A zone of Keewatin schists is found to be invaded along its planes of lamination by long stringers or apophyses of granitoid gneiss and of a pegmatitic mixture of coarsely crystalline quartz and felspar, or of almost pure felspar, which also occurs in irregular masses cutting the Keewatin schists. The strike here is N. 64° E., and the dip about vertical. Crossing from the head of this bay by a chain of small lakes and portages leading easterly to Trout Lake, the belt of Keewatin, which, as has been already stated, attains on Lac des Mille Lacs, a width of seven miles, is found to have disappeared. Contact with Keewatin.

About Trout Lake, typical granitoid gneisses, which extend across the height-of-land and down the south branch of the Savanne River, are the only rocks exposed, with the exception of a very narrow band, only ten to twenty chains in width, which occupies the ridge separating Trout Lake from Little Trout Lake. This seems to be an infolded outlier of Keewatin enclosed by the gneisses similar to the one occurring on Dog Lake. It is made up of felspathic quartzites with slight schistose structure and granitoid, quartzo-felspathic, massive rocks, intimately mixed with granites and gneisses belonging to the gneissic complex, which are here intermingled in great confusion with the Keewatin schists. Trout Lake.

Savanne Lake.

Savanne Lake is reached from Trout Lake by way of two small lakes and a portage of a mile and three-quarters; Laurentian granitoid gneisses are seen in the vicinity of this lake. They vary from fairly coarse red gneisses to fine black biotite gneisses, which apparently Savanne Lake.

hold some hornblende. Down the south branch of the Savanne River no exposures were seen, the river flowing through low swampy land. Ridges rising from the muskeg are composed of boulders of gneiss only. The disappearance of the Keewatin belt here is also proved by the section afforded by the Canadian Pacific Railway, where, with the possible exception of a few exposures of hornblende-schist about two miles south of Woodland, that may represent infolded Keewatin rocks, no exposures other than Laurentian are seen from west of Upsala down to about a mile south of Buda, where the northern edge of the southern Keewatin area crosses the railway.

Muskeg Lake.

Muskeg Lake.

Muskeg Lake lies entirely in granite-gneiss, generally coarse and but obscurely foliated and in places showing large crystals of felspar an inch or more in diameter.

Part of the shores of the lake and some of the islands are drift-covered, the banks of sand rising in places on the east shore to a height of more than thirty feet. Some of the islands are cultivated by the Indians who grow good crops of potatoes. The land about the lake is nowhere high, and in some places broad areas of muskeg are separated from the lake only by a barrier of sand and gravel heaped up by the ice and waves.

Beaver Lake.

Beaver Lake.

A very interesting series of rocks is exposed about this lake, which lies in a basin excavated in an arm of granite that extends southward from the main granite-gneiss area into the diorites and schists of the Seine River Keewatin belt.

Contact of granite-gneiss and diorite.

Contacts of the two series of rocks are frequent on both sides of the lake, showing the granite-gneiss invading the diorite in long arms and, in places, the gneiss invaded in a similar way by diorite. Although the general form of this granitic arm would indicate that it is intrusive in the diorite, the details of the contacts seen in many points about the lake show that both rocks have been in a viscid or liquid condition, and that each has invaded the other, producing a contact zone where the relations are most complex. Faults have also affected the rocks here and have helped to obscure their relations. One of these which shows considerable displacement, can be seen on the west side of the lake, where the line of faulting seen on a small island, is indicated by a breccia made up of semi-angular to well-rounded boulders and

Dioritic breccia.

pebbles of diorite and gneiss some of which are as much as two feet in diameter, contained in a matrix of rotted rock charged with pyrite and chalcopyrite. The inclosed blocks as well as the cementing materials are all dioritic on the diorite side and all granitic on the granite side of the belt. The line of fault continued to the main west shore, is seen there to be marked by a wide vein of white quartz. The conditions seen in these contacts seem to indicate that the present form of these rocks has been induced long after the first solidification of both, probably by pressure exerted when they were deeply buried under overlying strata which have been since denuded.

Niven Lake.

This lake, which lies two miles to the east of Nonwatin Lake, has an extreme length of five miles and is nowhere more than three-quarters of a mile in width, with a very irregular shore-line. The whole of the eastern end is occupied by diorites and schists of Keewatin age, excepting a few hundred yards of the south shore, where an isolated area of granite cuts the schists. The western part of the lake lies in the gneiss area which is here made up of hornblende-granite-gneisses and biotite-gneisses, becoming, close to the contact, crystalline felsites and diorites, which invade the diorites and hornblende-schists of the Keewatin, sending out into them long arms and vein-like stringers. Niven Lake.

Hawk Lake Route.

The route from Hawk Lake to Old Man Lake gives another section through this Keewatin belt, which has a width, where the route crosses it, of about six miles, extending from Pyramid Lake to Old Man Lake. Southward from the Canadian Pacific Railway, through Hawk Lake and the stream and lakes emptying into it from the south, and all about Pyramid Lake, biotite-granite-gneisses are seen, usually well foliated, and striking east-and-west. Across the Keewatin belt the exposures are infrequent, the route, for the greater part of the distance, following winding streams in flat marshy land. At the foot of Pyramid Lake, on two small lakes tributary to Brush Creek, about half way between Pyramid and Old Man lakes and along the northern and eastern shores of the last-named lake, the rock exposures that serve to define the belt, occur. They consist of chloritic and hornblendic green schists and occasional exposures of massive diorite. The general strike is parallel to the trend of the belt, about east-and-west. The quartz-schists and altered quartz-porphyries, which occur in con- Hawk Lake to Old Man Lake. Section.

siderable strength further west on the belt, seem to be wanting here, or, at least, they were not observed.

Seine Lake to Scotch Lake.

A route extending northwards from Seine Lake through Caribou and a number of smaller lakes to Scotch Lake and the Canadian Pacific Railway, gives a section across the measures of this Keewatin band to a point intermediate between Clearwater Lake and Brush Creek.

Rocks met with on this section.

The hornblende-gneiss division occupies the first half-mile along the shores of Seine Lake, the rocks consisting of greenish-white gneiss, highly quartzose, containing films of a green chloritic mineral, associated with dark quartz-diorite with a large proportion of hornblende. Biotite is not entirely absent, and in places the gneisses are biotite-gneisses. The boundary between the two has been placed so as to include on one side those rocks in which the biotite predominates and on the other those which shew the greater proportion of hornblende. Northwards along Seine Lake, typical biotite-gneisses strike pretty uniformly S. 85° E., with, however, much local twisting, particularly where, as is frequently seen along the lake, coarse pegmatite-like white gneiss invades the finer black gneiss, both in the form of irregular masses and sheets and as long arms, often enclosing angular blocks of the fine black biotite-gneiss. These gneisses continue fairly uniform in character to a point about half a mile beyond the first little lake north of Caribou Lake, where the hornblende gneiss division is again seen, the rocks as before consisting of syenites or quartz-diorites and a gneiss which contains both biotite and a green chloritic mineral.

Keewatin belt near Hawk Lake station.

The belt of Keewatin rocks that extends eastwards to Hawk Lake station and westwards to join the Seine River band, adjoins these rocks on the north. The belt has a width, where the route crosses it, of a little over three miles and three-quarters, and consists in the main of diorites and diabases with green hornblendic and chloritic schists which probably represent crushed forms of these rocks. A narrow fringe along the southern edge of the belt, is made up of quartz-porphyries in various degrees of alteration to the extreme of a regular sericite-schist with blebs of slightly opalescent to clear quartz. Rocks of the same character are occasionally met cutting the schists throughout the band, where crushed into a schist conforming in strike to the trend of the enclosing rocks. Along the northern border of the belt occur felspathic schists and quartz-schists with hard bands of schistose conglomerate, the pebbles of quartz and quartzite. Some of the schists exposed along the south shore of Norway Lake weather very rotten and rusty from the decomposition of thin sheets of iron-pyrites scattered through them.

Adjoining this belt on the north is an area of non-foliated biotite granite, which, near the contact with the diorites, becomes hornblendic, but which is, in the exposures which are plentifully seen about the lake, a coarse red granite of quartz, orthoclase and biotite. To the northwards the granite gradually assumes a foliated character, until on Lower Scotch Lake it becomes an ordinary, well-foliated, biotite-gneiss with, however, in certain layers, a small proportion of hornblende. The strikes vary considerably along the lake-shore, shewing considerable folding of the strata.

Granite and gneiss to north of belt.

Glacial Geology.

Direction of glacial striæ.

The evidences of glacial action over the whole area under consideration are very plain, everywhere in the form of well marked glacial striæ and grooving and in places as morainic accumulations of glacial drift. The direction of ice-movement was remarkably uniform. From the Kaministiquia River westward the striæ follow a direction about 25° west of south, gradually becoming more westerly in their trend until in the Rainy Lake country, as reported by Lawson,* their average course is about S. 40° W. North of Rainy Lake, between it and the railway, the course is about S. 30° W., and about the shores of the Lake of the Woods, S. 45° W. There are of course local deviations from the general direction, particularly where the trend of a lake- or river-valley makes a moderate angle with the general course. East of the Kaministiquia River there was a swing in the ice-movement towards Thunder Bay, as striæ along the Dawson road shew a direction 30° east of south. A few striæ in this eastern region seem to belong to the later set which is so prominent about Lake Nepigon and its neighbourhood. Their direction is about west.†

Morainic ridges.

Well marked morainic ridges are found at various points throughout this section along the Canadian Pacific Railway near Nordland. High ridges which lie to the north of the railway track are without doubt of this character. The ridges are generally composed of rolled boulders and sand, and extend for some distance approximately parallel with the track with a steep face towards it.

Kame-like ridge.

At the north-east end of Drift Lake a very beautiful example of a kame-like ridge comes down to the lake-shore. It is composed of rounded boulders of gneiss of varying size, with coarse sand composed of granitic débris filling the interspaces. Its course from the lake-

* Annual Report Geol. Surv. Can., 1887-88, vol. III. (N.S.) Part F.

† Report of Progress, Geol. Surv. Can. 1866-69; also Summary Report, Geol. Surv. Can., 1874.

shore is north-north east over a sandy flat from which it rises as a sharp ridge, from one chain to three yards wide at the top. At twenty-five chains back from the shore it widens out and merges into the general level of the country. On the portage leading south from the south end of Greenwater Lake toward Hoof Lake, a striking ridge of the same character is followed by the portage for seven chains. It is composed of sandy loam filled with well-rounded boulders of gneiss, diorite and various schists, and crosses a valley from side to side in a direction five degrees west of south, rising seventy-five feet above the valley. The top is merely wide enough for the trail, and the sides slope at the angle naturally assumed by the material.

Morainic accumulations.

Irregular morainic accumulations occur at a number of different points, notably over the region lying north of the valley between Nordland and Linkoing. This part of the surface is generally deeply drift-covered and shows irregular ridges and numerous cirque-like hollows about one hundred feet in depth and a little more in diameter at the top. The basins are generally dry, draining freely through the loose drift, but one was observed close to Prairie portage which held a small lake. Coldwater Brook which gushes out as a good sized stream from the base of the drift ridges, doubtless derives its water from the drainage of these basins. The water is quite clear and extremely cold. The temperature, ascertained by S. J. Dawson's exploring expedition in 1858 was 41°·5 Fahr.

Lacustrine Clays and Sands.

Area of red clays.

The basin, occupied by surface deposits of red clay and sand, extending westwards from Kaministiquia station on the Canadian Pacific Railway to within four miles of Nordland station, is bounded closely by the 1450 foot contour-line. It thus evidently forms an independent local lake-basin, cut off entirely from the Wabigoon basin further west by the higher land which forms the east-and-west watershed. Crossing Pigeon River at about twenty miles from its mouth, and Whitefish, Matawin and Shebandowan rivers at about the same distance from the Kaministiquia, this 1450 foot contour includes Dog Lake and the valley of Dog River nearly to its head with lower land extending eastward to Lake Superior. Morainic ridges of drift bounding the basin on the north, are probably terminal moraines accumulated at the foot of the glacier at the stage of its recession during which the lake had existed.

Various stratified deposits.

Stratified deposits of sand and gravel are found on Lac des Mille Lacs, Shebandowan and other lakes, at levels which vary too much to allow of their having been formed in one lake basin. The probability seems to be, rather, that small, local lakes were formed from time to time, whenever the climatic conditions were such as to cause a pause in the receding movement of the ice-front, forming ice-barriers bounding the northern shores of lakes of which other parts of the shore-line were formed of accumulations of glacial drift.

Glacial Striæ.

Glacial striæ.

Red River Road, 5 miles from Thunder Bay	W.
" 10½ " " "	S. 30° E.
" 13 " " "	S. 30° E.
Dog Lake, south-east end	S. 26° E.
" S.E. shore between East Bay and S.E. end	S. 4° E.
" " " N. of last	S. 5° W.
" western end of East Bay	S. 20° W.
" East Bay near east end	S. 36° W.
" " midway on north shore	S. 26° W.
" midway on west shore	S. 14° E.
" 2 miles north of S.W. end	S. 24° W.
" outlet S. 10° W. to	S. 11° W.
Matawin River, below Browns Lake	S. 8° W.
" " 3 miles above junction with Shebandowan River	S. 6° W.
Shebandowan River, 1 mile below lake	S. 5° W.
" " 3½ miles " "	S. 6° W.
Shebandowan Lake, 3½ miles west of outlet	S. 2° W.
" " 4 " "	S. 17° W.
" " 6 " "	S. 22° W.
" " west end of Lower Lake	S. 23° W.
" " near Beaver-house Hill	S. 31° W.
Mud Lake, east end	S. 22° W.
Peewatai Lake, near outlet	S. 24° W.
Greenwater Lake, 1 mile S.E. of Shelter Island	S. 26° W.
Lac des Mille Lacs, at height-of-land portage	S. 24° W.
" " first point north of portage	S. 20° W.
" " island north of Bolton Bay	S. 10° W.
" " island opposite Poplar Point	S. 19° W.
" " large island west of Pine Point	S. 11° W.
" " Baril Bay	S. 4° W.
" " Broad Point	S. 4° W.
" " north of Bull Island	S. 6° W.
Canadian Pacific Railway, 1 mile west of Matawin River	S. 21° W.
Canadian Pacific Railway, 1 mile west of Matawin River occasional heavier striæ	S. 4° E.
Canadian Pacific Railway, 2 miles west of Upsala.	S.
Round Lake, near Moss Tp. line, down steeply sloping surfaces	S. 11° W.
Huronian Road, 3 miles north of Loon Lake	S. 5° E.
Round Lake, near district boundary	S. 20° W.
Crooked Pine Lake, east end	S. 24° W.
" " 3 miles from west end	S. 21° W.

Glacial striæ—*Cont.*

Crooked Pine Lake, midway on south shore	S. 19° W.
" " west end	S. 29° W.
Sabawy Lake, south shore	S. 26° W.
" " west of last	S. 30° W.
Partridge Lake, S. W. end	S. 27° W.
Sawbill Lake	S. 16° W. to S. 24° W.
Clearwater Lake	S. 6° W.
Six miles north of Clsarwater Lake	S. 16° W.
Eye River, west of Right-eye Lake	S. 16° E.
Sturgeon Lake, north end	S.
Seine River, 4 miles N.E. of Island Falls	S. 10° W.
" north end Reserve Island	S. 24° W.
" west shore Moose Lake	S. 20 W. to S. 26° W.
" Steep Rock Lake, S.E. bay, on steeply sloping surface	S. 15° E.
" Steep Rock Lake, island near centre	S. 15° W.
" East end of Perch Lake	S. 5° W.
South shore of Perch Lake	S. 2° E.
" North " "	S. 16° W.
" North " "	S. 7° W.
" elbow west of Calm Lake	S. 26° W.
" 7th portage above Sturgeon Fall	S. 26° W.
" 4th " "	S. 32° W.
Lake just south of Jackfish Lake	S. 15° E.
Pine Lake	S.
Atikokan River, north of Trout Lake	S. 20° W.
Quetico River, 8 miles below Beaver-house Lake	S. to W. to S. 7° W.
Whitefish Lake, East shore	S. 32° W.
" north shore	S. 23° W.
" west shore	S. 26° W.
Atikokan River, 1 mile west of Sabawy Lake	S. 19° W.
Lac des Isles, south end	S. 34° W.
" north end	S. 41° W.
Pipestone River, below Pipe Lake	S. 14° W.
Crow Rock Lake, S. W. Bay	S. 2° W.
Clearwater Lake West, N. E. shore	S. 4° W.
Lower Scotch Lake	S. 7° W.
Fox Lake	S. 8° W.
Pickerel Lake, 1 mile east of Pine Portage (2 sets.)	S. 40° W. to S. 57° W.
Batchewaung Lake, island in main lake	S. 8° W.
Quetico Lake, N. shore of main lake	S. 8° W.

Economic Geology.

Iron.

Iron ores.

Iron ores are widely distributed throughout the Keewatin belts of the region dealt with in this Report. In the Matawin and Atitokan iron ranges extensive deposits of high-grade ore have been discovered, and their extent has been proved in some measure, by cross-trenching, test-pits, etc., and by the use of the diamond drill.

In the Matawin field the ores consist both of magnetite and hæmatite. Where they are exposed at the surface the ores are interbanded with chert and jasper, but exploitation by diamond drill has revealed, it is stated, large deposits of clean ore.

Atikokan Iron Belt.

On the Atikokan River, the iron-bearing belt is continuous for a long distance, showing at intervals good deposits of ore. The cleanest and best deposits occur near the eastern end of the belt, diminishing in amount and increasing in impurity as the band is followed westwards. The best surface showing is seen at the McKellar locations, between Magnetic and Sabawy lakes. The ore here occurs in a bluff which rises boldly from the right bank of the river at a distance of about three hundred yards back from the shore. A section across the iron-bearing band between lots 10 E. and 11 E. gave approximately the following thicknesses for the belts of magnetite, though the stripping at the time of my visit was not sufficient to afford a quite satisfactory section. From the face of the bluff thirty-six feet of clean ore is exposed, followed, further north by two other bands, one twenty-seven feet wide of interbanded clear and impure ore and another of unknown thickness, the intervening bands of country-rock having a thickness of about thirty feet. The bands can be traced along the bluff for over four hundred yards and occur as overlapping lenses of ore, which may die out as far as one particular lens is concerned, but is continued in recurring lenticular masses. The ore is a very good magnetite, showing a little pyrite and copper-staining in places but generally free from impurities. Dr. Hoffmann reports that an analysis of a specimen from the line between locations 10 E. and 11 E. was made by Mr. Johnston, with the following result* :

Iron ores of Atikokan belt.

McKellar locations.

Metallic iron	65·71 per cent.
Titanic acid	None.

The inclosing rock is a diorite with a large proportion of hornblende. Below Sabawy Lake, at the Wiley locations R. 400 and R. 401. At the time of my visit the trenches which, when made, must have given a good section across the belt, were partly filled in, so that the section seen was not a perfect one. The mode of occurrence of the ores here and their general character, are similar to those above referred to. The inclosing rock is also quite similar. Three beds of ore are here exposed, the most southerly about thirty-nine feet in width,

Wiley locations.

* Annual Report, Geol. Surv. Can., vol. V. (N.S.) 1890-91, p. 38 R.

made up of clean rich magnetite with only one narrow band of the country-rock. Two other bands of ore, with an intervening belt of country-rock occur to the north; the centre one of the same rich ore and the northern one of banded lean ore with a richer bed less than three feet in width. There is here an excellent showing of good ore extending along the ridge for about five hundred yards. A little pyrite occurs here and there. Dr. Hoffmann reports the following results, of analyses of specimens from the locality made by Mr. Johnston.*

Magnetite from location 400 R.

Analyses.

A massive magnetite.

Metallic ron	68·03 per cent.
Titanic acid	none.

Magnetite from location 402 R.

Massive, fine-granular magnetite.

Metallic iron	68·03 per cent.
Titanic acid	None.

Magnetite from location 403 R.

A fine-granular magnetite.

Metallic iron	64·55 per cent.
Titanic acid	None.

Magnetite, from two miles and a half west of Sabawy Lake.

A massive magnetite.

Metallic iron	67·42 per cent.
Titanic acid	None.

Locations further down the river.

Further down the river, at the second location, known as the Patterson location, the ore is well exposed in two rich bands of about thirty-five and twenty feet respectively. The ore-bands are here exceedingly rotted at the surface and probably hold much pyrite.

Still further down the river, at location 138 X, quite as broad a band of iron-ore bearing strata occurs. The ore is magnetite, but is very much interbanded and mixed with country-rock, only four or five feet of continuous, clean ore being noticed in the surface exposures.

At the Garland location, below Steep Rock Lake, the iron-bearing belt is exceedingly crumpled and folded, and it is very hard to arrive at the thickness of the ore-beds. At the top of an anticlinal fold, two feet of good clean ore occurs, with about sixty feet of interbanded ore

* Annual Report, Geol. Surv. Can., vol. V. (N.S.) 1890-91 p. 38 R.

and country-rock. A good deal of pyrite was noticed associated with this ore. The band has been affected not only by abrupt and complicated folding, but apparently also by faults.

Steep Rock Lake Iron Ore.

Steep Rock Lake ores.

On Steep Rock Lake, large angular blocks of a very good hæmatite were found in places on the lake-shore, and narrow bands of ore were seen on the west side of the eastern arm. The beds from which the blocks of rich float were derived seem to be largely covered by the waters of the lake, and were not discovered, though it is reported that beds of good size have been located on the mainland.

Matawin Iron Belt.

Matawin ore-belt.

The Matawin iron-belt extends from Kaministiquia station westerly to beyond Greenwater Lake. Magnetic iron ores are exposed at a number of points along it and both magnetite and hæmatite on the Matawin and Shebandowan rivers. On location W. 221 and adjoining locations, the ore-belt is made up of interbanded slaty diorite with magnetite and hæmatite. There is a broad belt of this ore, and though it is generally banded in character, some large deposits of clean ore are reported. Just below Weigaud brook and south of the river, where a shaft of about fifty-six feet in depth has been sunk, the dump showed good ore very much intermingled with jasper. The jaspilite has been very much crushed and shattered, and now forms a regular jasper breccia, the bands of jasper being broken so that they occur in small rectangular pieces surrounded by the iron and by the country-rock. Numerous slikensided surfaces further indicate the faulting and crushing which the rock has undergone. Hand specimens exactly resemble the jaspilite, illustrated in colours by Prof. Van Hise in his paper on "Principles of North-American Pre-Cambrian Geology,"* from Jasper Bluff, Ishpeming, and belonging to the Negaunee Formation of the Lower Marquette Series. Following this belt westwards, banded iron ores were seen outcropping at Copper Lake, south of Shebandowan Lake, and on the eastern shore of Greenwater Lake, this locality being referred to more particularly on a previous page dealing with the rocks about Greenwater Lake. The exposures at Copper Lake are limited in extent and probably not commercially valuable.

Magnetite and jasper.

Ores at Copper Lake.

Ores south of Moss.

Ores which probably form an extension of the same belt, on the further side of the Greenwater Lake gneiss area, occur south of Moss

* Sixteenth Annual Report, U. S. Geol. Surv., p. 798.

township. Specimens from this belt, examined in the laboratory of the Survey were found by Mr. Wait to contain respectively 42·64 per cent; 42·57 per cent and 51·20 per cent of metallic iron, with no titanic acid.*

It will be seen that good Bessemer ores occur in quantity in the district, and the problem of their utilization is simply one of economic smelting and a market for the product.

Gold.

Mode of occurrence of gold.

Gold is widely distributed throughout this district, occurring in greater or less quantity along all the Keewatin belts. It is generally associated with a contact between granitic intrusives, which in this district are generally the gneisses of the Laurentian, and the Keewatin. On the granitic side of the contact, the zone that has been found to be gold-bearing is quite narrow, and only exists where there has been extreme pressure and shearing, resulting in a broad band of rocks, granitoid in structure but which have apparently incorporated much of the material of the Keewatin basic rocks. On the Shebandowan sheet, only one location has yet developed into a mine, and it has been closed down for a number of years. Numerous locations have been taken up and preliminary development work done on many of them. At Gold Brook, a tributary of the Matawin, a broad zone of impregnated country-rock, carrying various sulphides and some gold has been blocked out in mining locations and some stripping and testing work has been done. Similar work has also been done on some properties along Shebandowan Lake, without any practical results up to the present.

The Huronian Mine.

Huronian mine.

The Huronian mine is situated on lot H. 1. near the centre of the township of Moss. The vein was discovered during the winter of 1870-71 by two Indians in the employ of the Hudson's Bay Company. Mr. Peter McKellar, of Fort William, shortly afterwards visited the property and reported favourably on it. A township was surveyed with this gold property as its approximate centre.

First worked in 1872.

The first actual mining was done in 1872, when about 100 tons of ore was taken out. Owing to its inaccessibility, little real mining was done for a number of years, until after the building of the Cana-

*Annual Report, Geol. Surv. Can., vol. VI. (N.S.) 1892-93 p. 36 R.

Photo. by R. Bell.

AURIFEROUS QUARTZ VEIN, PARTRIDGE LAKE, DISTRICT OF RAINY RIVER.

dian Pacific Railway, when active operations were undertaken, a ten-stamp mill, with concentrating machinery was erected in 1883, and plant for the chlorination process was added. A saw-mill was built and operated in connection with the stamp-mill and the shafts were connected by tramway with the mill. The mine was thus placed on a good running basis, though the distance from the railway was such that the operating expenses were necessarily large, as supplies could be taken to the mine only by hauling on sleighs in the winter time or in the summer by a canoe-route which involved much transhipment at the various portages. Rough wagon-roads were afterward cut out, one from Shebandowan Lake to the mine and another from Lac des Mille Lacs to the northern part of the township.

The country-rock at the mine is a green chloritic schist which in certain layers is an agglomerate in structure. A small intrusive area of granite, well exposed on Jackfish Lake, sends an arm south-westward to within a short distance of the mine. The vein is from six to eight feet in width and can be traced for a considerable distance, two other properties being situated on its prolongation in either direction. The quartz carries pyrite, chalcopyrite, galena, sylvanite and a little visible free gold. The mill has been closed since 1885. With improved facilities for transport, there seems a prospect that this property may again resume work. A great many locations have been taken up in the neighbourhood, but no other mining work has been done with the exception of a little surface work on the Tip-Cop and one or two other properties. Recently some of these old properties have been re-examined, but no mining operations have resulted.

Association of the ore.

Seine River Mines.

In the Seine River country, the first recorded discovery of gold-bearing veins seems to have been at Partridge Lake, where, in 1872, Mr. Archibald McKellar located several large veins of quartz which proved to contain gold but on which no work of any consequence was done. The veins are well exposed in a small island in the lake, as well as on the main shore of the lake itself. The accompanying photograph, taken by Dr. Bell, in 1890 represents one of these veins.

Discovery of gold on Seine River.

It was not until after the discovery of the now well-known gold district above Bad Vermilion Lake near the mouth of the Seine River in 1893, that prospecting began to be carried on actively in the Seine River country. Since that time the Keewatin band in which the valley of the river lies, has been explored in a desultory way throughout almost its whole length. A great number of locations have been taken up, and a large amount of development work has been done. The first mill erected was at Harold Lake, where the high gold-content of the small veins induced the owners to erect a five-stamp mill

Mill at Harold Lake.

The small veins originally opened up did not, however, provide sufficient ore to keep the mill running for any length of time, and the larger veins subsequently developed on the property did not contain so high a percentage of gold as the smaller ones first exploited.

The country-rock of these locations consists of diorites and green schists, cut and invaded by protogine granites and quartz-porphyries which are generally altered by pressure and shearing into sericite schists. One of these schists was examined by Mr. Barlow in thin section, who describes it as follows :—

Lithological character of country-rock.

" Macroscopically it is a greenish-gray to brownish-yellow gneissic rock with rough cleavage surfaces. Under the microscope it appears to be made up of a fine-grained ground-mass of quartz and felspar, most of the last-named mineral having been converted into muscovite which occurs in the form of minute scattered scales. In this are imbedded irregular grains of quartz, orthoclase and plagioclase, the quartz being by far the most abundant. Some of the plagioclase shows a double set of polysynthetic twinning lines crossing one another at right angles. Besides the scattered scales of muscovite, there is an abundant development of this mineral in wavy bands which flow around the porphyritic constituents, and which has doubtless been developed along shearing planes during the process of crushing to which the rock has been subjected. The muscovite is light yellowish-green and its abundance gives the prevailing colour to the rock. The porphyritic constituents occupy by far the greater portion of the slide, and the rock appears to have resulted from the alteration of a quartz-porphyry poor in ground-mass, or of a granite that has been subjected to intense pressure. The rock shows abundant evidence of this pressure in the dislocation and sundering of the felspars and the frequent granulation of the quartz fragments, all of which exhibit more or less distinctly the strain shadows due to uneven extinction. The frequent yellowish-brown colour of the rock is due to the abundance of disseminated particles of hydrated ferric oxide."

Irregularity of veins.

The veins on this property are extremely irregular in their occurrence, having been affected by the stresses which have folded and crushed the inclosing diorites and schists. As a result, they can seldom be traced into continuity or into any form of parallelism with one another.

Between Nonwatin Lake and Sturgeon Falls, a great number of locations have been taken up, chiefly in the Keewatin belt, and development work is being done on some of them.

Sawbill mine, location 313 X, and adjoining lots, is situated near the eastern shore of Sawbill Lake, an expansion of the Seine River north of Moose Lake. All about the lake are found rocks characteristic of a near approach to a band of Keewatin. They consist of various phases of crushed and altered granites and gneisses with small areas of included schists and diorite. Frequently the granites are intensely crushed and sheared, in places to such a degree as to become schists in structure. The Sawbill vein occurs in a band of these extremely crushed rocks, which have shearing and foliation planes trending in a direction N. 3° E. The vein, at the surface, has a width of over four feet, and it runs parallel to the trend of the inclosing rocks with a hade to the east of about 10° from the perpendicular. The vein is well marked and comes away freely from the hanging-wall and fairly so from the foot-wall, though on this wall the vein-material is to some extent mingled with the containing rock in the form of stringers and small parallel veins. On the strike, the vein is traceable for about 600 feet to the south, gradually failing in width until it becomes quite narrow. To the north, at about 300 feet from the present shaft a swamp covers the ground and conceals its further extension The hanging wall shows slikensided surface, and a thin parting of crushed green chloritic material. The vein may be classed as a fissure vein, belonging to that common class where the sides of the original fissure, at the close of the movement that produced it, remained close together, leaving little open space. The present hanging-wall probably represents an original wall of the fissure, and the foot-wall the outer edge of a belt of more or less crushed and shattered rock which has been carried off by the percolating solutions and replaced by vein-matter. The vein filling is a somewhat waxy quartz, carrying pyrite and chalcopyrite with some visible free gold. The question of its value should be easily ascertainable, and with the values claimed there does not seem to have been any good reason either for the undue inflation of the stock or for the subsequent shutting down of the mill. Since the above was written the mill has resumed work.

Sawbill mine.

Rocks of the vicinity.

Character of the vein.

Its contents.

In the neighbourhood of the Sawbill are a number of locations on which development work has been done. Little can be said of these here, as they have been opened up since my visit to the locality. The Hammond reef (so-called) is situated in this neighbourhood, almost adjoining the Sawbill. This, from descriptions published, is apparently

Hammond reef.

a most promising property. In the last report of the Ontario Bureau of Mines, 1898, *Prof. Coleman describes the reef as consisting of "a zone of greatly shattered protogine or altered granite in which quartz has been deposited, filling all the small fissures and cementing the rock together again. It may be followed for several locations in a direction about N. 25° E., roughly parallel to the south-eastern shore of Sawbill Lake. * * * At the time of my visit a cross cut was being made on location 337 X, the length being about 200 feet and the cut about 26 feet deep. Rather coarse-grained, granitoid gneiss, greenish-gray or reddish-gray in colour, occurs at each end of the cut, the space between showing crushed and slikensided protogine (granite) with much intermixed quartz, the width being about 100 feet. A band of green, schistose rock towards the western side of the cut, found under the microscope to be an impure dolomite with some chlorite, appears to influence the gold-contents of the zone, the richest rock occurring in its neighbourhood. The green dolomite weathers red. In it and the adjoining quartz, as well as in the protogine, iron-pyrites occurs in varying quantities, sometimes also a little galena, zinc-blende and magnetite. The gray rock was stated to be about nine feet wide dipping 50° to the south-east as observed on the rough foot-wall of green schist. Some minute specks of free gold were visible in rock from the north-east end of the cut and a panning of ore from the open cut gave a fair tail of gold, very fine colours for the greater part, but with a few larger particles. * * * On location 316 X., towards the south-west, the shattered band of protogine with intermixed quartz is much wider, at least 300 feet. Some of it is breccia-like and portions are of green schist similar to that already described. Here a series of small pits and stripping has been carried across the zone or reef, disclosing on the whole better looking quartz than that at the open-cut on 337 X. * * * Seven assays of ore from the Hammond Reef were made in the laboratory of the School of Science, Toronto, chiefly from samples obtained on 316 X. Three were select samples and of course ran above the general average. The highest, taken from a small cut 200 feet from the west wall on location 316 X, yielded 3 oz. 3 dwt.; two others, 1 oz. 18 dwt. and 1 oz. 9 dwt. respectively. Three samples taken from average rock gave a trace, 4 dwt. and 16 dwt. per ton. A specimen picked up from the tramway ballast gave 1 oz. 19 dwt., but, of course, an average of the ballast would probably run much lower. The results of assays given here must not be taken as representing the average value of the ore, since no attempt was made to sample such an immense body of ore in a complete way, our time being too short for

Description by Prof. Coleman.

Associated rocks.

South-western portion of vein.

Assays.

* Report of the Bureau of Mines, Ontario, vol. VII., pp. 130-1.

the purpose; but the results certainly show that the rock is auriferous over a considerable width." This appears to be a property which should give good results if economically worked on a large scale.

Other deposits in this vicinity.

The group of mines in the vicinity, occur at the contact of the western edge of the hornblende-gneiss rim which borders the extensive area of biotite-gneiss which is continuous in an easterly direction with that of Dog Lake and the country stretching away to the north and north-west. The rocks in which the mines are situated are made up of an intimate intermingling of Keewatin diorites and schists with the intruding granitoid rocks. In form, these rocks often are quite schistose and everywhere show the effects of extreme mashing and shearing.

Character of rocks of contact zone.

Thin sections of a few of this set of rocks, collected by Mr. Smith, were examined by Mr. John A. Dresser, of St. Francis College, Richmond, Quebec. Mr. Dresser says of specimen No. 15, from the north end of Sawbill Lake:—"This, in the hand-specimen, is a reddish-gray rock having a schistose structure and a somewhat granular appearance. The thin section presents a schistose mass of chlorite, quartz and sericite with calcite and a little iron ore. The masses of sericite suggest its derivation from orthoclase, while the chlorite may be a decomposition product of hornblende or biotite. This would then represent an acid rock of the series of granites or quartz-porphyries, much crushed and altered. It is probably a squeezed quartz-porphyry."

Quartz-porphyry.

Hornblende-gneiss.

Specimen No. 25. From the first small lake north of Sawbill Lake. "The hand-specimen is a coarse granitic rock, showing quartz, felspar and green matter of different shades, in about equal proportions. In the thin section it is seen to consist essentially of felspar, quartz, hornblende, chlorite and epidote. Both orthoclase and plagioclase are seen, the former probably in larger amount. The quartz shows strain-shadows in many places. The rock is evidently a hornblende-gneiss or a squeezed quartz-diorite, probably the former."

Specimen No. 28. From the foot of Red-paint Lake, near the contact between Keewatin and Laurentian, on the gneiss side of the contact.

Hornblende-granite-gneiss

"In the hand-specimen this is seen to be a fine, evenly banded, gneiss Flesh-coloured felspar and quartz are plainly seen alternating with bands of a green substance, apparently chlorite or hornblende.

"In the thin section, the essential constituents are found to be orthoclase, plagioclase, quartz and hornblende; by far the greater part of the felspar is orthoclase, only a few grains of plagioclase being seen. The wavy extinction of the quartz is remarkably distinct. The hornblende is in shred-like bands and is for the most part decomposed to chlorite. A few grains of iron oxide and possibly of muscovite occur, there are also a few grains of epidote. The rock is a hornblende-granite-gneiss, which has been subjected to great pressure.

Porphyritic diabase.

Specimens Nos. 26 and 27. From the same lake, collected on the Keewatin side of the contact.

" As hand-specimens, these are soft, grayish-green, calcareous rocks, showing evidence of pressure and carrying specks of pyrite. No. 27, has a finely laminated schistose structure, and is marked on its cleavage-surfaces by fine, parallel ridges. Both specimens effervesce readily with cold acid.

Under the microscope, No. 26 shows a number of crystals of felspar evidently plagioclase, with calcite, chlorite, zoisite, quartz and a little pyrite, hæmatite and leucoxene. One or two grains of quartz show strain-shadows and may be primary, but the greater part appears to be of secondary origin ; traces of a granular or porphyritic structure are seen in one part. It may represent a porphyritic diabase, but it is so much altered as to make it impossible to determine it with certainty. Its composition would suggest a rock of that series. No. 27 is a small section, showing only a fine-grained laminated mass of calcite, chlorite and quartz ; its origin is probably similar to that of No. 26."

Locations at Lynx-head and Island Falls.

At Lynx-head Falls, at Island Falls, and on a number of locations situated along the same belt of sheared granites, bordering the great area of Laurentian lying to the north, a considerable amount of development work has been done, but up to the present, no producing mines have resulted.

Source of the Gold.

Mode in which the gold was deposited.

The source of the gold has not yet been well established, though its constant association with the edges of granitic areas which are evidently intrusive in the schists, makes it probable that the veins really represent the latest effusions irom the magma which produced the granites at an earlier stage. The fissuring was probably the result largely of the squeezing due to the intrusion of the granitic mass, so that the process of fissuring and of vein formation in the fissures was a continuous one. The heated waters and vapours, carrying silicates and various minerals, rising through the fissures, and depositing in them the quartz and other vein-matter which contains the gold. This mode of fissuring has produced what are ordinarily described as true, fissure veins, where the fissure has remainod an open crack until filled by the vein-matter. It has also produced zones of impregnated country-rock, where there has not been any open crack but rather a zone of shattering and shearing, which has been equally effective for the passage of the mineral-bearing solutions; and has in some cases where such waters have impregnated and replaced the country-rock, produced so-called bedded veins, where the pressure has parted the schistose rocks most readily along their lamination planes, causing the deposition of vein-material along the openings. There seems to be no good reason why any or all of these may not afford good working mines, though the two former would probably be more continuous and permanent.

Silver Mines.

No silver mines that have proved of permanent value occur within the limits of the area included in these map-sheets. The area of silver-bearing Animikie lying within these limits is, however, very small and generally thin. A number of locations for silver have been taken up, and the Duncan shaft was carried down to a depth of 500 feet, though the Animikie was completely penetrated some distance from the bottom of the shaft. In this Animikie area, further south, a number of silver-bearing veins have been successfully worked. The mines of this region, together with the succession of the Animikie strata, have been very fully described by Mr. Ingall in a former report of this Survey.* Silver.

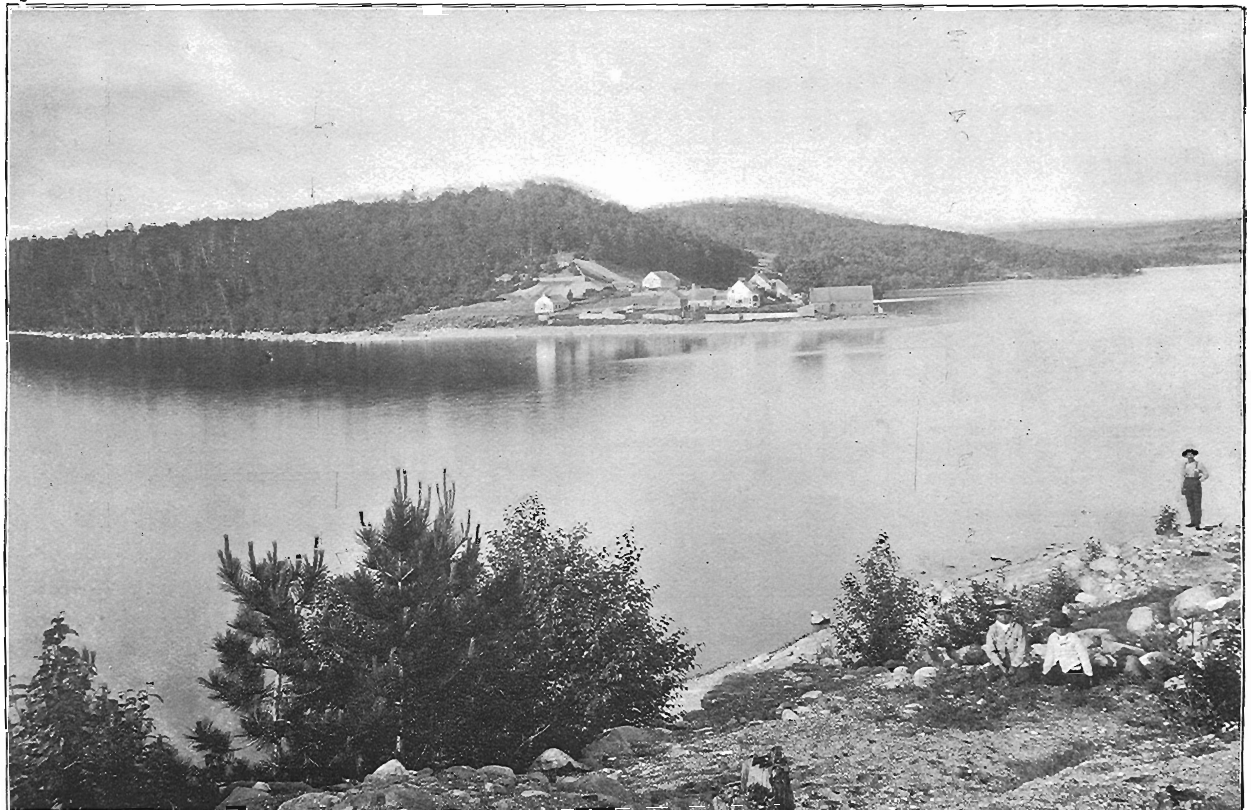
Other Minerals.

Though many other minerals of value occur in the district, none have been found in quantities that make them commercially valuable. Copper in the form of chalcopyrite occurs in many of the veins, molybdenite was observed in veins on the east shore of Lac des Mille Lacs, galena is not uncommon associated with iron- and copper-pyrites in many of the gold-bearing veins, and zinc-blende occurs sparingly. Copper. Galena.

Granite suitable for building stone occurs at a number of points in the non-foliated parts of the Laurentian areas. In the Keewatin areas, slates with a perfect enough slaty cleavage for commercial use may very probably occur, but none were observed. Extensive deposits of limestone occur on Steep Rock Lake, some of it pure enough to be of value. Granite. Limestone.

Mica is often found in crystals of considerable size in the pegmatite veins cutting Laurentian gneisses, but has not been found of sufficient size to be economically valuable. Felspar may be found, in quantity pure enough for porcelain making, as some of the pegmatites, notably near the head of Kashaboiwe Lake, become in places almost pure felspar. Mica. Felspar.

* Annual Report, Geol. Surv. Can., vol. III., (N.S.), 1887-88, pp. 1-131 H.



THE NARROWS (OBATCHEWANUNG), LAKE TEMISCAMING.

A constriction produced by an accumulation of sand, gravel and boulders, representing a terminal moraine of the glacier which occupied this valley about the close of the Glacial Period.

GEOLOGICAL SURVEY OF CANADA
G. M. DAWSON, C.M.G., LL.D., F.R.S., DIRECTOR

REPORT

ON THE

GEOLOGY AND NATURAL RESOURCES

OF THE AREA INCLUDED BY THE

NIPISSING AND TEMISCAMING MAP-SHEETS

COMPRISING PORTIONS OF THE

DISTRICT OF NIPISSING, ONTARIO, AND OF THE COUNTY OF PONTIAC, QUEBEC

BY

ALFRED ERNEST BARLOW, M.A.

OTTAWA
PRINTED BY S. E. DAWSON, PRINTER TO THE QUEEN'S MOST
EXCELLENT MAJESTY
1899
No. 672.

To GEORGE M. DAWSON, C.M.G., LL.D., F.R.S.,
Director, Geological Survey of Canada.

SIR,—I beg to transmit herewith my report on the geology, physical features and natural resources of the region in the vicinity of Lakes Nipissing and Temiscaming, comprising portions of the district of Nipissing, Ontario, and the county of Pontiac, Quebec. The report is accompanied by two maps, each on a scale of four miles to one inch, constituting sheets Nos. 130 and 138, respectively, of the Ontario series of geological maps.

My grateful acknowledgments for much kind assistance are due to Mr. W. F. Ferrier, until lately connected with this Survey as lithologist, to whom was entrusted the determination and description of many of the microscopic sections, especially of some of the more critical ones; to Dr. F. D. Adams, of McGill University, Montreal, for aid and advice on some points connected with the petrography of the district; to Dr. H. M. Ami and Mr. L. M. Lambe, of this Survey, for their examination of the collections made from the several Palæozoic outliers and the preparation of detailed lists of the fossils.

Acknowledgments are also due to Mr. Colin Rankin and Mr. H. K. Beeston, of the Hudson's Bay Company, who did everything in their power to forward the objects of the exploration; to Messrs. Frank Norris, of Baie des Pères, John Turner, of Temagami Lake, and Stephen Lafricain, of Bay Lake, officers-in-charge at these several places or posts belonging to the same company; to Mr. M. H. McLeod, C.E., engineer-in-charge of the construction of the Temiscaming branch of the Canadian Pacific Railway, and also to Messrs. J. C. Bailey, C.E., of Toronto, and H. K. Wicksteed, C.E., of Cobourg, engineers-in-charge of the location of the projected Nipissing and James Bay Railway, for information in regard to elevations at various points situated along or in the vicinity of the lines represented; to Mr. John Mann, of Baie des Pères; to Messrs. C. C. Farr and P. A. Cobbold, of Haileybury; to Messrs. J. B. and R. A. Klock, of Klock's Mills; to the Imperial Lumber Co., of Warren, Ont.; to Capt. Percy, late of the steamer *Meteor*, and Capt. J. O. Blondin, of the steamer *Clyde*, on Lake Temiscaming, and many others.

I have the honour to be, Sir,
Your obedient servant,

ALFRED ERNEST BARLOW

NOTE.—*The bearings throughout this report are given with reference to the true meridian.*

REPORT

ON THE

GEOLOGY AND NATURAL RESOURCES

OF THE AREA INCLUDED BY THE

NIPISSING AND TEMISCAMING MAP-SHEETS

COMPRISING PORTIONS OF THE

DISTRICT OF NIPISSING, ONTARIO, AND OF THE COUNTY OF PONTIAC, QUEBEC.

INTRODUCTORY.

The following report treats of that portion of the district of Nipissing, Ontario, and the county of Pontiac, Quebec, lying between latitudes 46° 13′ 21″ and 47° 36′ 47″ north, and extending from longitude 78° 49′ 54″ to longitude 80° 22′ 26″ west of Greenwich. This area is comprised in the two maps accompanying the report, known as the Nipissing and Temiscaming sheets, or Nos. 131 and 138 respectively, of the Ontario series of geological maps, on a scale of four miles to one inch. The district which each map represents, measures seventy-two miles in length from east to west, and forty-eight miles from north to south, thus embracing an area of 3456 square miles, or a combined area of 6912 square miles. The Nipissing sheet includes nearly the whole of Lake Nipissing and considerable portions of Lakes Temagami, Temiscaming and Keepawa, the boundary between the two sheets cutting the three last-named lakes about latitude 46° 55′. The main line of the Canadian Pacific Railway traverses the southern part of the Nipissing sheet, the eastern limit crossing the railway between Calvin and Eau Claire stations, while the western boundary is situated a short distance west of Warren station. The town of North Bay is the most populous and important place, and is one of the divisional points on the Canadian Pacific Railway, as well as the present terminus of the Northern division of the Grand Trunk Railway, although the actual intersection of the two lines is at Nipissing Junction, three miles south-east of North Bay. The Grand Trunk

Position of district.

Area and names of map-sheets.

Railways.

Canadian Pacific Ry. Grand Trunk Railway.

Nipissing & James Bay Ry.

Railway at present under the title of the Nipissing and James Bay Railway, holds a charter for a line to run northward from North Bay to some point on James Bay, and already has the road surveyed and located as far as the eastern extremity of Lake Temagami. A portion of the border of the map, near the south-east corner, has been broken in order to show the position of the comparatively old and important town of Mattawa, at the confluence of the Ottawa and the Mattawa rivers, as well as the junction of the Temiscaming and Keepawa branches of the Canadian Pacific Railway.

Areas in Quebec and Ontario.

Area covered by township surveys.

The Temiscaming sheet contains the northern parts of lakes Temagami, Temiscaming and Keepawa, and the southern portion of Lac des Quinze. The Ottawa River, from Mattawa to Lac des Quinze, flows through the region covered by the two maps, the deep-water channel of this stream forming the boundary between the provinces of Ontario and Quebec. There is thus an area of about 1780 square miles situated within the province of Quebec, forming part of the county of Pontiac, while the remainder, 5132 square miles is included in the district of Nipissing, Ontario. Of the area situated in the province of Quebec, only about 260 square miles has been surveyed into lots, included in the townships of Neudlac, Guigues, Baby, Duhamel, Laverlochère, Fabre and Gendreau, bordering on Lake Temiscaming; while in the province of Ontario an area of about 1911 square miles has been laid off into townships and lots, the greater portion of which (1685 square miles) is contained within the limits of the Nipissing sheet. The greater number of the townships on the Ontario side are of the more recent form adopted by the Crown Lands Department of that province, and measure six miles square, each township thus embracing an area of thirty-six square miles. Every township is divided into six concessions by east-and-west lines, run astronomically, which are designated by the Roman numerals, the order of numbering being from south to north, while the concessions themselves are subdivided into twelve lots by true north-and-south lines, which carry the ordinary Arabic figures. Each lot therefore measures one mile from north to south and half a mile from east to west, thus containing a superficies of 320 acres. Only every alternate lot-line is cut out through the bush, the intervening boundary being simply marked by a post on the concession line, these being known as "blind lines." A road allowance occurs every mile, coinciding with the township, concession, and side lines; while occasionally the "blind lines" are utilized for this purpose. The lines are all supposed to be run astronomically east-and-west or north-and-south as the case may be, although in some instances no allowance has been made for the convergence of meridians, thus giving rise

Townships, how sub-divided in Ontario.

to considerable error and confusion. Bordering the Mattawa River and Lake Nipissing, as well as on the western shore of Lake Temiscaming, the townships are of a somewhat larger size, corresponding in this respect with those of southern Ontario, while to the south of the Mattawa River, the townships belong to the older set, both in regard to size and the direction of their outlines and lines of subdivision.

Townships, how subdivided in Quebec.

On the Quebec side, the townships seem to have no regular or stated size, and while the lines are astronomical, their direction is determined by the general trend of the water-front. As a consequence, the lines of subdivision in the townships of Guigues, Duhamel, etc., are all run north-and-south or east-and-west respectively, as the upper portion of Lake Temiscaming has, in general, a north-and-south direction, while the township boundaries and side-lines of Gendreau and other townships situated in the southern part of Lake Temiscaming, have a direction of N. 60° E. or at right angles to the general trend of the lake in this vicinity, which is thirty degrees east of south. The distance between concession-lines is slightly over a mile, but the lots themselves are much narrower than those on the Ontario side, each being designed to contain about 100 acres, although in many instances this area is much diminished or increased. The concessions are denoted by the Roman numerals, while the ordinary figures are applied to the lots. Occasionally, both in Ontario and Quebec, the letters of the alphabet have been used to designate the concessions.

Work begun under Dr. Bell in 1887.

The preliminary part of the work in this district was done in 1887-88, while acting under instructions from Dr. R. Bell, as his assistant; but only about two months of each season were devoted to this work, and by far the greater portion of this time was occupied in some of the many detailed surveys necessary in a region concerning which but little had hitherto been known. This topographical survey was, of course, accompanied by as many observations regarding the nature and distribution of the various rock formations encountered as was possible in a survey of the kind.

Work not continuous.

The more pressing nature of the work in connection with the Sudbury mining district, caused my removal from this field to assist Dr. Bell in tracing out the geological and topographical details necessary for the map and report concerning that region, which has already appeared, so that work was not resumed on the Nipissing and Temiscaming sheets till 1892. The bulk of the work on these two maps was accomplished between 1892 and 1894, although about two months of the season of 1895 was required to complete it. It was found necessary to make a large number of topographical surveys, especially in the northern part of the district, and this portion of the work occupied by far the greater portion of our time and attention; but the detailed results thus obtained have added largely to our geographical knowledge of a region of which the physical features were but rudely represented, if at all, on the maps hitherto published.

Method of survey.

The distances were measured with a Rochon micrometer telescope, while the direction was determined by prismatic compass. The distances thus obtained from point to point, were further utilized as bases for a compass triangulation, by which the position of many of the smaller islands and some of the more conspicuous points on the mainland otherwise inaccessible were defined with sufficient accuracy. About the middle of July, 1887, agreeably with instructions received from Dr. Bell, then in charge of the work in the district of Nipissing, I proceeded from Lake Temiscaming by way of the Matabitchouan River and Rabbit Lake to Temagami Lake, in order to complete a detailed topographical and geological survey of that lake. This survey was commenced on July 23rd. The work was considerably retarded owing to the frequent presence of smoke caused by the unusually large number of bush fires, and many days this smoke was so dense as to render all attempts at surveying quite useless. Another cause which militated very greatly against the rapid and successful prosecution of the work during this and succeeding seasons, was the difficulty in procuring and retaining the services of suitable canoemen. In spite of these drawbacks, however, the survey of Temagami Lake was finished by September 15th, when a similar survey was undertaken of the route by way of White-bear and Rabbit lakes and the Matabitchouan River to Lake Temiscaming. During the summer of 1888, these surveys were continued, but scarcely two months of the season were devoted to field operations in this region. During this time, however, considerable progress was made in the topographical measurements of many of the principal lakes, among the more important of which may be mentioned, Cross Lake, the northern part of Obabica Lake, route from the north arm of Lake Temagami, by way of Red-squirrel and Annima Nipissing Lakes to Bay Lake on the Montreal River, as well as of many minor sheets of water to the north and north-east of Temagami Lake.

Work commenced.

Reasons for delay.

Survey of Temagami Lake completed in 1887.

Surveys in 1888.

Surveys in 1892-95.

In 1892, the survey and examination of the Nipissing district was resumed, with instructions from the Director to make whatever surveys were deemed necessary for maps, and a report of an approximately final character. An epitomized statement of the general progress of the work has been given each year, in which mention is also made of the various topographical surveys accomplished each season, in the four

Summary Reports of 1892 to 1895.* During 1892 and 1893, I was ably assisted by Mr. J. F. E. Johnston, upon whom devolved the greater part of the topographical work done during these two years. In 1888, and again in 1893 and 1894, I was accompanied by Mr. A. M. Campbell, of Perth. During the season of 1893 I had likewise the advantage of the assistance of Mr. E. M. Burwash, of Victoria University, Toronto.

Assistants.

For cartographical purposes, the various base, meridian and township lines run by the Crown Lands Departments of Ontario and Quebec have been utilized, and serve as excellent checks and corrections to the errors necessarily incident to a micrometer and compass survey. The geographical features of the area covered by the surveyed townships have, in the main, been adopted, supplemented, however, in many cases by additions and corrections of our own, which were sometimes found necessary. This information was chiefly available in the area of the Nipissing sheet, where over half the area has been divided into townships, and these in turn subdivided into concessions and lots. Besides these a number of surveys of a more general character have been made, the manuscripts and published plans of which have been found of much assistance in the general compilation, as well as in furnishing details in many cases not otherwise obtainable. Among the more important of these plans, the following may be mentioned: Murray's survey of Lake Nipissing and the Sturgeon River, and Logan's survey of the Mattawa River, published in the folio atlas to accompany the Report of this Survey of 1853-56. Murray's survey of Lake Nipissing, however, did not show sufficient detail in the western portion of the lake, so that a re-survey was carried out early in 1892. Austen's map of the Temagami River, with accompanying traverses made for the purpose of ascertaining the most feasible route for the location of a transcontinental railway line. Forrest's survey of the Montreal River was found excellent for all purposes for which it was required. Messrs. O'Dwyer and O'Hanly's survey of the Ottawa River and Lake Temiscaming, to delineate the boundary line between Ontario and Quebec, was found to be thoroughly reliable, while the Canadian Pacific Railway surveys enabled us to locate the exact position of the railway line.

Sources of geographical information.

Surveys by Logan and Murray.

Forrest's surveys.

O'Dwyer's and O'Hanly's surveys.

Canadian Pacific Ry surveys.

Early Explorations and Previous Surveys.

The history of the exploration of the region in the vicinity of the Upper Ottawa and Mattawa rivers, dates back almost to the first

District early known.

* Summary Report, Geol. Surv. Can., 1892, Part A, pp. 34-35. 1893, Part A, pp. 30-33. 1894, Part A, pp. 55-57. 1895, Part A, pp. 61-63.

settlement of Canada by the French. The almost invariable presence of detached parties of the war-like and much dreaded Iroquois in the region immediately adjacent to the upper St. Lawrence, usually forbade the utilization of this main artery as a route towards the west, so that in most instances the more peaceable, though more circuitous, passage by way of the Mattawa and the upper Ottawa River was the only practicable channel of communication between the scattered French settlements on the Lower St. Lawrence and the populous villages of the Hurons and other friendly Indian tribes inhabiting the region in the vicinity of Georgian Bay and Lake Simcoe. It is therefore not surprising to find that the various physical features presented in the regions in the vicinity of these streams were at a very early date among the best known, being especially familiar to the missionary and fur-trader, whose avocations forced them to make constantly recurring visits to the outposts already established in the distant west and north-west. The most prominent of these geographical features were appropriately designated, and most of the names then bestowed upon the numerous rapids, portages, etc., are still retained in common use throughout the district.

Mattawa route, why utilized.

The sheltered nature of its water-stretches, its comparative freedom from molestation, as well as its directness as a route to the great lakes and beyond, formed powerful inducements in favour of the original selection of the Ottawa and Nipissing route, at a time when the birch-bark canoe was the chief and often the only method of communication. The advent of steamboat navigation on the St. Lawrence River and the great lakes, however, as well as the building of the St. Lawrence canals, have during the present century caused this route to fall into comparative disuse.

Proposed canal.

The recently revived proposal to make use of these water-courses for purposes of modern navigation by the building of canals to overcome the obstructing rapids, seems likely again to bring this district into prominence.

Champlain's journey in 1612.

Soon after his arrival in this country, Samuel de Champlain, who was by nature more of an explorer and adventurer than a builder of colonies, determined on an examination of the head-waters of the Ottawa and beyond. He was all the more eager to undertake this investigation as

Nicolas du Vignau.

a young man, Nicolas du Vignau, had just returned, in 1612, after a year's absence among the Ottawa Indians, with a most wonderful tale. He claimed, during his absence, to have discovered a passage by way of the Upper Ottawa to the shores of a northern sea, to which he had penetrated, and there beheld the wreck of an English ship. The apparent clearness and consistency of the story deceived Champlain, who fancied that he might thus find the much coveted road to China and Japan. Towards the end of May, 1613, Champlain, accompanied by this Du Vignau, ascended the Ottawa as far as Lake Coulonge, where he was reluctantly dissuaded by the resident natives from proceeding further. They urged, as their main excuse for not seeming willing to guide him, the many insuperable difficulties to be encountered on the route, as well as the reputed fierceness and witchcraft of the Nipissing Indians, through whose country it was necessary to pass. Here also he learned that the whole story of Du Vignau's pretended discoveries was a fabrication, and that far from undertaking any such important journey as reported, he had resided continuously and quietly at the village during the entire period of his absence from civilization. This information, which was subsequently corroborated by Du Vignau's own tardy confession, enraged and disheartened Champlain, who, convinced of the fruitlessness of any further effort at the time in this direction, returned to Montreal, and subsequently to France.

Champlain's travels in 1613.

Early in 1615, however, Champlain returned to Canada, bringing with him four Recollets, one of whom Father Joseph Le Caron, was destined for missionary work among the Huron Indians. Arriving at Montreal, he found a large concourse of Indians already assembled, who had come hither from their homes in the vicinity of Lake Simcoe. These savages, always more eager for temporal than spiritual help, again pressed Champlain to aid them against their hereditary foe, the formidable Iroquois. Deeming it expedient at the time to comply with this oft-repeated request, Champlain hurriedly descended to Quebec to make the necessary preparations, leaving Le Caron and some of his compatriots with the assembled Indians to await his return. During Champlain's absence, however, the Indians decided to go back forthwith to their own home without him, and accompanied by Le Caron and his associates commenced the ascent of the Ottawa River. When Champlain returned to Montreal and found the place deserted, he immediately hurried after them, pursuing the usual course up the Ottawa and Mattawa rivers, over the height-of-land to Lake Nipissing and thence down the French River to Lake Huron. Champlain was thus the first European, with the exception of the humble friar who had only just preceded him by a few days, to gaze on the waters of Lake Huron, which he christened "Mer Douce."

Champlain's explorations in 1615.

Arrival at Montreal.

Discovery of Lakes Nipissing and Huron.

Champlain's map of New France, which was made in 1632, included all sketches and surveys from 1603 to 1629. Only the main routes of travel are represented, while the whole map exhibits, in a very rough manner, the salient physical features encountered during the progress

Champlain's map.

of these journeys and explorations. Lake Nipissing is called "Lac de Biserinis" while a rude outline of the Ottawa River above its confluence with the Mattawa is given, that must have been drawn from information supplied by the Indians.

Exploration closely connected with fur-trade.

The exploration of this district, as of others elsewhere throughout Canada, is inseparably bound up with the history of the fur-trade, the successful prosecution and extension of which required the constant addition of new territory. We thus find that many of the first exploratory expeditions were often undertaken by adventurers at their own expense, with the promise of various marks of distinction from those in authority in case of the success of their undertakings, while fur-trading licenses were granted to enable these men to indemnify themselves for their pecuniary outlay.

Delisle's map and position of Fort des Abitibis.

The limits of this traffic were quickly extended both northward and westward, and we find by reference to Delisle's map (1703) that the French then had a post (Fort des Abitibis) north of the height-of-land on the river Abitibi. This post, according to the memorial of Begon* was the most advanced station of the French toward Hudson Bay. From this same memorial, it also appears certain that the route northward by way of Lake Temiscaming and the Abitibi River (Monsony or Monsipy) was one of the best known, although the French traders avoided the immediate vicinity of Hudson Bay in order not to expose themselves to the insults of the Indians who were friendly to and traded with the English posts already established in that vicinity. It does not seem unreasonable to suppose, therefore, that some of the expeditions despatched by the Governors of Canada toward the close of the 17th century, to take possession of Hudson Bay, adopted this well known route by way of the Upper Ottawa and Abitibi rivers. All the earlier maps indicate many of the streams flowing northward from the height-of-land into James Bay with tolerable accuracy, thus showing that the early voyageurs were well acquainted with this portion of the country.

Expeditions to Hudson Bay towards the close of 17th century.

Fort Temiscaming early established.

Fort Temiscaming must have been one of the first posts established by the Northwest Company, if not acquired after its abandonment by the French, for Mr. Roderic Mackenzie, a clerk in this company who wrote "A General History of the Fur Trade," which forms the opening chapter of Sir Alexander Mackenzie's Travels in North America says:

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*Mémoire de Begon, Oct. 20 1725, qui explique les anciennes limites du poste de Témiscamingue.

†Voyages from Montreal through the Continent of North America to the Frozen and Pacific Oceans in the years 1789 and 1793. London, 1801. p. xxxiv.

"Lake Temiscaming where there has always been a trading post" while one of the buildings which had been used as a store-house and which was removed only a few years ago, bore dates on the large cedar beams which pointed to its erection some time near the close of last century. Mackenzie's travels.

Fort Temiscaming afterwards became the head-quarters of the Hudson's Bay Company in this district, containing the residence of the Chief Factor and all the necessary adjuncts in the shape of buildings, etc., which usually go to make up a well equipped establishment, forming one of the most important centres of the fur trade and containing besides a library embracing many volumes on science, travels and general literature. In 1888, however, this post, so long established, was abandoned, and a small store was erected at "The Point" near the village of Baie des Pères, which was found more convenient for purposes of general trading; while the opening up of the Canadian Pacific Railway had previously caused the removal of the head-quarters to Mattawa. Headquarters of the H. B. Co. Removal of post.

Temagami post, now situated on the west side of Bear Island on Lake Temagami, was moved to its present site in 1875, on account of the opening of an opposition fur-trading establishment, owned by Alexander Dukis, who soon left his stronger rival in undisputed possession of the place. Before its removal thence, this post was located on the shores of a small cove on the south side of Temagami Island, and ruins of the buildings are still visible at this place. Fort Wrath, of which the tumbled-down buildings may even now be noticed on the east shore of Lake Temiscaming, about a mile above Piché Point, was built to overcome the rival post operated by Mr. Piché, who still resides at his farm on the point which bears his name. This place was kept open for a few years only, when the necessity for its presence ceased. The somewhat important post near the mouth of the Sturgeon River, continued actively engaged in trade with the Indians until the opening of the railway, when it gradually fell into disuse and was finally abandoned altogether about the year 1890. Hunters Lodge, originally a trading establishment, situated on Hunters Narrows in Keepawa Lake, was abandoned about the same time. At several points on the Ottawa River and the lower portions of Lake Temiscaming, temporary posts were erected from time to time, but these were of no permanent importance, and when the reasons which brought them into existence disappeared, they were given up and forgotten. Buildings originally erected in 1887, and designed for storage purposes on Bay Lake, an expansion of the Montreal River, have Temagami post moved in 1875. Fort Wrath. Sturgeon River post. Hunters Lodge. Bay Lake post.

since been raised to the dignity of a post with an officer in charge. At present, in the area of the accompanying map-sheets, there are only three establishments, Temagami, Bay Lake and Long Point (on "Quinze Lake"), which receive any great quantity of furs, although a considerable number of skins come in casually to the posts at Mattawa and Baie des Pères during each year. Of these Temagami is the most important, but the gradual opening up of considerable areas in this district to settlement, and the diminution in point of number both of the fur-bearing animals and the Indians who are chiefly engaged in their capture, is already having a marked effect, showing a gradual, or in some cases a rapid decrease in the number of skins annually brought to market.

Long Point.

Decrease in fur-trade.

The opening chapters of Mackenzie's narrative, previously mentioned, give a brief description of the route generally pursued by the fur-trading canoes in gaining access to the various forts and trading posts of the interior. The rapids and portages of the Mattawa are enumerated, the names in most cases being the same as those in use at the present time, although the river itself is here called Petite Rivière. Nepisingui (Nipissing) Lake is also mentioned, and a short account given of the Rivière des François.* The first geological account of the region in question was that of Dr. J. J. Bigsby, who had come to Canada as medical officer to a regiment. About the year 1820, he received an appointment from the Colonial Government to make a general report on the geology of Upper Canada, the absurdly small sum of twenty-six pounds, as he informs us, being granted as pecuniary aid to carry out this extensive undertaking. Dr. Bigsby first made an examination of the Ottawa, Mattawa and French rivers, together with Lake Nipissing, having been granted a free passage to Sault Ste. Marie in one of the Northwest Company's canoes. He gives a good account of the Ottawa River itself and of the country adjoining this stream, and mentions that the Mattawa River, which was the western branch of the Ottawa, often called the Little Ottawa, was known as the Tessouac River by the Indians. The occurrence of crystalline limestones at the Talon Chute is noticed, among other interesting facts. The position of "La Ronde," a Northwest Company's post, is noted as being situated at the mouth of the Vase River, as well as its subsequent removal to one of the islands in Lake Nipissing.†

Work by Dr. J. J. Bigsby in 1820.

Crystalline limestones at Talon Chute.

During the progress of the magnetic survey of British North America, executed between 1842-1844 by Sir J. H. Lefroy, various

Lefroy's magnetic survey.

* See pp. xxxiv. and xxxv. Mackenzie's Voyages.

† Shoe and Canoe, vol. I. London, 1850. pp. 105 to 171.

observations were taken in this region to ascertain the magnetic variation, while latitudes were obtained at the following places: Hudson's Bay Company's post Mattawa, First portage on Little (Mattawa) River, Lake Temisique (Lower Trout Lake); Lake de Talon or Lake Walrond; Trout Lake, formerly called Lake de Grande Vase; Height-of-land portage, towards Lake Nipissing; and Cross Point on the south shore of Lake Nipissing, where a cross had been erected to commemorate some fatal accident.*

Upper Ottawa district comparatively unknown.

For many years the region in the vicinity of the Upper Ottawa River was comparatively unknown, except to the occasional traveller and missionary, and to those engaged in the fur-trade, whose business necessitated constant journeying to and fro along the main canoe-routes. In time, however, the almost inexhaustible supply of valuable timber known to exist in this district, attracted the attention of the enterprising lumberman, whose operations were so quickly extended north-westward that, by the year 1845, we find that lumber camps were in full operation in the vicinity of the Opimika Narrows (the "Galère") while some two or three years previously, red pine timber had been cut on Lake Temiscaming several miles above the Narrows at the Hudson's Bay Company's post. These lumbering outposts, however, were for the purpose of cutting red pine alone, the value of which at this time caused it to be sought for at greater distances than the white pine; for previous to this no white pine had been cut higher than Bennett Brook on the Ottawa River.

Lumbering begins.

Work by Sir Wm. E. Logan.

The first really accurate delineation of the topographical features within the area comprised by the two accompanying map-sheets, was made by Sir William E. Logan, the founder and first Director of the Geological Survey of Canada, in the year 1845.†

Reasons for work on Ottawa River.

A geological section across the western part of Canada, from Lake Huron to Lake Erie, having previously been made by Mr. Alexander Murray, in 1843, in addition to an examination into the stratigraphical relation of the rocks comprising the extreme eastern portion of Canada, by Sir William Logan himself, it was considered expedient that a third section should be undertaken across and embracing some part of the northern district. The Ottawa River was chosen, for various reasons, the chief of which was perhaps its accessibility and the greater immediate utility to the country at large which such a survey promised. Starting from Montreal, he made an examination of the various rock formations exposed on the shores of the Ottawa, taking occasional short

* See Lefroy's Magnetic Survey of the Dominion of Canada. London, 1883.

† Report of Progress, Geol. Surv. Can., 1845-46.

excursions inland wherever deemed necessary. This geological investigation was continued as far as the mouth of Bennett Brook, about five miles above the "des Joachim" Rapids. As this was the highest point yet reached in the topographical delineation of the course of the Ottawa, it was decided to make this the starting point of the contemplated survey of the upper portion of this stream. The distances were determined by the Rochon micrometer telescope, while the bearings and angles of intersection were obtained by means of a theodolite. The differences in level of the river at all the rapids were ascertained by careful levelling with a proper instrument and staff, the fall in the intervening stretches being estimated from a knowledge of the strength of the current. This survey was continued up the Ottawa as far as the first chute on the Rivière des Quinze, a short distance above the head of Lake Temiscaming. During the same season, and as a necessary adjunct, a similar survey was undertaken of the Mattawa River, from its junction with the Ottawa to its head-waters in Trout Lake, including also the portage-route by way of the Rivière de la Vase to Lake Nipissing, as well as a small portion of the shore-line of this lake in the vicinity of the mouth of this inlet. Observations for latitude were obtained at the starting point, the mouth of the Mattawa, the mouth of the Vase on Lake Nipissing, as well as at the mouth of the Keepawa on Lake Temiscaming. In fact, every precaution was taken to make this survey as accurate as was possible with the instruments and time at his disposal. The various topographical details, delineated in a map subsequently compiled by Sir William Logan himself on a scale of one mile to an inch, bearing valuable notes regarding the various rock formations encountered, is at present on file at this office, and although not issued as a separate publication, the information has been made use of in every subsequent map covering the district.

Topographical survey begins at Bennett Brook.

Survey to Quinze River.

Survey of Mattawa River.

Localities of observation for latitude.

Map by Logan.

A portion of the Ottawa River in the neighbourhood of the Mattawa, as well as the whole of this latter stream, were, however, incorporated in the atlas to accompany the report by Mr. Alexander Murray (1853-56). During the summer and autumn of 1854, Mr. Alexander Murray, of this Survey, was engaged in making exploratory surveys to the east of Lake Huron and Georgian Bay. These included a survey of the southern shore of Lake Nipissing, from the point where the French River measurement ceased in 1847, to the mouth of the Vase, where connection was made with Sir William Logan's survey of 1845, and thence of the north shore of this sheet of water to its "north-west angle."* In 1855, Mr. Murray continued this survey, commenc-

Murray's surveys in 1854-56.

*Report of Progress, Geol. Surv. Can., 1853-56, p. 101 et seq.

ing at the outlet of Lake Nipissing into the French River, along the western coast making connection with the work of the previous year.* In 1856 this survey was again extended, this time a start being made from the Hudson's Bay Company's Post on Sturgeon River near Lake Nipissing.

Ascending the Sturgeon River for about fifty-two miles to the mouth of the Maskinongé, the measurements were carried up this important branch through Murray, Washkigamog, Maskinongé-wagaming and Mattagamashing lakes to Wahnapitae Lake, and down the Wahnapitae River to Lake Huron.†

Surveys of Keepawa Lake.

In 1855, Duncan Sinclair made a survey of Keepawa Lake, with a view of defining and locating certain timber limits. This survey, although excellent for the purpose for which it was undertaken, nevertheless lacked certain details essential for a correct elucidation of the geological features, thus necessitating a re-survey which was accomplished by Mr. J. F. E. Johnston, of this Department.

Canal surveys.

Acting under instructions from the Commissioner of Public Works, Mr. Walter Shanly, C.E.‡ in 1856-57 made a detailed examination of the route contemplated for a canal to connect the waters of the St. Lawrence with those of the Great Lakes by way of the Ottawa, Mattawa and French rivers, and Lake Nipissing.

In 1858-59, another examination of the same route was made by Mr. T. C. Clarke, C.E.,§ also in accordance with instructions received from the Commissioners of Public Works.

Forrest's survey of Montreal River.

In 1867, Mr. A. G. Forrest, acting under instructions from the Crown Lands Department of Ontario, made a survey with transit and chain of the Montreal River, starting from its intersection with a due west astronomical line, supposed to be run on the parallel of latitude of 47°56′, between Michipicoten Harbour on Lake Superior and the head-waters of the Montreal River. This astronomical line was started about the same time from its eastern and western extremities. Mr. Duncan Sinclair who was entrusted with the eastern portion of the line succeeded in running a distance of 105 miles from the Montreal River, while Messrs. A. P. Slater and R. Gilmour, ran eighty-

Astronomical line.

*Report of Progress, Geol. Surv. Can., 1853-56 pp. 128 and 135 et seq.

†Report of Progress, Geol. Surv. Can., 1853-56, pp. 145 et seq.

‡Report of Walter Shanly, Esq., On the Ottawa Survey,—Toronto. March 22nd, 1858. Also Report on the Ottawa and French River Navigation Project,—published by order of the Montreal Board of Trade, 1863.

§Return of Recent Survey and Report of the Engineer on the Ottawa Ship Canal Quebec, 1860 by Thos. C. Clarke, C.E.

Forrest's work.

four miles eastward from Michipicoten Harbour. Mr. Forrest, from the intersection with Sinclair's line made an instrumental traverse of the Montreal River to its mouth on Lake Temiscaming, a distance of one hundred and one and a quarter miles, at the same time taking notes on the timber and other natural resources of the country extending for three miles on either side of the stream. These surveys, commenced in 1866, were completed in 1867. Their primary object seems to have been to determine the feasibility of the construction of either a wagon road or railway to the Red River country through the district in question.*

Traverse by Lindsay Russell.

About the same time (June 13th to August 16th, 1867), Mr. Lindsay Russell, made a micrometer traverse of Lac des Quinze and the Upper Ottawa, connecting with H. C. Symmes' survey of Grand Lake. Mr. Russell during the same season made a similar survey of the route to Lake Abitibi, as well as a traverse of this large sheet of lake, then for the first time correctly measured.†

Surveys under Mr. Rowan.

In 1871, Mr. Alexander McKenzie, acting under instructions from Mr. James H. Rowan, who had charge of the Canadian Pacific Railway surveys from the Mattawa to the Red River, made a track-survey northward by the Ottawa and Abitibi rivers to James Bay, returning by way of the Moose and Michipicoten rivers to Lake Superior.‡

In 1871-72, Messrs. Lloyd, O'Hanly and Austen, also under Mr. Rowan's instructions, made exploratory surveys from Mattawa by way of the Ottawa and Montreal rivers to a point about half-way between this latter stream and one of the branches of Moose River.§

Work by W. McOuat.

In 1872, Mr. Walter McOuat of this Survey was engaged in a geological examination of that portion of the country to the north and east of Lake Temiscaming. The work performed by Mr. McOuat in the Temiscaming region embraced a most painstaking geological examination of Rivière des Quinze, Lac des Quinze and the route thence northward to Lake Abitibi, including a micrometer survey of the shores and islands of that lake. He also made a micrometer traverse of the Blanche River as far as Round Lake, accompanied by an examina-

Survey of Blanche River.

*See Remarks, on Upper Canada surveys, 1867 pp. 56-62.

†See Report Commissioner of Crown Lands, Quebec, 1868, p. XVII, also descriptions of the Surveyed Townships and Territories of the province of Quebec, 1889, pp. 416-424.

‡See Progress Report on Surveys Canadian Pacific Railway, 1872 p. 74.

Also Report on Surveys Canadian Pacific Railway, 1877, pp. 5-47 and 48.

§ See Progress Report on Canadian Pacific Exploratory Surveys, 1872. These surveys comprised Divisions B, C and D, respectively, mentioned in these reports. The surveys were begun on June 10th, 1871, and the last of them was completed by July, 1872. See also Report on Surveys, Canadian Pacific Railway, 1877, pp. 5 and 47.

tion of the rocks in the immediate vicinity of this stream.* The plans to accompany his report have never been published, but the information contained has been utilized in subsequent general geological maps embracing this area.

Provincial boundary survey.

In 1872-74, Messrs. O'Hanly and O'Dwyer, joint commissioners for Ontario and Quebec, made an instrumental traverse of the Ottawa from Mattawa to the head of Lake Temiscaming, and surveyed a line running northward from a point on the "Chenail du Diable," near the mouth of the Rivière des Quinze as far as the height-of-land.†

C. P. R. surveys.

During the year 1876, in connection with the location of the Canadian Pacific Railway, Mr. Marcus Smith, then acting engineer-in-chief, made an examination of the eastern portion of Lake Nipissing, as well as of the "Beuve" (Veuve) River as far as the forks, about twenty-five miles from the mouth.‡

In 1879, Mr. W. A. Austen, for the Canadian Pacific Railway, ran a trial location survey from a point situated a short distance (404 feet) east of the deep-water landing at South-east Bay (or East Bay) of Lake Nipissing, in a north-easterly direction for sixty-three miles up the valley of the Sturgeon River.§ As a part of the same survey, Mr. Austen made a micrometer survey of the Temagami River, the southern portions of Cross and Temagami lakes as well as the route from thence to Maskinongé-wagaming Lake, by way of Obabica and Wawiagama lakes.

Guerin's examination.

During the summer of 1884, commencing in June, Mr. T. Guerin, engineer of the Public Works Department, Ottawa, undertook an examination of the Ottawa River and Lake Temiscaming with a view to ascertaining the feasibility, at a reasonable cost, of the various schemes urged on the Government from time to time, looking to an increased facility in the navigation of these waters.||

Work by Dr. Selwyn.

In the summer of 1884, Dr. Selwyn, during the progress of an examination of the numerous rock-cuts exposed along the line of the

*Report of Progress, Geol. Surv. Can., 1872-1873 pp. 112 et seq.

† The manuscript plan of a scale or 40 chains to one inch bears the date, Dec. 27th, 1875, while the joint report filed with the Crown Lands Department, is dated Ottawa, Dec. 7th, 1874.

‡ Report Canadian Pacific Railway, 1877, pp. 359-360.

§ Appendix 18, "Report Canadian Pacific Railway, 1880, pp. 290-296." A plan on 4000 feet to an inch, detailing these explorations, as also two profiles of the Sturgeon River are on file at the Department of Railways and Canals, Ottawa, and have been of much assistance in the compilation of the accompanying maps.

|| Ann. Rep. Minister of Public Works, 1884-85, pp. 103-124.

Canadian Pacific Railway, paid a visit to the Manitou Islands in Lake Nipissing, and the list of the fossils then collected from the Cambro-Silurian outliers comprising seventeen species, together with a few notes regarding their occurrence was published by Dr. H. M. Ami*.

Fossils.

The Rev. J. M. Goodwillie, who was stationed at North Bay for some years, has made an extensive collection of the fossil remains from these islands, and these have now been examined and their identification has greatly added to the list appended to this report.

Mr. Ulrich determined a small collection of fossils for Professor N. H. Winchell, which were collected by Mr. T. D. Ledyard, of Toronto.† In 1889, Prof. N. H. Winchell paid a visit to North Bay, and gives a record of his observations made in that vicinity.‡

Examination by Prof. G. K. Gilbert.

In 1889 Mr. G. K. Gilbert made an examination of the vicinity of North Bay and the country eastwards towards Mattawa, with a view to obtaining any evidence regarding the former existence of an outlet for the Great Lakes, immediately following the retirement of the ice-sheet. The possibility and even the probability of the existence of such an outlet had been looked upon for some time with favour by some geologists, although facts in support of these views were not forthcoming previous to the communication made by Mr. G. K. Gilbert to the meeting of the American Association for the Advancement of Science, held in Toronto in August, 1889. The general substance of the remarks then made were published under the title of "The History of the Niagara River."§

Prof. Wright's observations.

In September, 1892, Prof. G. F. Wright visited the neighbourhood of North Bay and Mattawa, making certain observations seemingly confirmatory of the former existence in the Mattawa valley of this outlet, and embodying the results of his observations in a paper entitled, "The Supposed Post-glacial Outlet of the Great Lakes through Lake Nipissing and the Mattawa River." ||

F. B. Taylor's observations.

In the autumn of 1893, Mr. F. B. Taylor made some observations in regard to the occurrence of beaches in the vicinity of North Bay, and their relations to this supposed old outlet of the Great Lakes.

* Can. Rec. Science, April, 1892, pp. 108 et seq.

† American Geologist, vol. XVIII., No. 3, September, 1896, p. 178.

‡ Eighteenth Annual Report, Geol. and Nat. Hist. Survey, Minnesota, 1889, p. 501.

§ Sixth Annual Report of the Commissioners of the State Reservation at Niagara for 1889, pp. 61-84, and reprinted in the Smithsonian Report for 1890, pp. 231-257.

|| Bull. Geol. Soc. Am., vol. IV., 1893, with discussion by Dr. Robert Bell, pp. 423-426.

The results then obtained were communicated to the Geological Society of America, and published in the bulletin of that society.* In 1895, another visit was paid to the Nipissing District with the similar object of gaining additional information in regard to the recent changes of level.†

In 1896, a third visit was paid to the region in the neighbourhood of the Mattawa and Ottawa rivers, and the results then obtained were communicated to the Geological Society of America.

Latitude and longitude of Mattawa.

In 1890, William Ogilvie, acting under instructions from the Department of the Interior, Ottawa, fixed the latitude and longitude of Mattawa, the latter by telegraph from Ottawa.

Surveys of Nipissing and JamesBay Ry.

In 1892, Messrs. H. K. Wicksteed and Patterson, under the direction of Mr. J. C. Bailey, C.E., of Toronto, made the location survey of the Nipissing and James Bay Railway from North Bay to the North-east Arm of Lake Temagami. Mr. Patterson had charge of the location of the southern portion of the line from North Bay to Marten Lake, and Mr. Wicksteed of the northern part.

Surveys by M. H. McLeod.

The building of the Temiscaming branch of the Canadian Pacific Railway and the surveys and levels made in connection therewith, have been used in the present map and report, the information being kindly supplied by Mr. M. H. McLeod, the engineer-in-charge.

General Physical Features.

General character of country.

The general character of the country may perhaps be best described as that of an uneven or undulating rocky plateau, with a gentle slope towards the east and south-east. Although in detail the surface of this plateau is far from uniform, consisting of a succession of more or less parallel rocky ridges, with intervening valleys occupied by swamps or lakes, still the district as a whole has a general elevation varying from 900 to 1200 feet above the sea. There are no very prominent hills, the highest seldom attaining a greater altitude than 300 feet above the surrounding region, while throughout most of the district, hills of 50 to 100 feet in height are rather conspicuous topographical features. The highest land in the whole area is situated near the north-west corner of the Temiscaming sheet, immediately to

* Bull. Geol. Soc. Am., vol. V., pp. 620-626 with two maps, also American Geologist, vol. XIV., Nov., 1894, pp. 282-285.

† *Ibid*, vol. XVIII, August, 1896, pp. 108-120.

the west of Lady Evelyn (Mus-ka-na-ning) Lake, where a range of hills of which Maple Mountain is the highest peak, rises to the height of a little over 2000 feet above the sea, according to Dr. Bell.

Influence of underlying rock on surface contour.

The influence exerted by the underlying rock on the general contour of the surface, is perhaps nowhere better exemplified than in the region embraced in this report. In the southern and south-eastern portions, where the prevailing rocks are the various gneisses and granites included as Laurentian, there are no hills of any great height, the general surface presenting, as usual, a rather monotonous succession of low rounded hills, with correspondingly shallow rocky valleys. In the northern and western portions, however, those areas in which the quartzites are present, as well as those in which the plutonic rocks, chiefly granite and diabase, are prevalent, rise into rather important elevations; while in those regions which are underlain by the slaty member of the Huronian, are on the other hand low and flat. A remarkable resemblance exists between the contour of the surface, occasioned by the presence of the diabasic rocks, and that produced by the heavy-bedded and massive quartzite, that forms the highest member of the Huronian exposed in this district, both rising into comparatively high rounded or broken ridges, and rendering the stretches of country where such rocks prevail, exceedingly rough and hilly. This is especially the case with the region to the north and north-west of Wakemika and Lady Evelyn lakes, and also between Friday and Whitebear lakes and the Montreal River; although the whole of the area coloured on the map as underlain by those rocks partakes essentially of this rugged character. This rough and broken contour is in marked contrast to the flat surface characteristic of the region in which the slates obtain.

Examples of differing topography.

The contrast is probably nowhere better shown than in the north-eastern part of Lady Evelyn Lake, where the quartzite which crosses the lake at the Obisaga Narrows forms high and perpendicular cliffs for a short distance, while to the east, as far as the Waswaning Narrows, the shore on both sides is low and swampy, with only a very occasional exposure of the flat-lying slaty rocks. At the elbow to the east of the Waswaning Narrows, a high ridge of diabase crosses the lake, forming rugged hills which constitute the western side of that portion of the lake known as the Mattawapika. Thus within a few miles, on the same lake, are exhibited examples of all three types of surface produced by the underlying quartzite, slate and diabase.

Character of granite areas.

The large area coloured as granite, to the north-east of Lake Temagami, may perhaps be best described as a region of flooded *roches* *moutonnées*, for the hills are all low and rounded, while the intervening hollows are occupied by exceedingly intricate and shallow, swampy lakes or marshes. The valleys of the smaller rivers are usually narrow, and many of the streams are nothing but a succession of small lakes united by rapid rocky or bouldery discharging channels.

Valley of Ottawa River and Lake Temiscaming.

Probably one of the most interesting of the physical features presented by the district is the valley occupied by Lake Temiscaming and the Ottawa River. The greater portion of this valley is a very steep, rocky gorge, fringed on either side by lofty hills or perpendicular cliffs which rise abruptly to a height of from 400 to 600 feeet above the surface of the water, while the average of a large number of soundings indicate that the lake has a mean depth of over 400 feet. The depression, therefore, occupied by these waters would be about 1000 feet below the level of the surrounding country, and as the bottom of the lake, wherever examined, consisted in the deeper portions of a very fine gray unctuous clay or silt, this depth may have been much greater before the accumulation of this material. From Mattawa to the mouth of the Montreal River, these abrupt and rocky shore-lines prevail, but above the mouth of this stream the lake undergoes considerable expansion and the shores exhibit a more gradual slope towards the surface of the water. The traveller ascending the Ottawa River is thus usually impressed with the mountainous character of the district, but an ascent of the hills on either side at once shows that the adjoining country is comparatively level, and that what appeared as ranges of hills are in reality the inclosing walls of this great valley.

Adjoining country.

River valleys.

The Mattawa and Montreal rivers and in a lesser degree the Sturgeon and Temagami rivers occupy rather deep and important depressions in this rocky plateau.

Lakes.

The district is traversed with rivers which are as important and well known as the lakes which they serve alternately as inlet and outlet. The Ottawa is of course the largest, but only a portion of this, from Mattawa to Lac des Quinze is included within the area of the accompanying map-sheets. The Sturgeon likewise finds its source beyond the confines of this region, as also does the Montreal River, although by far the greatest portion of both streams is represented on the present maps. The Sturgeon is the larger of these two rivers, draining about 3000 square miles, while the Montreal drains an area of about 2500 square miles. The Matabitchouan, Mattawa, Keepawa, Temagami, Otter-tail and Otter rivers are also worthy of mention, although much smaller than the rivers first named. The Blanche River is a stream of considerable size, but only a small part of the lower portion is included in the Temiscaming sheet.

Lakes.

In common with other regions characterized by the presence of Archæan rocks, this district is remarkable for the number of lakes both large and small which are scattered over its surface. These lakes are in themselves noteworthy, not only for their many intricacies, but also because of the great number of islands which dot their surfaces. At first sight these lakes are seemingly governed by no law in regard to their distribution, but a somewhat closer examination reveals the dependence of geographical outline on the geological structure. In order to bring out more fully the intimate relation subsisting between the topographical outline and the nature and attitude of the enclosing strata, a careful compilation and correlation of the various strikes or direction of the foliation of the gneisses has been made, exhibiting with as close an approximation to the truth as is possible the various curves and folds assumed by these rocks.

Distribution dependent on geological structure.

Principal lakes.

The following nine lakes, with their areas and elevation above mean sea-level may be particularly noted :—

	Area. Square Miles.	Height above sea.
Lake Nipissing	345	640·5–647·8
" Temiscaming	125	577·8–591·8
" Keepawa	120	873·7–883
" Temagami	100	964
Lac des Quinze	40	845
Lady Evelyn Lake	18	930
Obabica Lake	11	932
Obashing Lake	11	822
Rabbit Lake	8	938

Outlets of Lake Temagami.

Lake Temagami, during the earlier portion of the summer, drains both northward, by way of Nonwakaming and Lady Evelyn lakes into the Montreal River, and southward by way of Cross Lake and Temagami River into the Sturgeon, the water thus ultimately finding its way into Georgian Bay and Lake Huron. The southern outlet, however, is the larger and deeper stream, while the northern one is usually dry towards the end of July each summer, and is thus only utilized in time of high water. Rabbit Lake finds its main outlet into the Matabitchouan River from the north-east corner of the lake, but a bay extending to the south-east is connected at extreme high water with Ross and Burwash lakes at the head of Macdonald Creek, which in turn empties into the Matabitchouan River at the Fourth Bass Lake. Annima-nipissing Lake, a large and important sheet of water situated between Lake Temagami and the Montreal River, which has usually, as the name implies, been regarded as the ultimate source of the Nipissing water, is 1070 feet above the sea, while Breeches Lake, which is in reality at the summit, is 1085 feet above the

Outlets of Rabbit Lake.

Annima-nipissing Lake.

Elevations of highest lakes.

sea. The highest lake in the whole region is Wilson Lake, at the head of one of the branches of the Matabitchouan River, and this is 1173 feet above the sea, while the height-of-land between this lake and the Montreal River is a little over 1200 feet above the sea.

Denudation.

Pre-glacial excavation.

In many of the descriptions which have from time to time appeared concerning this, in common with other Archæan regions, undue prominence has been given to the erosive effect produced during the glacial epoch. The prodigious number of lakes both great and small which are so eminently characteristic of districts underlain by Archæan rocks, have in general been referred to as original rock-basins which owed their existence to the excavating power of an immense glacier, while the mammillated hills and complementary valleys everywhere prevalent, as well as the constant occurrence of parallel grooves and scratches, have been adduced as additional evidence of the adequacy of the glacier to produce all the inequalities of the existing surface. The detailed examination of the region, however, amply demonstrates that the sculpturing to which the surface owes its present configuration, was practically completed long before the advent of the glacial epoch, and that the main valleys, especially those of the Ottawa and Mattawa rivers, were in existence long prior to the deposition of the Palæozoic sediments.

Depth of the old valleys.

In the first place, the more important lakes and rivers occupy such deep and extended depressions that seem inexplicable on any theory of glacial action or ordinary erosion by water. The bottom of Lake Temiscaming is on an average about a thousand feet below the level of the surrounding country, and in no place did the sounding lead reveal the original rocky bottom which has been more or less deeply covered by silts and by accumulations of drift material. Portions of the Mattawa and Montreal rivers are fully six hundred feet below the level of the rocky plateau through which they flow, and in many places exhibit steep, often perpendicular banks, composed of the hardest and most massive crystalline rocks.

Many valleys not coincident with direction of ice-flow.

Secondly, the trend of many of these valleys does not coincide with the general direction of the ice-flow, as revealed by the striæ and grooves which mark many of the exposed rock-surfaces of the plateau. These striæ in general vary from S. 10° W. to S. 30° W., while S. 20° W. may be assumed as a fair average of the direction of the ice-flow throughout this region. The deepest valley, that occupied by Lake Temiscaming and the Ottawa River, from the mouth of Wabi Creek to its confluence with the Mattawa River, has a direction of S. 30° E. while the valley of the Mattawa runs about east-and-west, thus forming considerable angles with the general striation, while the Montreal and Sturgeon rivers are intersected almost at right angles by these grooves and scratches. On the shores of Lake Temiscaming, and also on the Montreal River, many of the striæ exhibited have a direction corresponding with these valleys. These may either represent a differential movement in the mass of the ice itself, whereby the lower portion was forced by reason of its plasticity, to conform to the inequalities of the existing surface while the upper portion continued on its general south-westerly course; or, as seems more probable, these grooves may have belonged to a local glacier occupying these valleys towards the close of the glacial period. On the upper or wider portion of Lake Temiscaming, striæ belonging to the general glaciation may be noticed on the same rock-surface as other markings which belong to this local glacier, but the more abundant and strongly marked grooves throughout the lower portion of the valley, are seen conforming to its various changes of direction.

Some striæ correspond with direction of certain valleys.

Valleys not corresponding with strike.

Again, many of these valleys do not correspond with the strike of the rock in their immediate vicinity. The Ottawa valley is the best illustration of this fact, for the foliation of the gneissic rocks which compose most of its shores intersect this gorge almost at right angles. The depressions occupied by the Sturgeon and Montreal rivers also form considerable angles with the strike of the rocks in the immediate neighbourhood. Very often the streams occupy singularly straight and deep chasms in very hard rocks of different composition, valleys which it seems impossible that the ordinary erosive action of ice or water could ever have opened up, and which preserve their uniform direction with very little deviation in their course even when the river has left a softer rock to enter an area where the hardest varieties prevail.

Cut in rocks of different composition.

Valley of Montreal River.

The Montreal River, from "The Notch," near its mouth, to the bend above the portage to Mud Lake, a distance of twenty-one miles, flows through a rocky gorge, the course of which is in general N. 40° W. At this point the course of the valley changes abruptly to S. 45° W., which is maintained till Bay Lake is reached, a distance of four miles. From this point upward a valley extends as far as the Great Bend, beyond the confines of the present map, which is almost if not quite parallel to that occupied by the river below Mud Lake portage. Of course the river presents many minor deviations in its downward course, but the remarkable uniformity in direction of the valley through which the stream meanders, is maintained through successive alternations of slate, quartzite, graywacke and diabase, the character and composition of the surrounding rocks having apparently little or no effect in determining the course of this depression.

The existence, likewise, of Palæozoic outliers occupying portions of these valleys, seems ample proof of their existence as such from a very early time. The occurrence of an outlier of limestones, shales and conglomerates belonging to the Niagara, was noticed by Sir William Logan on Lake Temiscaming in 1844. This outlier appears as a shallow syncline resting unconformably on the slates and quartzites of the Huronian. The conglomerate, grit and arenaceous limestones representing the basal portion of the section, may be seen forming a narrow fringe from Piché's Point to Chiefs Island, on the east side of Lake Temiscaming, while a small patch of similar rocks crops out on the west side from Haileybury northward towards Wabi Bay. The limestones are present on the islands to the north of Bryson Island, and on the peninsula between Suttons and Wabi bays extending beyond the limits of the present map. The boulder-conglomerate that occupies the eastern shore to the south of Chiefs Island, is composed of large angular or subangular blocks derived from the Huronian quartzite which forms rather abrupt hills immediately behind this exposure. These detached fragments doubtless represent what was originally a talus, formed at the foot of this steep slope, and when the submergence took place, the intervening spaces became filled with detritus composed of the same materials, in a finer state of division, together with a small proportion of calcareous matter. This conglomerate and grit rest upon a surface which had clearly assumed a hummocky character before the deposition of these sediments, while the action of the glacier flowing down Lake Temiscaming long afterwards striated and polished the whole, leaving a surface with a net-like structure, through the meshes of which protrude rounded or ovoid sections of these rocky hillocks. Limestones and sandstones of Black River age are seen resting on the mammillated surfaces of Laurentian gneiss on the Ottawa, six miles below Mattawa, and also about five miles above Deux Rivières, as well as on the Manitou Islands, Lake Nipissing, while sandstones which are probably of Chazy age, but which have yielded no fossils, were noticed on Iron Island in the same lake.

Palæozoic outliers.

Basal beds of Niagara.

Black River limestone.

The occurrence of such outliers at various points throughout these valleys show that they existed in very early Palæozoic times, and indicate the transgression of the sea thus far inland at intervals during

Transgression of Palæozoic sea.

this, the Palæozoic, the submergence having been greatest during the Niagara, when the sea reached the northern end of Lake Temiscaming and may possibly have been connected by narrow arms and straits with that extending southward from Hudson Bay.

Hummocks. Pre-glacial rock-surface.

The rounded or *moutonnée* surfaces of all these rocky elevations, though no doubt accentuated by later glacial action, have in the first place been due to the unequal progress of rock decay. The work of Lawson, Low, Coste and Laflamme,* who have during the progress of their several explorations made critical and extended examinations of the relations existing between many outliers of Palæozoic strata and the subjacent Archæan rocks, clearly shows that the mammillated surface long antedates the glacial epoch, and was as characteristic of the surface upon which the earliest Palæozoic sediments were deposited, as that upon which the great glacier rested in glacial times. The chief cavities, vertical precipices and deep, narrow gorges must have been determined by great transverse or lateral breaks. The causes which operated in their formation must have been in force with marked intensity long before the deposition of the Niagara, for as has been shown, the valley had been practically completed before the deposition of these sediments. The rounded contours of the rocky plateau and the intervening hollows, doubtless represent the depth to which these crystalline rocks had undergone disintegration during the immense lapse of time while they were exposed to the action of the weather and other denuding agencies before the glacial epoch, while the ice simply removed the loose material resulting from such decomposition, smoothing and striating the rocky surfaces encountered.

Cliffs along lakes and rivers.

Both quartzite and diabase, and sometimes also the massive slate (or graywacke) which occurs as a transition between the more fissile slate beneath and the quartzite above, frequently from cliffs from fifty to two hundred feet in height, the angle of slope being considerably lessened by a talus of angular blocks detached from above. Good examples of these quartzite cliffs are furnished by the shores on the west side of Lake Temiscaming, opposite Bryson or Moose Island, at the Obisaga Narrows on Lady Evelyn Lake, as well as by the steep hills on the west side of Cliff Lake, while the Manitou or Devils Rock on the west side of Lake Temiscaming, south of Haileybury and the western shore of Temagami Lake, opposite the Hudson's Bay post are excellent instances of the vertical precipices produced by exposures of diabasic rocks. Prominent cliffs formed of

* Bull. Geol. Soc. Am., vol. I, pp. 163-173, also Annual Report, Geol. Surv. Can., 1882-83-84, part D.

the massive slate or graywacke may be noticed on the Matabitchouan River immediately above the Fourth Bass Lake, as also on the west shore of Lady Evelyn Lake, south of Wendabin Bay. The action of the frost and weather are continually loosening large masses of these cliffs, which then fall with a great noise, and this phenomenon is so frequent that one of the lakes (Manito-peepagee), to the west of Lake Temagami, has received its name on the supposition that the Evil One was the cause of the disturbance.

Soil.

Although the district as a whole cannot be said to be suitable for agricultural purposes, still in many places considerable areas of good land are known to exist. The largest continuous tracts of such land are to be found in the vicinity of the northern portion of Lake Temiscaming on both sides of the lake, and thus both in Quebec and Ontario, although the larger proportion is in the latter province. The Crown Lands Department of Quebec has sub-divided the two townships of Guigues and Duhamel and portions of four others, Fabre, Laverlochère, Baby and Neudlac. These by no means exhaust the arable land on this side, but are sufficient for the present requirements of settlement. On the opposite shore of the lake, Ontario has laid out and divided into lots, twenty-five townships which extend along the western side of the lake, and running in a north-westerly direction include the valleys of Wabi Creek and the Blanche as far as Round Lake. Only five of these townships and the southern portion of four others are included within the area covered by the accompanying map. Areas of good land. In Quebec. In Ontario.

The area thus sub-divided is in general composed of level or slightly rolling clay land. In some places the clay sub-soil is overlain by clay loam or sandy loam, while in other instances a rather barren yellow sand appears at the surface. In the province of Quebec, where the surface has in many places been almost completely denuded by repeated forest fires, this clay is best seen. From the Quinze River a little south of Quinn Point, large areas are covered with a thick mantle of stiff gray clay through which protrude exceedingly rough and prominent hills of quartzite, granite, diabase and breccia-conglomerate. These hills rise abruptly from an otherwise level clay plain, for the surface characterized by the presence of this clay exhibits a singularly flat appearance with only a gentle rise towards the base of the hills. Character of soil. Clay plains.

On the Ontario side, the township of Lorrain is rough, rocky and broken, and for the most part unsuitable for farming purposes. Along the valleys and in the vicinity of Lake Temiscaming the soil Lorrain.

is clay, but these clay flats are of comparatively small extent. To the north-west, however, in the townships of Bucke and Dymond there are quite a number of farms, and a large area of cultivable land exists, so that the villages of Haileybury and Liskeard seem destined to become the centres of a considerable agricultural community.

Bucke and Dymond.

Limestone plateau.

The top of the limestone plateau which constitutes that portion of the Niagara outlier forming the promontory dividing the northern end of the lake, is generally overlain by a light sandy loam soil, although in many places the underlying rock is destitute of any such covering. In the south-western part of Dymond and the southern portions of Hudson and Henwood, a series of rocky ridges of the Huronian slate occur. In the township of Henwood these ridges have a general north-and-south trend ; while in the township of Hudson the slate rises into hills some of which are nearly 200 feet in height. North of these ridges, according to Mr. Hermon, the soil is white clay, the surface generally level and the appearance of the country flat and swampy.

Hudson and Henwood.

Valley of Mattawa.

Between Mattawa and North Bay, to the south of the Mattawa River, in the townships of Papineau, Calvin, Bonfield and Ferris, considerable areas of land exist which may be utilized for farming purposes, and their proximity to the line of railway makes these of value. Already these townships contain a large number of excellent farms and the region is rapidly becoming settled. The soil is usually a clay-loam, rather rocky and stony in places, but seems to yield excellent crops. In the vicinity of North Bay the land is sandy and light.

Valley of Sturgeon River.

The valley of the Sturgeon, below the Temagami River, contains many wide and extensive flats which are susceptible of improvement, but above this stream the valley is much contracted and the flats decrease both in number and extent as the river is ascended, and towards the mouth of the Maskinongé River the country becomes much more broken and for the most part poor and rocky. Between Smoky Falls and the mouth of the Temagami, the country in the vicinity of the river is tolerably level and composed of gray clay overlain by sand. The soil is for the most part a sandy loam and affords support to a thick growth of hardwood and evergreens which by their sturdiness attest the good qualities of the soil beneath. Clearances have been made at intervals along the river, with the exception of that portion flowing through the Indian reserve, as far as the mouth of the Temagami. A short distance below the mouth of the Pike River, on the south side of the river, is an axtensive farm cultivated for many years for the purposes of supplying the lumbering camps of Mr. J. R. Booth, and a road connects this depot with the Canadian Pacific Railway at Cache Bay station.

Smoky Falls and Temagami River.

To the west of Sturgeon Falls there are a large number of farms which continue up the valley of the Veuve River, almost as far as Warren station, where the valley becomes very narrow. The soil throughout the valley is a stiff gray clay, and as the vegetable mould overlying has been burnt off it has a tendency to cake in dry weather. In the vicinity of Sturgeon Falls the soil is very sandy, but the clearances continue to the east as far as the boundary of the Indian reserve, and to the south almost to the lake shore, although the land in general in this direction is flooded during the spring freshets.

Veuve River.

Near Sturgeon Falls.

On the Montreal River above Bay Lake, there are large areas of arable land, especially between Bay Lake and the Mattawapika. The region to the north-west is very flat and level, underlain by clay, and although swampy at present, would probably be easily drained or dry up when cleared. These areas are most likely continuous with similar tracts noticed to the south-west of the townships of Henwood and Hudson.

Montreal River.

A large tract of country extends from the vicinity of North Bay and the southern part of the townships of Widdifield northward to the Opimika Creek. The soil is in places sandy and in some spots considerable clay is present, but the whole of this stretch of country is covered by a mixture of hardwoods and evergreens, thus denoting a rather good soil beneath. The greater portion of the district, however, is extremely rocky and barren, the level areas being chiefly occupied by swamps, many of which would be difficult to drain, while the area thus drained would in most cases be insufficient for purposes of farming. Of the country surrounding Temagami Lake and the greater part of the central portion of the area, only small tracts would be available for purposes of settlement. The soil in general is extremely light and without the aid of artificial fertilizers would soon fail to yield any adequate return. The rosy picture too often drawn of immense tracts of land available for agricultural purposes, is to say the least very misleading, for apart from possible mining and its timber resources, by far the greater portion of the region will only be valuable as a health and recreation ground for tourists and sportsmen The great tracts of forest as yet untouched by the axe, the vast number of picturesque lakes, both great and small, with fish and game in abundance seem to render the district especially attractive for such purposes.

Between North Bay and Opimika Narrows.

Great part of area unsuitable for farming.

Climate.

In regard to the climate of the district as a whole, it may be said in a general way, that the advent of spring is from three weeks to a

General climatic character.

month behind that of the region immediately surrounding the city of Ottawa, with a correspondingly earlier setting in of the winter. The winter is as a rule one of long continued and severe frosts, while the summer is proportionately shorter and much cooler than the country bordering the lower Ottawa. The average fall of snow in winter as well as the rainfall during summer is likewise considerably in excess of that in regions further to the south.

Opening of navigation.

Navigation generally opens on Lake Temiscaming about the end of the first week in May, although in occasional unfavourable seasons it is sometimes delayed a few days longer, while Keepawa Lake does not usually break up till a week later. In 1893, the ice on the latter lake broke up and moved out between the 15th and 17th of May. Lake Temagami, which occupies the height-of-land between the waters flowing to Lake Temiscaming and those emptying into Georgian Bay, being nearly 400 feet above the last-named lake, does not generally break up till the latter part of May, the lake usually being clear of ice about the 24th of May. The season of navigation closes, as far as Lake Temagami is concerned, between the 10th and 15th of November, while on Lake Temiscaming steamers have been known to make fairly regular trips within a few days of Christmas, although as a rule these boats cease running early in December.

Closing.

Progress of spring.

The snow begins to melt about the middle of April, and has generally all disappeared by the 10th of May, although both snow and ice were noticed in secluded nooks and cracks along the sides of the precipitous cliffs on the west side of the Ottawa River as late as the end of May. Mr. C. C. Farr, formerly of the Hudson's Bay Company, and now postmaster of Haileybury, who has become identified with this young and flourishing settlement, states that "seeding-time commences about the first week in May and ends, so far as oats are concerned, about the fourth of June, though oats have been sown as late as the 20th of June, and have done fairly well. Potatoes can be planted as late as the 20th of June, and it does not profit much to put them in before the 24th of May. Corn, cucumbers and melons can be sown about that date. Haying commences about the 14th July, harvest the 15th August."

Harvest.

Summer frosts.

Summer frosts, so much dreaded by the farmers, specially in districts newly opened for settlement, have in the past proved a rather serious barrier to the successful raising of wheat, while oats have suffered severely, particularly in clearances situated some distance from the larger bodies of water. Frosts generally occur from the 18th to the 25th of August on the calm, clear nights following heavy north winds.

In the vicinity of Lake Temiscaming the settlers often escape them altogether on account of their proximity to this large sheet of water, or their crops are but slightly injured, the more tender vegetables frequently being the only sufferers. The gradual clearing up of the land and the draining of many of the swamps will, however, materially mitigate this difficulty, particularly in the district in the vicinity of Lake Temiscaming, which is the area most suitable for extensive settlement.

The Native Inhabitants.

Indians.

The Indians who reside within the area under description belong to the once numerous and powerful Algonquin family. They speak the Otchipew or Chippewa language, the same as that in use among the many bands which are scattered over the wide territory to the north and west of Lake Superior, with only a few minor alterations. They are divided into three bands known respectively as the Nipissing, Temiscamingue and Temagamingue bands. On June 30th, 1887, the census taken by the Department of Indian Affairs showed a total Indian population of 394, while on June 30th, 1897, this population had only been increased to 430. The census taken in 1887 showed the following numbers in each band, Nipissing 165, Temiscamingue 136, and Temagamingue 93, while that taken in 1897 shows the population of the several bands to be, Nipissing 193, Temiscamingue 162, and Temagamingue 75. While therefore the total Indian population of the district shows a slight increase, one of the bands (Temagamingue) is slowly but surely decreasing. Two of the bands are comfortably settled on spacious reserves but no tract of land has yet been allotted to the Temagamingue band. The Nipissing band resides chiefly in two small villages situated on the north shore of Lake Nipissing. The larger of these is about two miles west of North Bay to the south-west of Beaucage station on the Canadian Pacific railway, while the smaller one is located near the western boundary of the reserve, about four miles south-east of Sturgeon Falls. The Indians and associated half-breeds have built a considerable number of rather substantial dwellings, each with a small cultivated patch attached, on the northern bank of the Quinze River, forming the village or settlement of North Temiscaming.

Their number.

Places of residence.

Timber.

White pine.

All the early explorers speak in terms of enthusiasm of the original great forests of the region here described. The most valuable tree from a commercial standpoint is the white pine (*Pinus Strobus*), and in spite of the extensive operations carried on almost uninterruptedly by the lumbermen throughout a large part of this region during the past fifty years, this tree is still present in considerable quantity. Next in importance and more abundantly distributed is the Norway or red pine (*Pinus resinosa.*) In the early years of the lumber trade, the greater value of this tree caused it to be sought for at more remote distances than the white pine, and thus we find at this time that camps for cutting red pine timber were many miles in advance of those erected for the purpose of securing white pine logs. The superior qualities of the white pine, however, soon came to be recognized and in time completely drove the red pine from the market, or so limited its sale that only a few of the finest trees were hewed down and utilized. Of late years, however, the marked diminution in size and quantity of the white pine has again brought the red pine forward, and both varieties are now cut without discrimination. The red pine seems to flourish on the apparently sterile sand plains, which are a feature in many parts of this district, and frequently forms exceedingly thick groves on the sides of hills where sand and gravel have collected, or on points composed of these drift materials which jut out into many of the lakes.

Red pine.

Jack-pine.

Jack-pine, called by some, pitch-pine, or bastard spruce (*Pinus Banksiana*) is very often encountered in the more barren and rocky areas, and its presence seems an almost certain indication of the extreme poverty of the underlying soil. It is usually more or less scrubby or stunted in its growth, although occasionally, as in some areas to the north-west of Lake Temiscaming, it attains sufficient dimensions to be utilized for rough lumber. In the vicinity of the southern and eastern shores of Lake Nipissing, the scanty groves of dwarf-like evergreens are almost wholly composed of this species, the hardy roots penetrating the various cracks and crevices of the rock. This tree also seems to select sandy or gravelly plains which have been overrun by fire and which had previously been occupied by a luxuriant growth of red or white pine.

Spruce.

Both white and black spruce (*Picea alba* and *Picea nigra*) are frequently met with, the latter being more abundant, but are too small to be of any commercial value for lumber, although many individuals would make excellent masts or spars.

Cedar.

White cedar (*Thuya occidentalis*) is usually found fringing the banks of streams or the shores of lakes, where it often forms a thick and at times an almost impenetrable undergrowth. Overhanging trees are frequently undermined by the waters or current during times of high water, and thus it happens that most of the drift-wood encountered, belongs to this species. Its favourite haunt also seems to be the marshy hollows or flats, which so commonly occur between the rocky hills, and extensive areas of swamps are almost entirely covered with a dense forest of this tree. As a rule, the tree is small and more or less stunted in its growth, while the larger individuals are frequently hollow at the butt. To the north and north-west of Lake Temiscaming many fine specimens of this tree were noticed.

White birch.

The white or canoe birch (*Betula papyrifera*) is also of very common occurrence, and together with the aspen poplar forms the prevailing second growth in areas which have been recently swept by fire. Both species in these instances form very thick groves of tall and straight though small trees. Interspersed with the more prevalent evergreen, especially where the soil is deeper and better, are occasional large trees which are of sufficient size to furnish good bark for canoes, as in the Sturgeon River valley, where good sized specimens may still be procured. The birch-bark canoes made on Lakes Nipissing and Temagami and at Mattawa, have always been considered the very best of their kind both in build and material, but of late years the supply of good and suitable bark is becoming perceptibly less.

Poplar.

Three varieties of the poplar were noticed throughout the region, the balsam or rough-barked poplar (*Populus balsamifera*), the white or aspen poplar (*Populus tremuloides*) and the large toothed poplar or aspen (*Populus grandidentata*). The poplar sometimes forms stately trees, especially in the Sturgeon River valley and in the country to the north and north-west of Lake Temiscaming. Tamarac, sometimes called hackmatack and occasionally juniper (*Larix Americana*) is abundant, and in common with the cedar and in a lesser degree the spruce, affects the low-lying areas or those portions of the forest where moisture may be readily and constantly secured. The immense tracts of swampy land between the head-waters of the Tomiko and Ottertail rivers to the north of the Spruce Lakes contain an abundant supply of good sized specimens of this tree, and it is constantly met with all through the region whenever the conditions are favourable to its growth.

Tamarac.

Balsam.

Hemlock.

The balsam or fir (*Abies balsamea*) is one of the most common in the moist areas. Hemlock (*Tsuga Canadensis*) was noticed northward to the Indian portage-route to Keepawa Lake, a short distance below the mouth of the Keepawa River, but no specimens were observed as far north as the Old Fort Narrows. It occurs rather abundantly and of large size in the vicinity of Lake Nipissing and on the Sturgeon River, but was not remarked in the northern and north-western portions of the region. The basswood or linden tree (*Tilia Americana*) was occasionally noticed on the Sturgeon River, while Sir William Logan mentions individuals two feet in diameter, associated with black birch and maple of similar dimensions, in the hardwood strip of country extending from behind the hills north of Trout Lake at the head of the Mattawa River to the Opimika Narrows on Lake Temiscaming. The basswood was also noticed mixed with maple, elm, poplar and balsam near the mouth of the Blanche at the north end of Lake Temiscaming.

Basswood.

Yew.

The American yew, sometimes called ground hemlock (*Taxus baccata* var. *Canadensis*) is an exceedingly common shrub, and is particularly noticeable, as when present it often forms an almost impenetrable underbrush. Alder and willow of several varieties are present in the various swamps or lining the banks or shores of streams and lakes.

Alder and willow.

Hardwood comparatively scarce.

Maple.

Although nearly all the principal varieties of hardwood are found in this region, the proportion which such trees bear to timber of a softer description is quite insignificant. Of the maple family, perhaps the most abundant is the sugar maple (*Acer Saccharum*), which is frequently of large dimensions. The soft maple (*Acer rubrum*) is also present in large quantities, but the black or bird's eye maple (*Acer nigrum*) is only rarely met with in the valleys of the southern portion of the region. The mountain maple (*Acer spicatum*) is one of the common varieties in moist ground, while the striped maple (*Acer Pennsylvanicum*) was noticed in many places. This tree is often called Moosewood, because the green and juicy tops form a favourite food for the moose, although the true "moosewood" (*Dirca palustris*) was noticed in many places suitable to its growth.

Moosewood.

Yellow birch.

Black birch.

Oak.

Large trees of yellow birch (*Betula lutea*) were remarked throughout the region, especially in the vicinity of the northern end of Lake Temiscaming, while specimens of the black or cherry birch (*Betula lenta*) were seen over thirty inches in diameter in the region to the north of the Mattawa River. The blue oak or swamp white oak (*Quercus macrocarpa*) is the most abundant of the oak family, and its favourite haunt seems to be the alluvial flats or intervals along the banks of streams where the soil is sufficiently moist and fertile. Here it is associated with the white elm (*Ulmus Americana*), which forms large and beautiful trees, the black or water ash (*Fraxinus sambucifolia*). The white oak (*Quercus alba*) seems to delight in lighter and drier soil, and good specimens were seen growing in the vicinity of Fort

Temiscaming. The red oak (*Quercus rubra*) was also noticed in places as far north as our explorations extended. Ironwood (*Ostrya Virginica*) is tolerably abundant and good. Specimens were noticed growing with the American beech (*Fagus ferruginea*) in the strip of hardwood land about five miles west of the Opimika Narrows on Lake Temiscaming. Ironwood. Beech.

Of the wild fruits, the thimble berry (*Rubus villosus*) is only very sparingly represented if at all in the south-eastern portion of the district on the Ottawa, but the red raspberry (*Rubus strigosus*) is abundant on all neglected clearings, or in areas which have been burnt and in the vicinity of deserted lumber camps. The wild grape (*Vitis riparia*) was seen growing on Mann Island, Lake Temiscaming, as well as on several islands of Lake Nipissing. Both varieties of the low-bush cranberry (*Oxycoccus macrocarpus* and *O. vulgaris*) are found on many of the marshes which are so prevalent around Lake Nipissing. The former species is the variety generally collected, and the extensive swampy flats in the vicinity of the mouth of the Sturgeon River on Lake Nipissing is the principal locality for these berries. They formerly were a source of considerable revenue to the thrifty Nipissing band of Indians, who took them in barrels down to the French River to sell to the traders on Lake Huron. Several barrels of the smaller variety of cranberry (*O. vulgaris*) were sent to Toronto, but did not command a sufficient price even to pay expenses. Berries.

The high bush cranberry (*Viburnum Opulus*) grows in damp ground along the river-valleys or on the margins of lakes where the shores are low. The bushes are sometimes between ten and twenty feet in height, and are especially abundant on the Devil's Channel, at the head of Lake Temiscaming, on the shores of Mann's Island in Lake Temiscaming, and fringing the banks of the Little and Ottertail rivers further to the south. The two varieties of blueberry commonly met with (*Vaccinium Canadense* and *V. corymbosum*) are present on all surfaces which have been lately swept by fire, and the Indians have been known to set fire to some of the smaller islands in order to get a supply of this fruit. *Vaccinium Canadense* prefers the drier and more rocky locality, but is also frequently noticed in swampy flats directly exposed to the sun's rays, while *Vaccinium corymbosum* with less abundant though much better and larger fruit, prefers a deeper and richer soil as well as localities which are more in the shade.

Fauna.

Of the deer tribe the most abundant are the moose (*Alce americanus*) and the red or Virginia deer (*virginianus Cariacus*). Owing to the Moose and deer.

recent provisions made by the Ontario Government looking to their preservation, aided no doubt by the advance of settlement to the south, these animals have become exceedingly numerous. The moose in particular is abundant, and their "runways" especially in the vicinity of rivers and lakes off the frequented routes of travel, are usually better beaten than many of the cattle paths in the neighbourhood of considerable settlements. This is notably the case on the Ottertail River, which flows into Lake Temiscaming from the west about four miles above the Opimika Narrows, on the small stream connecting Boice and Wicksteed Lakes as well as on the lower part of the Montreal River. It is only within the last ten years that the red or jumping deer have become at all numerous, and before 1887, only occasional specimens were shot, but now every sandy beach in the more secluded portions of the region is covered with the imprints of the feet of these animals.

Wolf.

The wolf (*Canis lupus*) has likewise become rather common, although a few years ago they were rarely if ever encountered. These animals follow very closely the migrations of the deer.

Moose and deer moving northward.

Both moose and red deer are gradually moving northward and north-westward, the former being met with in the vicinity of Abitibi Lake where previously they were unknown, while occasional specimens have been shot, according to Mr. A. P. Low, close to Moose Factory on James Bay.

Caribou.

The woodland caribou (*Rangifer caribou*) is not at all abundant, and chiefly inhabits the region to the north and north-east of Keepawa Lake, becoming more numerous to the north-east. The black bear (*Ursus americanus*) is still a rather common animal, but the constant demand for and ready sale of the skins has led to their diminution.

Fur-bearing animals.

Specimens of the fox (*Vulpes vulgaris*) are encountered and the skins find a ready sale. The Canada lynx or wild cat (*Lynx canadensis*) is likewise found, but only occasionally. The otter (*Lutra canadensis*) and the beaver (*Castor fiber*) are fast becoming extinct in this region, although signs of their presence may still be seen on many of the less frequented streams and ponds.

The fisher (*Mustela pennantii*), the sable or marten (*Mustela americana*), the stoat or ermine (*Putorius ermineus*), the mink (*Putorius vison*) and the muskrat (*Fiber zibethicus*) are also met with, and the two last named are still abundant in the region. The skunk (*Mephitis mephitica*) is very common, especially in the vicinity of the settlements or lumber camps, where they come to feed on the rubbish thrown from the kitchen.

Small animals.

The porcupine (*Erethizon dorsatus*), ground hog (*Arctomys monax*) and the hare or rabbit (*Lepus americanus*) are also common.

The chipmunk or striped squirrel (*Tamias striatus*), the red squirrel or chickaree (*Sciurus hudsonius*) and the flying squirrel (*Sciuropterus volucella*) are likewise common throughout the district. Squirrel and Chipmunk.

No special attention was devoted to noting the presence or habits of the birds of the district, but a few observations regarding the most noticeable ones may be of interest. Ducks are as a rule comparatively scarce throughout the greater part of the area, chiefly because of the marked absence of wild rice, their favourite food, and the somewhat rare occurrence of open marshes, their customary habitats. There are, however, several very notable exceptions to this rule, and the shallow swampy bays which characterize the west portion of Lake Nipissing, the north-eastern extremity of Shabosagi or Wicksteed Lake, as well as the northern end of Lake Temiscaming are favourite resorts for a rather large number of ducks during certain months both in the spring and autumn. During the summer months it sometimes happens in passing over the less frequented routes that occasional specimens of the black duck (*Anas obscura*) and the wood duck (*Aix sponsa*) are met with. Birds. Ducks comparatively scarce. Black and wood duck.

The merganser or saw-bill (*Merganser americanus*) is a very familiar sight along the numerous waterways, especially at the foot of small rapids. Merganser.

Occasional specimens of the pied-billed grebe or dabchick (*Podilymbus podiceps*) were also met with. The great northern diver or loon (*Urinator imber*) is also a common inhabitant of the district. With few exceptions each of the small lakes has a pair of these birds, while in the larger expanses of water every individual bay or arm contains two loons, who year after year return with great regularity to the same locality for breeding purposes. Hell-diver. Loons common.

The osprey (*Pandion haliäetus carolinensis*) was frequently noticed, the nest being usually situated on the very summit of a lofty white pine "rampike." Fish-hawk.

The herring gull (*Larus argentatus smithsonianus*) is also one of the most abundant birds of the lakes of this region. Its nesting place is usually on bare rounded hummocks of rock, almost completely destitute of soil or vegetation. Gull.

The raven (*Corvus corax principalis*) very often builds on the inaccessible ledges of the high rocky perpendicular cliffs. Some of the principal localities where these birds have nested from year to year are—the Roche à Corbeau and "The Canal" on Lake Keepawa, the west side of Lady Evelyn Lake, the Crow Rock in the northern part of Raven.

Annima-nipissing Lake and other places where the cliffs are high and sufficiently steep. The belted king-fisher (*Ceryle alcyon*) is constantly seen along the margins of creeks and rivers. The ruffed grouse or

Partridge.

birch partridge (*Bonasa umbellus togata*) is very common, as is also the Canada grouse or spruce partridge (*Dendragapus canadensis*).

Ptarmigan.

Both the white ptarmigan (*Lagopus lagopus*) and rock ptarmigan (*Lagopus rupestris*) are also occasional visitors to this district.

Fish.

Sturgeon.

Habitat.

Fish are exceedingly abundant in nearly all the lakes. The largest fish met with is perhaps the lake or rock sturgeon (*Acipenser rubicundus*) although many individuals of the lake trout nearly equal the sturgeon in size. The sturgeon was formerly a rather abundant inhabitant of Lake Nipissing, but of late years, owing doubtless to the increase in the number of settlers, are less common there.

Trout and Whitefish.

From an economic standpoint, however, the lake trout (*Salvelinus namaycush*) and the whitefish (*Coregonus clupeiformis*) are the most important, as they are not only abundantly and widely distributed throughout the larger lakes of the district, but form a usual and valuable article of diet among the scattered settlements. Both these fish, although present in considerable quantity in Lake Nipissing, attain their largest dimensions in the clear depths of Lake Temagami. There are no trout in Lake Temiscaming or the Ottawa River or even in Lake Keepawa, although most of the lakes immediately tributary to these contain abundant and fine

Brook Trout.

specimens of these fish. The brook trout (*Salvelinus fontinalis*) although comparatively rare, is rather widely distributed, and its presence in any stream or lake is a sure indication of unusually clear and cold water. The small lakes to the west of the Mountain Rapid on the Ottawa contain them in abundance while they are exceedingly numerous in the Opimika Creek and the lakes which this drains, especially Emerald Lake. Latour Creek, which empties Trout Lake, in the township of Lorrain, on the west side of Lake Temiscaming, has always been a favourite fishing resort for the inhabitants of the Hudson's Bay Company's old post, although the largest and finest specimens of this fish in the whole region may be procured in the streams entering Willow Island Lake to the west of Lady Evelyn Lake.

Lake Herring.

Closely allied to the whitefish is the fresh-water or lake herring (*Coregonus artedi*), which is somewhat abundant in many of the lakes.

Next in importance to the trout and whitefish are the various species of bass and sunfish which, with the exception of the black

Black bass.

bass, do not attain to any great size. The black bass are of excellent quality and exceedingly plentiful, these fish being found in most of the lakes comprised within the area of the map-sheets. Both species, the large-mouthed and small-mouthed, are present (*Micropterus salmoides* and *M. dolomieu*). There is an extreme variability in point of colour which is clearly owing to the nature of their surroundings. In lakes and streams where the water is of a prevailing brownish tint, the bass have a correspondingly dark hue, while in the clear, greenish water of Lake Temagami and Little Lake to the east of the Old Fort Narrows, the bass have a pale-green coloration. This variation in hue is not a peculiarity affecting the bass alone, but may be also noticed in the trout, pike and especially in the pickerel. The finest specimens of these fish may be secured in Lady Evelyn Lake (which contains no trout), Temagami, Red Cedar, Annima-nipissing, White-bear Net and Rabbit lakes, although these by no means exhaust the list; while on Lake Temiscaming and Little Lake, though not so abundant, the specimens obtained are generally of very large size.

Colour dependent on surroundings.

The rock bass or red eye (*Ambloplites rupestris*) and the common sunfish (*Lepomis pallidus*) are also extremely numerous where conditions are favourable.

Rock-bass and Sun-fish.

The common yellow perch and the pike-perch or pickerel are closely allied forms. The yellow perch (*Perca americana*), although of good quality, is generally small, rarely attaining over one pound in weight, while the average size is very much smaller. It is not of economic importance as a food fish like the pickerel. The pickerel (*Stizostedium vitreum*), called by the French, doré, is possibly next to the trout and whitefish the most valuable food fish found in the region. During several weeks of summer (generally in August) these fish retreat to the deeper water of the lakes, but at other times they may be readily secured in large numbers either by means of nets or with hook and line. At the Old Fort Narrows on Lake Temiscaming, it is by far the most abundant fish. It is also present in most of the other lakes throughout the district, especially in Lakes Keepawa, Obashing and Temagami. The general weight is from four to seven pounds, but one caught by us on White-bear Lake weighed fifteen pounds, while another from Hunters Lodge Narrows on Lake Keepawa, measured twenty-seven inches in length.

Perch.

Pickerel.

Where Pickerel abound.

Both the common pike (*Esox lucius*) and the great pike or maskinongé (*Esox nobilior*), are found, although the former is by far the more abundant The pike is a very common inhabitant in nearly all the lakes, while the maskinongé is comparatively rare, although several individuals were caught at the Old Fort Narrows on Lake Temiscaming.

Pike.

Maskinongé.

Eel, Cat-fish and Chub.

The common eel *(Anguilla rostrata)* is also present in many of the lakes, particularly Temiscaming and Temagami. Other fishes which might be mentioned are several species of sucker, the common cat-fish *(Amiurus nebulosus)* and the silver chub (*Semotilus corporalis*) but none of these are of economic value.

Good fishing lakes.

While most of the lakes are very abundantly supplied with fish, there are some which deserve special mention. Temagami, Annima-nipissing, Whitebear and Rabbit Lakes are *par excellence* the waters in which both trout and whitefish are found in greatest quantity and best quality, while the bass, pickerel and pike are also of large size and excellent quality. Lady Evelyn and Temiscaming lakes contain no trout. The Opimika and Old Fort Narrows on Lake Temiscaming have always been and still are excellent fishing places, the fish chiefly caught being pickerel, pike and bass. Pickerel are caught in great numbers in the spring, above the dam on Lake Keepawa near the outlet of the Keepawa River, as well as Hunters Lodge Narrows, while the Narrows on Obashing Lake is also a favourite resort for these fish.

GEOLOGY.

GENERAL STATEMENT.

Geological Subdivisions.

The several geological systems and formations represented in the region covered by the accompanying map-sheets and subjacent to the Pleistocene superficial deposits, may be thus stated in descending order :—

PALÆOZOIC { SILURIAN—*Niagara.*
CAMBRO-SILURIAN—*Trenton.*
Birdseye and Black River.

ARCHÆAN { HURONIAN.
LAURENTIAN — *Diorite-gneiss and granite-gneiss or "Fundamental gneiss."*

Archæan rocks.

Laurentian and Huronian.

The Archæan rocks of the region here described may naturally be separated into two great subdivisions, that of the so-called Lower Laurentian and the Huronian, although a few small isolated inliers of crystalline limestone, and one at least of a dark-gray, exceedingly squeezed and altered gneissic rock, are found to be inclosed in the ordinary granitic and dioritic gneisses. These are unimportant in this district, and so small in area that it has not been possible to distinguish them separately on the map. They resemble very closely rocks which in regions further to the south and south-east are known as the

Grenville series. The present report therefore does not include any discussion of the relations of the rocks classed as Huronian with those of the Grenville series. These two series do not come in contact in this area, and the question of their relations is at present being made the subject of special investigation in central Ontario. Grenville series.

Under the name Laurentian, in the area here described, are included a great number of varietal forms of granitic and dioritic materials, having essentially the chemical and mineralogical composition of such rock-types, but differing in their foliated texture, a difference which although almost invariably present is sometimes obscure and occasionally fails altogether. Their subdivision in the present report is based solely on their petrographical and mineralogical characters, for although their prevailing foliation, frequently marked by alternating bands of varying composition and colour, resembles in some respects an original stratification, it has been found impossible to make any such stratigraphical subdivision corresponding to that of later and truly bedded formations. Laurentian.

Detailed investigations both in the field and with the microscope, by various geologists and petrographers, have of late led to the belief that most of these gneisses have an origin in common with their more massive equivalents, and that the prevailing foliated character has been imparted to the rock-mass by differentiation in a slowly cooling magma of more or less heterogeneous composition, or as a result of deformation by pressure after the rock had undergone either partial or complete consolidation. The cogency of the arguments which have been urged in favour of the recognition of the greater part, at least, of these rocks as foliated irruptives now seems beyond question. Origin of gneisses.

Every recent report aiming at scientific accuracy, is necessarily prefaced by an apology or explanation of the use of the term Laurentian to include such gneissic rocks of irruptive origin, that have been in a molten or plastic condition at a time subsequent to the deposition and hardening of later truly stratified rocks with which they are intimately associated and occasionally interfoliated. The use of the name Laurentian.

It must therefore be clearly understood that in placing the rocks here representing the Laurentian at the base of a table such as that just given, it is not intended to indicate that they stand for any distinct or prolonged lapse of geological time, nor to affirm that these rocks as a whole, in their present condition, and with the foliation they now possess, really antedate those of the Huronian system. This, it will be shown, is not the case in many, if not in most instances where a question of the kind can be determined.

Origin of Fundamental gneiss.

The Fundamental gneiss is here therefore accorded a priority in description to which it is not structurally entitled, as it may possibly represent in great part, the first-formed crust of the earth, which, necessarily thin and fragile, and so liable to frequent upwellings of the molten mass beneath, has undergone successive fusions and recementations before reaching its present condition. As at present mapped, it is regarded as a complex of irruptive plutonic rocks, representing repeated and intricate intrusions of basic and acidic material. Although in many instances, and in limited areas, the succession of such irruptions can be ascertained, with tolerable accuracy, any attempt to correlate this succession in detail over extended areas, has invariably ended in more or less complete failure.

Formation of granite and diorite gneiss.

In general, however, it may be stated that the earliest secretions of the magma from which these rocks have solidified consisted of a series of granitic and dioritic gneisses, very evenly and distinctly foliated, varying in colour from reddish through reddish-gray and gray, to dark-green and almost black.

Successive intrusions.

These gneissic rocks were subsequently invaded by a massive, deep-red biotite-hornblende-gneiss that usually possesses a more or less distinct foliated structure, marked by the parallel alignment of the bisilicate minerals. It seems highly probable, however, that no great lapse of time intervened between these successive irruptions, as the latter in all probability represents the residual portion of the magma, necessarily more acidic and homogeneous in composition. Dykes of coarse pegmatite, as well as of fine-grained aplite, cut the different varieties of gneissic rocks or are frequently interfoliated with them.

Granite near Annima-nipissing Lake.

To the north-east of Lake Temagami, there is a large area of flesh-red granite, which in many places, especially in the vicinity of Carrying and Annima-nipissing Lakes, has a distinct foliated structure. In appearance, composition, and behaviour it has so close a resemblance to similar rocks mapped as Laurentian further to the south that it is proposed to include it with these rocks.

Granite area between Rabbit and Temagami Lake.

Between Temagami and Rabbit lakes, there is a somewhat similar granite, which, however, is continuous with the main Laurentian area to the south, and is accordingly designated by the same coloration. In both cases these rocks pass by insensible gradations into a medium-textured dark-green gabbro or gabbro-diorite, with which they are intimately associated, by an increase in the plagioclase and the preponderance of hornblende as the coloured constituent. Although in the accompanying map these gabbro masses are shown in the colour usual for such basic intrusions, it must be borne in mind that they are believed to represent basic portions or segregations of the same magma that has elsewhere crystallized as granite.

Huronian.

The Huronian rocks are generally clastic in composition, appearance, and microscopic structure, and in this respect are in marked contrast, even in their most altered phases, to those described as constituting the Laurentian of the district. A large proportion of these stratified rocks indicate the existence of intense and widespread vulcanism, which evidently characterized this period ; their composition and structure showing a most intimate association of undoubted volcanic ejectamenta with material resulting from the ordinary processes of erosion and sedimentation. The breccia or breccia-conglomerate which is so abundantly represented, and here forms the basal member of the Huronian, is composed chiefly of angular, sub-angular, or rounded fragments of red and gray granite, diabase of different degrees of texture, and various fine-grained slaty and hälleflinta-like rocks, embedded in a fine-grained, often argillitic matrix, consisting of similar material in a much finer state of division, with chlorite and sericite filling the smaller interstices.

Early misconceptions

In earlier reports on these rocks, the much greater relative abundance of the granitic fragments, coupled with the somewhat distinct foliation observable in a few of these, was evidently taken to be sufficiently strong and positive evidence to justify their description as strata resulting from the degradation of the Laurentian gneisses and granites. The more detailed and critical examinations made during recent years, covering the country between Lakes Huron and Temiscaming, show, however, the error of such a conclusion in any wide or general sense. Thus the rock, first described under the name of "chloritic slate-conglomerate" by Sir William Logan, must be regarded as essentially of pyroclastic origin, the volcanic ejectamenta having been evidently spread out upon the bottom of a shallow sea, where they have undergone in many instances considerable attrition and rearrangement by water. Much of the coarser material cannot be correlated with anything now known to be present at the earth's surface in this region; while the intimate association of this rock with diabase and gabbro intrusive masses, rather than with the granites, reveals a close genetic relationship subsisting between these rocks, that cannot be regarded as merely accidental.

Slate conglomerate.

Division of Huronian.

Throughout the area, the Huronian, where fully represented, is separable into three distinct subdivisions which are, in ascending order, as follows :—(1.) *Breccia or breccia-conglomerate.* (2.) *Graywacke shale or slate.* (3.) *Felspathic sandstone or quartzite.*

Breccia conglomerate.

As a rule, the lowest number, or breccia-conglomerate, presents only obscure evidence of stratification, and wherever such were visible the rock occurs in thick massive beds, showing only a slight inclination or dip. This may be well seen in the hills on either side of Lake Temiscaming between the Montreal River and the Old Fort Narrows. Where subjected to pressure, however, as is very frequently the case, the cleavage-foliation thus developed is a much more prominent structural feature and is thus very often mistaken for the bedding. This is especially the case in the region immediately adjacent to Lake Temagami, where this rock is very widely exposed and where it is associated with and squeezed between large masses of diabase and granite.

Graywacke and shale.

Superimposed upon this, and forming a transitional rock upwards into the succeeding subdivision, are beds of varying thicknesses of graywacke or felspathic sandstone, less massive in structure; while the coarser fragmental material gradually disappears as an ascent is made in the series. The succeeding shale or slate, which is in general very similar in composition to the graywacke or the finer matrix of the breccia-conglomerate beneath, is often beautifully banded in varying shades of green, purple or brown. The cleavage in most cases corresponds with the bedding, although occasional instances were noticed where cleavage or jointage planes were developed at considerable angles with this bedding. Superimposed on this slate, in many parts of the area, is a very massive much jointed quartzite or grit, generally sea-green in colour because of the abundance of minute scales of sericite distributed through the finer portions of the rock. Occasionally, however, it has a reddish tinge, and the arkose then closely resembles a granite, both in composition and appearance. The rock is so massive that it is often only by the parallel alignment of certain coarse quartzose and other fragments that the original bedding can be distinguished. These various members of the Huronian here follow one another in regular and often nearly horizontal succession, except in the vicinity of the large igneous masses, where they show considerable evidence of disturbance as well as of alteration.

Arkose.

The Palæozoic rocks represented in this area consist of outlying patches of the following formations:—(1) *Birdseye and Black River*, (2) *Lower Trenton*, (3) *Niagara*.

Birdseye and Black River on Lake Nipissing.

The outliers representing the Birdseye and Black River formation, are exposed on some of the islands composing the Manitou group in Lake Nipissing. These are of very limited extent and consist of sandstones, limestones and shales, the whole section probably not exceeding thirty feet in thickness.

Some small exposures of sandstones and arenaceous limestones occur overlying unconformably the gneissic rocks of the Laurentian on the Ottawa River below Mattawa. The fossils secured from these thin exposures, indicate that the containing rocks are of lower Trenton age, and thus somewhat higher in the stratigraphical succession than those occurring on the Manitou Islands. Trenton below Mattawa.

The Niagara formation, as exhibited in this district, is composed of light-buff or cream-coloured limestones and shales, with a basal boulder-conglomerate, or sandstone, unconformably overlying the Huronian slates and quartzites on the shores and islands of the northern portion of Lake Temiscaming. The strata composing this formation form a low, shallow, synclinal trough. Niagara formation on Lake Temiscaming.

The coarser varieties of drift material, such as boulders gravel and sand, are rather abundantly represented on the higher grounds, the surface being everywhere more or less encumbered with the larger erratics, especially on those slopes facing southward, while the comparatively shallow and rocky intervening valleys are frequently filled with coarse yellow sand, sometimes derived mainly from the decomposition of rock almost *in situ*. These boulders are usually of rock types prevalent in the district, but some show carriage from considerable distances. With the exception perhaps of the Mattawa, Nipissing, and Temiscaming valleys, there is little or no clay present in this district, the flatter details of topographical outline being given chiefly by deposits of coarse yellow sand. In the Temiscaming valley, there is a thick and extensive deposit of a stiff, stratified, gray clay which in many places effectually conceals the rock beneath. This clay occurs in flats of considerable area, through which the various streams have cut deep and tortuous channels, while protruding through these clay plains are steep and rocky hills of the prevailing types of the Huronian strata. In the wide depression the deepest and most northern portion of which is occupied by the Mattawa River, and which has also been utilized in the construction of the Canadian Pacific Railway, the minor valleys, and often too the separating rounded rocky elevations, are covered by clay deposits containing a considerable intermixture of boulders. Pleistocene deposits.

In the vicinity of North Bay and Sturgeon Falls, a considerable depth of coarse and yellow sand is present at the surface, concealing the gray clay beneath ; but to the west of Sturgeon Falls, especially in the vicinity of Verner, the stiff, gray, stratified clay comes to the surface, forming flats which have been burnt over or cleared. So far no fossils have been found in these clays, although in places diligent search was made for any such evidence of their origin, especially in the hard concretionary nodules which may be occasionally noticed.

Areas covered by different rock formations.

The areas covered by the several rock-formations may be stated roughly as follows: On the Lake Nipissing sheet there are about 3186 square miles of Laurentian, and 270 square miles of Huronian, while on the Lake Temiscaming sheet there are only 946 square miles of Laurentian, 2470 square miles of Huronian and associated eruptives, and forty square miles of Silurian. The two sheets combined therefore show 4132 square miles occupied by Laurentian, and 2740 square miles by Huronian and associated granites and diabases. The Silurian covers about forty square miles, but extends north-westward to a considerable distance beyond the northern confines of the Lake Temiscaming sheet. The aggregate area of Cambro-Silurian strata exposed on Lake Nipissing and Ottawa River is less than two square miles.

Laurentian.

Origin of name

The name Laurentian was originally proposed by Sir William Logan, in 1853, as the most appropriate designation for rocks classified by him in previous reports as the "Metamorphic Series," and which were believed to be identical in composition and origin with similar rocks so named and described by Lyell. The term thus introduced soon received an almost universal adoption by geologists, as a convenient one for the gneissic crystalline rocks found to underlie unconformably the Palæozoic strata, and presumably forming the oldest of the geological systems. The urgent need of such a distinctive appellation was recognized as a consequence of the ambiguity which would necessarily arise from the use of such a general term as "metamorphic," which is applicable to any group of strata in an altered condition, while the peculiar fitness of the name was suggested by the fact that these rocks were found to constitute the bulk of the Laurentide mountains, a series of elevations lying to the north of the River St. Lawrence, and which were so called by the late Mr. Garneau, the historian of Quebec.

Urgent need of name.

Origin of term "gneiss."

The term "gneiss" or "gneuss" was originally employed by the early Saxon miners for the country-rock containing the Erzgebirge silver ore deposits The rocks so named were divided into a "red" and "gray" variety, which although differing somewhat in their component minerals presented many features in common that caused them to be included under a uniform designation. The rocks so described are closely analogous in composition and structure to many of the rocks within the area of the present map-sheets, and to which the name "gneiss" has been usually applied. The name was very generally adopted by geologists, and its use was primarily restricted to rocks essentially granitic in their composition and appearance, differentiated solely on account of their foliated texture; the persistency of this peculiar structure over large areas, presumably furnishing proof of a difference in origin from the normal or massive type. Gradually, however, the use of the term became so extended as to include a great variety of crystalline rocks differing widely in composition and origin, but which exhibited in common a more or less decided tendency to a parallel arrangement of their component minerals.

Use of term extended.

Although modern petrographical studies have demonstrated the inapplicability of such a term for purposes of accurate description, except as an affix to denote the structural features of the rock-types examined, the name must still be employed as a convenient "field" term, as a means of rough description and correlation, where detailed microscopic examination is either impossible or considered unnecessary.

Gneiss useful and necessary field term.

The origin of these gneissic crystalline rocks was, for a long time, more or less a matter of theory and conjecture. Previous to the promulgation of the theories regarding rock metamorphism, first held by Hutton and subsequently by Lyell, to whom we owe the first use and definition of this term, these rocks were regarded as portions of the primeval crust, which had either never been enveloped by the later sedimentaries, or from which such covering, if originally present, had been removed as a result of subsequent upheaval and denudation. Such rocks were then almost invariably referred to as the "Fundamental gneiss or granite" and believed to be the basement or floor upon which all subsequent sedimentary formations were deposited. Metamorphism, either regional or contact, has always been considered the most potent influence in the destruction of evidences of original structure and composition in rocks subjected to the effect of the earth's internal heat, or that engendered by the proximity of eruptive masses.

Origin of crystalline rocks.

The various changes, however, which this term describes, were for a long time thought to be confined entirely to sedimentary strata, while masses of igneous plutonic rocks were regarded as too hard and unyielding to be at all affected by the metamorphosing agencies of even the most profound orographic movements. Foliation, though long held to be entirely distinct from stratification in the case of slaty and other allied rocks, was in the instance of these gneissic rocks regarded as the surviving traces of the parallel structure due to original sedimentation, which had escaped obliteration. It is only in very recent years

Metamorphism not confined to sedimentary rocks

Foliation distinct from stratification.

that this impression has been overcome by detailed examination and study, both in the field and with the microscope, carried on by many individual observers in large and widely separated districts, showing clearly that foliation and schistosity cannot be assumed to denote original stratification.

Work by Lossen.

The first really exact and satisfactory account of crystalline schists resulting from the metamorphism of massive eruptives, was given as the outcome of the detailed work by Lossen in the Hartz Mountains, who, as early as 1872*, directed attention to the deformation of diabases occurring in contact with granites, and showed the close analogy existing between the results of contact and regional metamorphism, as well as the production by metamorphic agencies of a foliated structure not connected in any way with stratification.

Work by Lehmann.

The most important contribution, however, in regard to the effects of dynamic metamorphism, appeared in 1884, from the pen of Prof. Johannes Lehmann, who after several years detailed studies on the origin of crystalline schists, based on a very large number of observations, made chiefly in Saxony, but also in Bavaria and Bohemia, published his celebrated memoir on this subject.† The conclusion is reached that "gneiss" is simply a structural form of granular felspathic rocks, and as such is capable of subdivision according to composition into varieties corresponding with the types of the ordinary massive plutonics, while the prevailing parallel structure may be, but very rarely is, original. He regards these foliated rocks as of igneous origin and not in any way related to sedimentary deposits, the characteristic structure being developed as a result of "stretching" when the rock was in a solid state. It is further concluded that such rocks become more evenly and finely banded in proportion to the intensity of such "stretching" action.

Daubrée's opinions.

Results of work by Naumann and Reusch.

Work by Teall and Williams.

Daubrée was also convinced that the schistose and foliated structures frequently assumed by massive rocks was not connected with original stratification, but secondarily developed as a result of pressure before the rock had wholly solidified. ‡Naumann emphasizes this latter fact, while Reusch, from studies undertaken in the vicinity of Bergen in Norway, also comes to similar conclusions. In England, Teall, from his examination of the metamorphic area in the vicinity of the Lizard in Cornwall|| reaches results closely resembling those of Lehmann;

*Zeitschr. Deutsch. Geol. Gesell. vol. XXIV, p. 763, Berlin, 1872.

†Untersuchungen über die Enstehung der Altkrystallinischen Schiefergesteine. Bonn, 1884.

‡Etudes synthétiques de géologie Expérimentelle, p. 432. Paris, 1879.

||Geol. Mag., Nov., 1886.

while in the United States, in the gabbro area near Baltimore, Maryland, as well as in the greenstone-schist area of the Menominee and Marquette regions in Michigan, the late Prof. Geo. H. Williams has shown the secondary development of a schistose structure in originally massive plutonic rocks.* In Canada, Lawson,† from his examination and studies of the rocks of the Lake of the Woods and Rainy Lake districts, was the first to draw attention to the fact that the various foliated crystalline rocks usually classified as Laurentian, were largely plutonic rocks, which have crystallized slowly, probably under an extremely gradual diminution of temperature, from a thickly viscid, coherent or tough hydrothermal magma. The foliation was explained as a result of "differential pressure which by causing a yielding or deformation, induced a flow in the mass." Work by Lawson.

Previous, however, to the appearance of these results, the metamorphism of sedimentary rocks occurring "as deeply buried and sunken strata" had been so clearly described and so strongly advocated by Lyell and others, that their views gained an almost immediate and world-wide credence and adoption. It is therefore not surprising that, in the desire to trace back as far as possible the sequence of geological events as revealed by the accumulation of stratified deposits, there should have been included at the base a complex of crystalline rocks attesting the presence not of conditions favourable to sedimentation but revealing the early unstability of the necessarily thin and weak crust, as a consequence of which it was probably peculiarly subject to upwellings of the molten mass beneath. The ultimate result being a series of immense batholitic intrusions, composed for the most part of foliated plutonic rocks, which subsequent upheaval and denudation have revealed at the present surface of the earth. The outward resemblance of these foliated or gneissic rocks to certain undoubted clastic rocks, present in later geological formations, which were known to have undergone extensive deformation and alteration; as well as their interfoliation with truly bedded rocks seemed abundant reasons for their classification as one uninterrupted series represented by this immense accumulation of stratified material. Their intimate association with crystalline limestones, which were believed to have originated in much the same manner as later calcareous strata, was also cited as additional evidence of their deposition as ordinary aqueous sediments. Subsequent work in the county of Argenteuil, rendered almost classic by the detailed labours of Sir William Logan, as well as Metamorphism. Resemblance to altered stratified rocks.

*Bull. U. S. Geol. Surv., Nos. 28 and 62.

†Annual Report Geol. Surv. Can., vol. I., (N.S.)., Part C. C., 1885.

in other extensive areas of Archæan rocks in Canada, have since shown the fallacy of many of the conclusions then reached, and both Adams and Ells are firmly convinced that the undoubtedly clastic rocks present in the area usually considered as "typical" of the Laurentian, form but a small proportion of the rocky complex, while they are associated with and inclosed by much greater volumes of gneissic rocks closely allied in petrographical characters to granite, diorite and gabbro.

Difficulties attending first examinations.

In the early years of the Canadian Geological Survey, the advance of accurate and detailed information regarding these rocks was greatly retarded for several very obvious reasons. In the first place, by far the larger portion of the country characterized by the presence of such rocks was a vast almost uninhabited wilderness of forest. The only access to such regions was by means of canoes, through obstructed and often little known routes of travel. These conditions have in a great many instances been improved of late years by the gradual settlement of the country and the necessary construction of roads. In the second place, great difficulty was for a long time experienced in obtaining trained and reliable observers competent to deal with the many difficult and complex problems presented. Sir William Logan, when carrying on his work in this connection, was often forced to depend for information covering many essential details, on observations by men scarcely possessed of the requisite qualifications.

Thirdly, the extreme metamorphism and deformation to which all such rocks had presumably been subjected on account of their very great antiquity, and the absence of any known methods by which their original minute structures and mineralogical composition could be deciphered, presented seemingly insuperable barriers to the complete and satisfactory explanation of their origin. In the fourth place, the very natural assumption that such rocks represented extremely metamorphosed sediments, and the consequent application of the ordinary methods of geological research made use of in the much later and typical stratified deposits, served only to aggravate the difficulties already existing.

Use of microscope.

The adoption of the microscope for petrographical research removed the main difficulties attending a satisfactory study of these rocks, marking an era in geology, since which time the progress in exact knowledge has been rapid. In fact, the accumulation of reliable information connected with this long-debated subject has already assumed such large proportions that many geologists look hopefully forward to the time when we shall probably possess an even more complete knowledge of these rocks and their manner of formation than we now do of many more recent rocks.

Logan's work on Ottawa River.

In 1844, when Logan decided to make an examination of the region bordering the Ottawa River, he found a mass of foliated crystalline rocks that seemed to him capable of subdivision into two conformable series, although in this as well as many succeeding reports, he included them under the one group, which he subsequently called Lower Laurentian. The lower or older series consisted exclusively of "syenitic gneiss showing no end to the diversity of arrangement in which the minerals and the colours will be observed, but there is a never failing constancy in respect to their parallelism. But this though never absent is sometimes obscure." These rocks were supposed by Logan to occur in the form of a low anticlinal arch in the region extending from the Mattawa River to the vicinity of the combined mouths of the Montreal and Matabitchouan on Lake Temiscaming. The upper series is stated to crop out in the district to the south of the Mattawa and Ottawa rivers and to be characterized "by the presence of important bands of limestone which have undergone extensive crystallization as a result of extreme metamorphism," while the various gneissic rocks which separate the several bands of limestone "differ in no way either in constituent quality or diversity of arrangement from the gneiss lower down."

Subdivision into Upper and Lower Laurentian.

Ottawa and Grenville Series.

Subsequently, this lower gneiss was called the "Ottawa Series," while the upper group, differentiated solely in the first place on account of the presence of the limestones, was included under the name Middle Laurentian or Grenville Series. The name Upper Laurentian was given to a terrane formed chiefly of anorthosites which were afterwards shown to be of irruptive origin, and with which were classified by mistake certain gneissic and limestone bands, identical in character with those included as the Grenville Series and to which they clearly belong.

Upper Laurentian.

In the district therefore covered by the Nipissing and Temiscaming sheets, the rocks to be described would, under the old classification, have been included as Lower Laurentian, although in the area to the south of the Mattawa River, precisely similar gneissic rocks, because of their inclusion of small isolated patches of crystalline limestone, have usually been described as of Grenville or Middle Laurentian age. These patches of crystalline limestone are only very occasionally present and are evidently caught up by and embedded in much greater volumes of gneissic or foliated rocks here of truly igneous origin, in such a way as to point to the conclusion that in these limestones we may have small remaining portions of a sedimentary series, which, although highly altered, have not been wholly absorbed by the surrounding foliated material.

Use of term Laurentian.

The term Laurentian, as applied in connection with the map-sheets here under description, therefore includes only such granite and diorite gneisses as are usually characteristic of this ancient complex.

The gneissic rocks exposed throughout this district fall naturally into two great groups.

Two groups of gneisses.

I. An acidic group:—consisting of those foliated rocks, similar in composition to granites, etc., to which they correspond, their differentiation being determined solely by their foliated texture, which usually pronounced, is sometimes obscure and occasionally altogether absent.

II. A basic group:—These rocks occur interbanded with the more acidic gneisses and represent either basic segregated portions of the granite magma, or foliated basic irruptives allied to diorites, diabases, etc., caught up in it.

The results obtained from the detailed petrographical examination of the large number of thin sections prepared from typical specimens, specially selected as representing all the observed varieties occurring in the region, coupled with extended observations concerning their field relations, has furnished the most convincing proof that the vast majority of such rocks may be referred to some type of irruptive material. On the other hand, those gneisses whose origin may be in doubt and which are in some cases held to be sedimentary, constitute an exceedingly small proportion of the whole series. In fact, the results obtained from the examination and study are very closely analogous to the conclusions arrived at by Sir Archibald Geikie regarding similar old rocks exposed in the British Isles, who says: "These rocks are in the main various forms of eruptive material ranging from highly acidic to highly basic; they form in general a complex mass belonging to successive periods of extrusion; some of their coarse structures are probably due to a process of segregation in still fluid or mobile, probably molten material consolidating below the surface; their granulated and schistose character and their folded and crumpled structures point to subsequent intense crushing and deformation; their apparent alternation with limestone and other rocks which are probably of sedimentary origin are deceptive, indicating no real continuity of formation, but pointing to the intrusive character of the gneiss."

Opinions by Sir A. Geikie.

The chief facts which together seem to prove the originally igneous character of the rocks above referred to may be stated as follows :—

1. *Composition of the gneissic rocks.*—The microscope reveals at once the identity of these in mineralogical composition with the different known varieties of granite and diorite, the constituents present, in many cases, showing little or no alteration, except that produced by local weathering, or as a result of somewhat limited dynamic metamorphism.

Composition of gneisses.

In order to ascertain whether the chemical composition of these gneissic rocks would bear out the conclusions derived from their study in the field and under the microscope, six analyses were made in the Laboratory of the Survey by Mr. F. G. Wait. The following are the results :—*

Analyses.

	I.	II.	III.	IV.	V.	VI
—	Granitite-gneiss.	Granitite-gneiss.	Granitite-gneiss.	Granite-gneiss.	Cyanite-granite-gneiss.	Quartz-mica-diorite-gneiss.
Silica	71·69	69·39	67·74	67·50	66·94	44·92
Alumina	14·84	17·46	16·13	18·23	17·84	18·88
Ferric oxide	....	....	1·50	....	....	2·73
Ferrous oxide	1·25	1·38	1·96	2·39	4·30	13·76
Manganous oxide	tr.	....	tr.	....	tr.	0·26
Lime	1·03	2·14	4·41	1·85	1·86	9·07
Magnesia	0·37	0·52	1·36	1·56	1·82	5·38
Potassa	7·09	2·77	1·30	4·25	3·36	0·53
Soda	3·13	5·18	4·92	3·79	1·85	2·94
Water at 100° C.	0·10	0·06	0·10	0·08	0·15	0·20
" above 100° C.	0·49	0·47	0·86	0·90	1·75	1·62
Totals	99·99	99·37	100·28	100·55	99·87	100·29

I. Granitite-gneiss from west shore of Taggart Bay, Keepawa Lake—in previous reports usually referred to as red orthoclase gneiss, granitoid gneiss or gneissoid syenite. The rock is of a deep flesh-red colour, massive and granitic in appearance, the foliation being imparted by the parallel disposition of the coloured constituents. It is highly felspathic and only very occasional thin bands of basic material occur which are at all continuous. It contains much microcline, orthoclase, plagioclase and quartz, with much smaller quantities of biotite and epidote. Sphene, sericite, chlorite, apatite, allanite and zircon are present as accidental

Description of gneisses.

*Annual Report, Geol. Surv. Can., vol. IX., (N.S.) Part R., pp. 18-20.

Description of gneisses analysed.

or secondary minerals. The rock has evidently been subjected to considerable pressure. The felspar and quartz have often undergone advanced granulation, while the surviving large individuals exhibit marked undulous extinction. Microcline, as might be expected, is abundant, as also areas of granophyre.

II. Granitite-gneiss from south shore of McLarens Bay, Keepawa Lake. This was selected as representing the light reddish-gray granitic genisses so common in the district. The hand specimen shows a light-gray, rather fine-grained micaceous granitic rock, tinged with red oxide of iron, and showing only indistinct foliation. Composed of orthoclase, microcline, plagioclase, quartz and biotite with a little apatite, zircon, sphene, magnetite and occasional minute individuals of secondary muscovite and epidote. The biotite shows a slight alteration to chlorite in some instances and occurs for the most part in small isolated plates, possessing a rude parallelism and rarely aggregated together. It shows only slight evidence of pressure.

III. Granitite-gneiss from west shore, Lake Temiscaming at north end of Opimika Narrows. A good average sample of the ordinary so-called gray-gneiss. Macroscopically, this is a very distinctly foliated rock, the foliation being produced by alternating bands of light and dark-gray colours. The darker bands are composed almost wholly of the coloured constituents while the light-gray portions are made up chiefly of quartz and felspar. The thin section shows quartz, orthoclase, plagioclase, biotite and epidote as the principal constituents. Epidote and titanite are common inclusions in the mica.

IV. Granite-gneiss from the north-west shore of Leonard Inlet, Wicksteed Lake. The hand specimen shows a rather coarse-grained, grayish, indistinctly foliated rock, much stained with yellowish-brown iron oxide and showing large phenocrysts of white orthoclase. The chief minerals present are orthoclase, microcline, plagioclase, quartz, biotite and muscovite. Apatite, zircon, epidote, zoisite, allanite? and pyrite were also noted in very small quantities. The rock has evidently been subjected to considerable dynamic action. The muscovite is primary intergrown with perfectly fresh reddish-brown biotite.

V. Cyanite-granite-gneiss from the east shore of the Ottawa River, half a mile north of Snake Creek. The hand specimen shows a coarse-grained granitic rock with a distinctly banded structure caused by layers rich in biotite, alternating with layers of quartz and felspar comparatively free from that mineral. The distinctive feature of the rock is the abundance in portions of it of a light, to deep-blue cyanite, in large columnar individuals, some of which are half an inch across and an inch in length ; garnets of a deep pink colour are also plentiful, and some individuals are as much as half an inch in diameter. Under the microscope the rock is seen to be composed of orthoclase, plagioclase, quartz, biotite, cyanite and garnet with smaller quantities of muscovite, graphite, titanite, zircon, apatite, pyrite, pyrrhotite and epidote. The rock is typically holocrystalline and granitic and shows no extreme evidence of granulation.

VI. Quartz-mica-diorite-gneiss from Ottertail Creek, lower end of the 2nd portage above the junction with the north branch. In the hand specimen this is a dark-gray, almost black, glistening, evenly foliated rock stained in places with iron oxide. It is composed of plagioclase, orthoclase, quartz, hornblende and biotite, with sphene, apatite, zircon, pyrite, magnetite and limonite as accessory minerals. The hornblende is much more abundant than the biotite. The evidence of pressure is very limited. The rock constitutes the dark basic bands so characteristic of exposures of the gray gneiss.

General result of examiations

Time would not permit of the separate analysis of each rock-type included in the accompanying table, and therefore no attempt can be made to institute comparisons in detail with the published analyses of granites and diorites. Sufficient has been done, however, to show somewhat clearly that in general these foliated rocks bear a close analogy in chemical composition to their massive equivalents, while on the other hand, they are quite different in this respect from any rock resulting from ordinary processes of sedimentation. As Dr. Adams remarks,* the points of distinction and those which mark them as of igneous origin are, high silica, combined with low alumina and high percentage of alkalies. The lime also, as is usually the case in granites, is in excess of the magnesia. It would seem, however, that the granite-gneisses, as a rule, are more basic than their massive equivalents, although presenting an equally wide range in their silica contents. The decrease in silica is accompanied by an increase in the alumina, while soda tends to exceed potash in the more basic varieties thus marking a passage to the gabbros and diorites. The high percentage of alumina with low alkalies noticed in No. V. is due to the presence of cyanite, but otherwise the composition is essentially similar in every other respect to the ordinary granitites of this and other Archæan districts. There is as is usual in granites, the preponderance of lime over magnesia which though slight in this case, is nevertheless in marked contrast to the sillimanite gneisses described by Adams* where the magnesia is often nearly three times as abundant as the lime.

*Annual Report, Geol. Surv. Can., vol. VIII. (N.S.) Part J, p. 44.

The quartz-mica-diorite (VI.) is analogous in chemical composition to the most basic phases of the gabbros and diorites. The hornblende and biotite are much more abundant than the felspathic constituents, while quartz is only very sparingly represented.

Structures.

2. *Microscopical structure.*—The various thin sections examined, show unmistakably the holocrystalline structure so characteristic of granite, diorite and gabbro, the felspar and quartz individuals forming comparatively large areas of interlocking grains, especially in the more acidic portions or bands in the rock, with which are associated the hypidiomorphically developed bisilicate constituents. There is no suggestion whatever, in the great majority of such rocks, of the secondary enlargement which in certain arkoses and quartzites produces a somewhat similar interlocking arrangement, as the rocks have, in many instances, been subjected to but limited metamorphic action. The foliation, which is the differentiating characteristic of these rocks, is often so coarse that it is only apparent in large specimens or somewhat extended exposures of the rock. This parallelism is, therefore, often indistinguishable with the microscope, so that in the thin sections the resemblance is complete between foliated and non-foliated varieties of such essentially similar mineral aggregates.

Order of generation.

At the present day, fused magmas are regarded as a more or less complex solutions, which, by reason of their high temperatures, obey the same laws in the order and method of their solidification as those which govern the crystallization of ordinary solutions of a similar heterogeneous composition. Thus, in the numerous thin sections examined, a certain general and definite order is observable in the generation or crystallization of the various component minerals that has been rather closely adhered to in the progress of consolidation. In this manner zircon, sphene, apatite and primary epidote, which are the first to form in the slowly cooling mass, are almost invariably present in shapely outlined and well developed crystals, evidencing considerable freedom from restraint during the progress of their formation. The various iron ores which may happen to be present, are of earlier generation than the coloured or bisilicate individuals, which latter are usually present with hypidiomorphic outline, although occasional individuals often show sharp and well defined crystallographic boundaries. The customary grouping together in masses or nests of such basic material, produces a mutual interference of the constituent individuals which militates greatly against perfection of crystal boundaries. The various apatites, sphenes, etc., which are the first minerals to form in the cooling rock-mass, usually occur, as might be expected, either embedded in, or in close conjunction with such ferro-magnesian constituents, although the rest of the rock, while much poorer relatively in such minerals, may not be entirely free from them. The felspar and quartz, which are the last to solidify, occur in more or less irregular areas, usually elongated in the direction of the foliation, or showing, especially in the case of the quartz, that the residual spaces existent in the rock-mass were already of this form and character.

Field relations.

3. *Macroscopical structure.*—The various dark and light-coloured bands of relatively greater or less basicity, succeed one another across the strike or cut one another off, thus suggesting, even to a casual observer, a complicated intrusion of one portion through another, although the frequent absence of any distinctly recognizable boundary between the different folia shows clearly that such conditions obtained in the mass long before its final consolidation. Although especially when arranged in approximately horizontal position, the alternation of such bands resembles somewhat closely the parallelism produced by the alternating sequence of stratified material of differing coarseness and composition, a closer inspection shows that there is no evidence whatever of the sorting and rearrangement by aqueous agencies so characteristic of all sedimentary strata. The tendency to nuclear aggregation observed in the crystallization of the first-formed constituents, seems to be a usual and marked feature, not only of slow cooling magmas, but of all highly saturated and complex solutions when undergoing change to the solid state. It is therefore quite evident, both from macroscopic and microscopic examination, that perfection of foliation is reached in these gneisses when, during the process of cooling, accompanied by differential movements, the pressures produce a kind of flow in the still mobile mass, thus tending to the parallel disposition of the various bands or masses of differing composition. The viscosity of the whole was such as to prevent the too free transmission of the material of contiguous bands or portions, thus furnishing the approximately sharp lines of division so frequently observed.

4. *Junction with overlying rocks.* — The immediate contact, or line of junction, with originally overlying clastic rocks, reveals undoubted evidence of the irruptive character of the gneisses. Numerous and detailed observations have been made of the line of demarcation between these Laurentian gneisses and Huronian slates and quartzites, which latter are of undoubted clastic origin. The behaviour of the gneissic rocks under these circumstances, is precisely similar in every respect to that which obtains in the case of granite, intrusive through

Laurentian intrusive through Huronian

neighbouring bedded strata. Detailed descriptions have already appeared* regarding the various contact phenomena witnessed along the line of junction between the Laurentian and Huronian, embracing not only this region, but also the district to the south-west included within the area of the Sudbury and French River map-sheets (Nos. 130 and 125, Ontario). The facts there noted, and since borne out by more extended observations, show distinctly that the gneisses are intrusive in the Huronian, and are, therefore, in their present form younger than the clastics which they invade. Although, in places, a seeming transition exists which might be mistaken for an alternating sequence of stratified material, the relations thus observed find their true explanation in the presence, at these places, of a zone of varying thickness formed by a commingling of the sedimentary material with the igneous rocks, as a result of actual fusion, or by the presence of a series of more or less parallel dykes piercing these clastics.

Two kinds of foliation.

The foliation presented by these rocks is of two distinct kinds, although there is almost every possible gradation between these two extremes. It may consist of the parallel arrangement of certain of the constituent minerals, usually the bisilicates, but sometimes also the porphyritic felspars, or it may be due to an alternation of lighter or darker bands, showing a varying chemical and mineralogical composition. Intermediate phases of such structures are produced by the development, in more or less approximately parallel position of nuclei, or nests, of the ferromagnesian constituents, whose gradual coalescence into ever-lengthening bands, produces ultimately that perfection of foliation actually found.

The foliation just described, is the one characteristic of the more massive and granitoid varieties, included under the first or acidic group, and is evidently the result of the application of pressure to a magma of somewhat homogeneous composition. On the other hand, the second variety of foliation is produced by alternating sequences of rocks belonging to both acidic and basic groups, and has been imparted to the rock-mass as a result of differentiation in a slowly cooling magma of heterogeneous composition, aided by a flowing movement in a more or less constant direction.

Foliation produced when rock was only partially consolidated.

The results obtained by the microscopic examination indicate, in the most positive manner, that the banded structure so universally observable in such rocks, was imparted to the whole mass while still in a molten, or, at most, only partially consolidated condition. One of

*American Geologist, vol., VI., pp. 19-32 (July, 1890), also Bull. Geol. Soc. Am., vol., IV., pp. 313-332.

the most significant facts noticed in this connection, is that many of the most markedly foliated gneisses show little or no trace of having been subjected to any great degree of deformation; nor is there any reason whatever to suppose that the rocks so examined have undergone such recrystallization as to mask the evidence of such action, if any previously occurred. In many instances, it is equally certain that subsequent dynamic action has, after the complete solidification of the magma, somewhat modified and accentuated such foliation, but even in these cases, there is every reason to believe that pronounced parallelism previously existed as a primary structure of such rock-masses, before the application of pressure.

Effects of dynamic action.

The somewhat uniform direction in strike of this banded structure, over the larger portion of the area covered by the accompanying map-sheets, and its marked correspondence in direction with the line of outcrop of the neighbouring stratified Huronian rocks, seem to point to the conclusion that the resistance offered during the irruption of these gneisses by such hard strata, has been the main determining feature of the direction of foliation. During the progress of this igneous invasion, the forces of upheaval acted along certain definite lines or centres, thus producing irregular ovoid forms, often of great area, the inner portions of which are now occupied by comparatively flat-lying gneisses, or, in occasional instances, by more massive or granitoid varieties, surrounded by an outer border or zone where the foliation becomes much more pronounced. In certain instances, where the dome-like structures thus produced have been denuded, and are of limited extent, a great diversity exists in both the direction and angle of dip of the foliation within a comparatively small area, but where, as is usual thoughout this district, these ovoid areas are of great size, the direction of foliation shows a corresponding increase in uniformity.

Uniformity of strike.

Structural features.

Intimately associated with these gneisses and granites, are certain portions, often of themselves constituting considerable and therefore important rock-masses, which, on account of certain peculiarities of composition, as well as from their structural relations with the surrounding rocks, have been commonly referred to as "pegmatite," and which by reason of their usually coarse crystallization have been sometimes called "giant granite." Haüy first applied the name pegmatite to the intimate admixture of orthoclase and quartz, also known as graphic granite. Later, Naumann extended its use to include all the coarse varieties of muscovite-granite, vein-like in appearance and frequently containing tourmaline. Subsequent writers, as detailed investigations into its composition and origin proceeded, have still further

Pegmatite.

widened its use, until, at the present day, the employment of the term in connection with that of the parent plutonic mass with which it is associated is necessary, before any definite idea can be formed of its precise mineralogical composition. In petrography the terms micro- and macro-pegmatite have always been used in a structural sense only, to denote those intergrowths of quartz and felspar, or of two differing species of felspar which are sometimes characteristic of occurrences in rocks of these minerals. Thus the various plutonic masses of syenite, diorite, gabbro and diabase, may each have their individual pegmatitic equivalents, representing the final product of their solidification, although the abundance of such aggregates in connection with these rocks is much less than in the case of granites. This comparative infrequency is perhaps most adequately explained by the relatively much greater basicity of such rocks, their more rapid rate of cooling, as well as the comparative scarcity, throughout the greater portion of the mass, of any such abundant and intimate association of fused rock and heated water as would tend to their formation; for, while it has been clearly shown by M. Fouqué and Michel-Lévy, that diabase and similar basic rocks may be artificially reproduced in the laboratory from a state of simple dry fusion, it is extremely doubtful whether any extensive intrusive process produced by natural causes is ever unaccompanied by a greater or less abundance of superheated water as an integral portion of the fused mass.

Use of terms.

In the region under description, the granite pegmatites are, as usual, by far the most abundant, but there are occasional dykes in which the occurrence of oligoclase and hornblende as the main constituents would determine their classification with the diorites.

Composition of pegmatite.

In composition, these pegmatite masses consist essentially of quartz and the more acid felspars, chiefly orthoclase, oligoclase, albite and microcline, while muscovite is the prevalent ferro-magnesian constituent, when any is present, and hornblende and biotite are much less characteristic. The parallel intergrowth of orthoclase and albite to which the name perthite has been applied, is an abundant and sometimes prevailing felspathic constituent of the pegmatite dykes, especially in the vicinity of Mattawa. The composition is therefore somewhat variable, but these dykes or vein-like masses are essentially similar, though somewhat more acid than the normal plutonic rock of which they represent the most highly differentiated or final product of consolidation. Thus, in those areas where the gneissic rocks contain a superabundance of basic material, with plagioclase as the predominating felspathic constituent, the associated pegmatite usually shows a corres ponding increase in relative basicity, oligoclase seemingly being the most abundant felspar. In areas of hornblende-granite, the associated pegmatites contain hornblende as the coloured constituent. The preponderance of the granitite gneisses or biotite-granite-gneisses in this region, is represented also by a far greater relative abundance of the pegmatitic phases of such rocks, while the far greater prevalence of muscovite, which usually occurs altogether replacing the biotite of the normal parent plutonic, evidences the presence of the greater abundance of heated water tending to the more or less complete elimination of the iron present in this bisilicate and the consequent conversion of the mineral into muscovite.

Accessory minerals.

The pegmatites have not yet been examined sufficiently in detail to call for any lengthy mention of their accessory or accidental minerals. In other districts these masses are especially noted as favouring the development of many of the more unusual and rare minerals. In a pegmatite dyke cutting gneissic rocks about a mile north-west of Eau Claire station, opaque crystals of beryl occur. The crystals secured are usually of a pale yellowish but sometimes of a bluish colour and some of them would exceed five pounds in weight. An examination by Mr. R. A. A. Johnston, of some specimens collected from the same locality by Mr. C. W. Willimott, showed likewise the presence of the comparatively rare minerals, xenotime and polycrase. Cyanite, although an abundant constituent of the granitite-gneisses in the vicinity of Les Erables rapids and the mouth of Snake Creek on the Ottawa, exhibits its most perfect crystallographic development in the coarser and more acid bands which are evidently of pegmatitic origin. Fluorite is also an abundant and frequent constituent in the pegmatites cutting the gneisses near the Ottawa in the township of Cameron, about five miles east of Mattawa. In the necessarily more or less hurried examination of the large number of these pegmatite masses, there was found, however, a conspicuous monotony in composition.

Intrusive in character.

The intrusive character of pegmatite is now so generally recognized, that the various theories, formerly extant, regarding it as in some manner due to aqueous infiltration and deposition, may be considered as disproved, while the view that pegmatite constitutes the most acid phase or final differentiation product attending the progressive crystallization of certain intrusive plutonic rocks has been very clearly and

*Annual Report, Geol. Surv. Can., vol. IX. (N.S.) p. 13 R ; also Am. Jour. Sc., March, 1899, p. 243 : also Summary Report Geol. Surv. Can., 1898, p. 167.

ably set forth by Lehmann*, Bröggert†, Williams‡ and others, and all have given expression to the opinion that water played a most important role in their formation. Probably the most satisfactory explana- which has yet appeared, is that lately issued as the joint production of Messrs. W. O. Crosby and M. L. Fuller, of Boston.§ These authors recognize "that the most satisfactory explanation of this blending of the pegmatite with quartz veins on the one hand, as with the normal granite on the other, is to be found in a corresponding blending of aqueo-igneous fusion with igneo-aqueous solution; and this dynamic gradation, it appears to us, can only result from the gradual hydration of the residual magma during the slow centripetal solidification of a body of magma and a consequent elimination of water."

Opinions of Messrs. W. O. Crosby and M. F. Fuller.

In this paper the authors further state that pegmatite should be regarded, "not as a distinct species or family of rocks, but rather as a possible textural phase of all, or nearly all, the plutonic rocks; and we may, in general, say of any plutonic rock, that it may be crypto-crystalline, microcrystalline, macro-crystalline or pegmatitic."

Formation of pegmatite.

The consensus, therefore, of recent opinion, seems to favour an intrusive origin for pegmatite, the progressive increase in hydration of the residual magma being explanatory by a corresponding increase in acidity of its later crystallization.

The stages represented completely by the occurrences in this region, show a perfect and practically uninterrupted continuity during the consolidation of these rocks, from an original condition of hydro-igneous fusion characteristic of the magma from which the comparatively fine and even-grained parent plutonic is generally believed to have resulted, to conditions of aqueous solution which must have obtained in the viscous mass from which the latest quartzose segregations have solidified. Such views are in harmony with the known occurrences of most of the quartzose masses and veins, so frequently present in these Archæan rocks, and which have evidently originated by a process closely allied to that described above, in consequence of the deposition from supersaturated solutions of highly siliceous material, and are substantially contemporaneous with the parent plutonic mass with which they are so intimately associated.

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*Ueber die Entsehung der altkrystallinischen Schiefergesteine 1884, p. 24 et seq.

†Die Mineralien der Syenitpegmatitgänge der südnorwegischen Augit und Nephelinsyenit I, Theil pp. 215-225. Translated by N. N. Evans, Can. Rec. Sc., vol. VI., Nos. 2 and 3, pp. 33-46 and 61-71.

‡Origin of the Maryland Pegmatites, XVth Ann. Rep. U. S. Geol. Survey, pp. 675—686.

§Technology Quarterly, vol. IX., No. 4, December, 1896, pp. 326-356.

The age relations of the component minerals are practically the same as that in the more usual types of plutonic rocks. Thus biotite, muscovite, and the more basic felspars, crystallized out in regular succession in the order mentioned, showing a gradual decrease in perfection of idiomorphic development. The more acid felspars, and finally the quartz follow, the latter, especially, showing little or no evidence of crystal boundaries, occupying the interspaces left by the earlier development of the more basic constituents. When drusy cavities exist in these pegmatites, as well as in the quartzose and more vein-like occurrences, the silica sometimes exhibits a decided tendency towards crystalline development. The presence of such unfilled spaces, especially in the immediate vicinity of such perfect crystal forms, seems to furnish evidence of the insufficiency of the siliceous material in solution to fill the spaces, permitting a more or less unrestricted development of the remaining quartz. They likewise point, not only to the extreme acidity of the last remaining portion of the partially solidified magna, but also to its approximately homogeneous composition.

Age relations of component minerals.

The exact depth below the earth's surface necessary for the formation of these pegmatites and their parent masses of normal plutonic rocks, as well as the amount of pressure during the progress of their crystallization, is a mere matter of speculation. Of recent years a perfect gradation has been traced from the typical holocrystalline structure characteristic of granite, gabbro and other plutonic rocks, in a vertical distance of a few hundred feet upward, into a porphyritic phase at the surface; while the pressure required, as pointed out by Brögger, would be obtained by the presence of superimposed material, great enough to prevent the water, separated out by the progressive crystallization, from escaping freely to the surface.

The most distinctive feature concerning the development of these masses, is their extremely coarse crystalline texture, which is in very striking contrast to the normal or usual crystallization of the parent plutonic rock with which they are associated. The resemblance in many of the quartzose varieties to quartz veins, originally regarded as due solely to lateral secretion and aqueous deposition, is so very marked that it is difficult to see how any hard and fast line can be drawn between these separate occurrences. Usually in these cases there is a somewhat indistinct zone-like arrangement of the material, the masses presenting a finer grained felspathic portion in the vicinity of the walls, and showing a continuous transition towards the interior, which is often occupied by comparatively large allotriomorphic masses of almost

Coarse texture of pegmatite.

Some quartz veins pegmatitic in origin.

pure quartz. Usually there is a perfect gradation into the parent plutonic when this is the inclosing rock-mass, while an undoubted passage can very frequently be traced into areas of pure quartz, and occasionally into rather typical or ordinary quartz veins.

Two phases of pegmatite.

In the region embraced by this report, there are two somewhat distinct phases of such rocks. The most frequent and abundant is perhaps represented by the acidic facies of the gneisses constituting the coarser and more felspathic and quartzose bands. These present all the distinguishing characteristics of pegmatite, although occurring in perfect conformity with the prevailing foliation. In composition they show the usual great preponderance of felspar and quartz, with only very occasional flakes of biotite, which in many cases has undergone notable bleaching owing to the elimination of a considerable proportion of the iron originally present. Such biotite is much paler in colour, with less marked pleochroism, and shows the brilliant chromatic polarization colours, though perhaps in a less degree, so characteristic of the lighter coloured mica. The most frequent and abundant coloured constituent, however, is muscovite, which in some cases, at least, is an original constituent, although a great deal has undoubtedly resulted from the alteration of the biotite. These pegmatitic bands very evidently represent the residual and more acid portions of the magma which have crystallized *in situ*, and may be referred to as examples of what has been called "sedentary pegmatite." They usually show a perfect, though somewhat rapid, transition into the more basic bands immediately adjoining, and are therefore to be regarded as more strictly contemporaneous than those constituting the second mode of occurrence. These are masses or apophyses of residual and consequently more fully hydrated and acid portions of the magma, which have invaded and filled various cracks and fissures occurring in the gneissic *massif* or in the neighbouring clastic rocks. They are usually present in more or less marked conformity with the foliation of the gneissic rocks, but very often fill rifts which intersect this at considerable angles. Although in the detail of their structural relations, many of these occurrences are obviously newer than the associated gneisses, the general examination of the masses throughout the whole area seems to show that they must be regarded as substantially of the same age. The process of crystallization was evidently practically continuous, from the first development of the earlier constituents in the still molten and viscous magma to the filling in of the most minute cracks and fissures by the remaining quartz, marking the final step in the complete solidification of the whole mass. Intimately associated genetically with these pegmatites, are certain veins and even veinlets of quartz,

Composition of pegmatite.

Sedentary pegmatite.

Structural relations.

Relative age.

Method of formation.

sometimes containing felspar, which penetrate and anastamose through the prevailing gneisses as well as through the clastic rocks of this district. These are especially numerous and well developed along the lines of contact between the various plutonic masses and the Huronian clastics, and it seems probable that by far the greater number of these infiltrations of secondary quartz are due to the extravasation and differentiation of the numerous large masses of these deep-seated irruptives exposed so frequently throughout this area.

Origin of some quartz veins.

In those portions of the area coloured as Laurentian, where the rocks present have solidified from a magma more or less homogeneous in composition, the foliation generally present is seen to consist usually of a parallel alignment of the bisilicate individuals, or, at most, of small nests or nuclei composed of an aggregate of scales or fragments of such constituents. Such rocks are in many instances of somewhat later generation than the more evenly foliated gneisses, and frequently contain considerable masses or fragments of these that have been caught up during the irruption of the former. At other times, such homogeneous masses are simply more granitoid portions of the prevailing gneiss, into which they merge both across and along the strike of the foliation, so that both are strictly contemporaneous with one another. The area of granite to the north-east of Lake Temagami, especially in the vicinity of Carrying and Annima-nipissing lakes, has a marked foliated texture, due to the more or less parallel disposition of aggregates of greenish chlorite scales resulting from the decomposition of the biotite originally present. This foliation is more pronounced near the junction with the Huronian slates on these lakes, gradually fading on passing inwards towards the centre of the mass. On Lake Temiscaming, as well as near the south end of Cross Lake, the Laurentian in contact with the breccia-conglomerate of the Huronian is a massive granite, very poor in bisilicates, but which gradually merges southward into very typical and evenly foliated gneiss, showing the usual alternating sequence of acidic and basic material. In the vicinity of Lake Nasbonsing, the rock, wherever exposed, is a massive flesh-coloured gneiss, very rich in orthoclase and microcline, while the foliation is produced by the parallel disposition of a rather sparing quantity of hornblende and garnet. This rock passes by insensible gradations into the more evenly foliated varieties exposed on the north shore of the lake between Nasbonsing and Bonfield stations, although in the vicinity of Bonfield station itself, the rock is so massive that little or no structural details could be traced.

Foliation of homogeneous gneisses.

Relative age.

Granite around Annima-nippissing Lake.

Laurentian on Temiscaming and Cross Lakes.

Gneiss of Lake Nasbonsing.

Where greater heterogeneity in the original composition of the magma has prevailed, the foliation present shows a corresponding

Foliation of gneisses of heterogeneous composition.

increase in the perfection of its development, consisting as it does of alternating bands of lighter and darker coloured material, representing numerous varietal forms of rock-types which may be referred respectively to either the acidic or basic groups already mentioned. This foliation it is which generally characterizes the rocks exposed in the area covered by the accompanying map-sheets.

Structural relations.

The component bands are of variable thickness. Occasionally there is an exceedingly sharp line of demarcation between the alternating folia, but as a general rule there is a complete, though somewhat rapid transition from one to the other. Even in their subordinate arrangement the constituent bands show the same marked tendency towards parallel arrangement, and a thick bed of prevailing felspathic composition will, in cross section, present short dashes or small patches of biotite or hornblende all drawn out in one direction; while, on the other hand, the more basic portions show a similar definite arrangement of long lenticules of lighter coloured material, in which a relatively greater amount of felspar or quartz is present. The continuity of these folia, both large and small, is broken at frequent intervals, sometimes abruptly, but usually by a gradual thinning out in either direction. Frequently, before such interruption takes place, bands of essentially similar composition may be formed immediately above or below, which in turn pinch out in both directions to be again replaced by others. This irregularity in horizontal arrangement is equally true of their downward or vertical extension, so that the whole section, of even a small area of any such rock-exposures, presents an exceedingly complicated arrangement of lighter and darker material of greatly varying acidity and basicity. It is quite evident from their macroscopic arrangement, that their formation was attended with an extremely gradual diminution of temperature, for the frequent absence of sharp lines of demarcation between these bands of widely different composition, seems to point to the re-absorption by the later and more acid portions of the magma of the first formed or faster cooling basic portions, perhaps many times repeated before the final consolidation of the whole mass.

Method of formation.

Dynamic action.

In many places, the dark bands evidence the action of extensive crushing and crumpling, showing that great movements have taken place in the whole series. These movements were doubtless approximately synchronous, and closely connected with the invasion and cooling of the more acid portions of the magma. The most curious and complicated structures are thus often produced, this complexity being enhanced by the frequent dislocation, accompanied sometimes by considerable separation and displacement, of those portions which evidently existed originally in unbroken continuity. Such intricate structures are, however, usually extremely local in their development, the gneiss elsewhere in the vicinity often showing little or no sign of extreme disturbance. Although, as a general rule, the direction of this foliation shows a marked uniformity over large areas, there is a considerable diversity in arrangement in this regard, as indicated on the accompanying maps.

Mode of occurrence.

A careful correlation of the many observations made, shows clearly that these gneissic rocks occur for the most part in the form of large rudely oval or concentric masses whose longer axes have in general a direction according with the prevailing strike of the foliation. Frequently such large ovoid masses present quaquaversal dips, which in cross-section simulates the ordinary anticlinal arch. About a mile east of Mattawa station, the Canadian Pacific Railway cuts through a small dome of these gneissic rocks, composed of beautifully sharp alternating felspathic, micaceous and quartzose bands, showing a remarkably perfect example of very pronounced differentiation. The section as presented on either side of the railway track, presents a marked resemblance to a low anticlinal dome. Plate III. The truly igneous character of the composing rocks, however, would not permit of such an interpretation. In size these ovoid masses vary greatly, some of the curvings belonging to ellipsoids many miles in diameter while others are a mile or less in diameter.

Structural features.

Dip.

As a rule the folia or *laminæ* have a prevailing dip to the south-east or south, which is singularly uniform over large areas. This inclination is generally rather steep, usually considerably over 45°, while, frequently, as in many places along the shores of Lake Temiscaming, the foliation is almost, if not quite, vertical. On Seven League Lake and southwards to Mattawa, as well as westwards to Tomiko Lake, the bands frequently succeed one another in almost horizontal succession, the dip, if any, being generally southwards at a low angle. Even in this area, however, there are frequent exceptions to this rule, and the rocks often show a rapid change in this prevailing horizontality as though the bands had been subjected to frequent disturbances and dislocation during the progress of their formation. Thus in the vicinity of North Bay and the northern portion of Lake Nipissing, the gneisses often approach a vertical attitude, while on the southern shores in the vicinity of French River, similar rocks are nearly horizontal.

PETROGRAPHY OF THE LAURENTIAN.

Work by Messrs. Ferrier and Barlow.

The petrographical work done in connection with the present report was carried out with the co-operation of Mr. W. F. Ferrier, Lithologist to the Geological Survey, to whom credit must be given for many of the results obtained.

The writer and Mr. Ferrier worked in conjunction on the problems involved and with so free an interchange of ideas throughout, that no attempt will be here made to separate the examinations, more than to mention that many of the more critical specimens were made the subject of special study by Mr. Ferrier.

Object of studies.

The main object of these detailed studies has been, not only to obtain more accurate information with regard to the composition and minute structures of the various rocks, but also to gain an increased knowledge of their origin and the relationship existing between the alternating bands of relatively greater or less basicity.

Classification of gneisses.

Incidentally, a table has been prepared, showing a classification of these old crystalline rocks, displaying not only their composition, but also their close affiliation with one another. This table may recommend itself to petrographers, as it has done to the authors, and it is hoped may be found of material use in future work undertaken in areas of similar Archæan gneissic rocks.

Much microscopical work has also been accomplished in connection with a series of specimens taken as illustrative of the various contact phenomena exhibited along the line of junction between the Laurentian and Huronian. This has enabled a more accurate interpretation and description of the various facts having reference to the relative ages of these two series of rocks. Field-work, no matter how careful or extended, in areas characterized by the presence of Archæan strata, must of necessity lose much of its value if unaccompanied by concurrent petrographical studies. In the present instance, the results have been adduced, not only from a critical and extensive examination of the numerous rock-exposures in the field, but also by a careful correlation of the facts thus ascertained with those acquired in the petrographical laboratory.

Classification.

Principle of classification.

Any system of classification applied to such a series of foliated rocks must, necessarily, in some respects, be unsatisfactory; but a grouping together according to their mineralogical composition seems on the whole to be the best that can be adopted in the present state of our knowledge.

As already stated, however, there can be no doubt that all of the petrographical types represented in the gneisses from this region are allied in their chemical composition and mineral constituents to such plutonic igneous rocks as granite, syenite, diorite, gabbro, etc., but, as might be expected, there is a passage from one rock-type to another, sometimes gradual, sometimes very abrupt, according to the abundance or scarcity of certain minerals.

Object of classification.

It must be borne in mind that the classification here adopted is an arbitrary one, based on the mineralogical composition of the rocks, and to a certain extent on variations in their structure, the object being, excluding theoretical considerations, to establish certain well defined petrographical types that have been found to be constant in the area examined, and to which specimens from other districts may be referred.

No attempt has been made to examine minutely all the specimens collected, but good examples of the more prevalent types have been selected and described in detail.

Gneisses divisible into two great classes.

As previously stated, the gneisses of the region may be placed in two great divisions, the acidic, characterized by orthoclase as the predominant felspar, and the basic, by the predominance of plagioclase. Biotite is by far the most abundant ferro-magnesian constituent of the first division, and hornblende of the second.

Acidic gneisses divided into seven groups.

The first division may be subdivided into seven groups, dependent on the presence of one or other of the coloured constituents. Arranged, approximately, according to frequency of occurrence in the collection, they are as follows :—

1. Gneisses characterized by the presence of biotite and primary epidote.

2. Gneisses in which biotite alone is present.

3. Gneisses in which both biotite and muscovite occur.

4. Gneisses in which hornblende accompanies the micas.

5. Gneisses in which cyanite, graphite, garnet, etc., accompany the biotite.

6. Gneisses in which hornblende alone is present.

7. Gneisses in which muscovite alone is present.

The relationship of these rocks to their analogous massive types may be seen by reference to the accompanying table.

Two varieties of basic gneisses.

Of the second division, the basic, or hornblende gneisses, two varieties may sometimes be distinguished, first, those which represent seggregated bands of the more basic material of the original granitic magma, and secondly, those which are undoubted basic eruptives folded-in with the more acidic gneisses.

It is not always possible to make this distinction, but examples of each of these two varieties have been observed.

Classified according to their mineralogical composition they naturally must be placed close to each other.

No arbitrary line possible.

Amongst the first, whilst certain names have been applied to individual specimens, it is manifest that no hard and fast lines can be drawn in the field. For instance, a band of which one portion would have the mineralogical composition and characters of a quartz-mica-diorite may pass insensibly into material having all the characters of a hornblende-granitite, according as the plagioclase diminished and monoclinic felspar increased in quantity.

Absence of augite.

One remarkable fact in connection with these basic bands, is the great scarcity in them of augite, none of the hornblende containing cores of that mineral, or affording any direct evidence of having originated from it.

In the Laurentian area lying to the north of the Island of Montreal, recently described by Dr. Adams,* on the contrary, the basic bands in the gneiss appear to consist largely of pyroxene rocks.

I.—The Granite-gneisses.

Orthoclase gneiss.

In colour these rocks range from a light-gray to a decided red. The red rocks represent what has usually been called by the older writers on the Archæan, the "red orthoclase gneiss," but we find in the field every gradation from the gray to the red gneiss, the one passing imperceptibly into the other in many localities, and the microscopical examination has failed to detect any essential point of difference between these two varieties.

Composition.

The red gneisses contain a large quantity of hydrous iron-oxides distributed through them, to which the coloration is due, and they

*Annual Report, Geol. Surv. Can., vol. VIII. (N.S.), Part J., 1896.

also appear to have a larger proportion of microcline than the gray ones. Plagioclase was not observed to exist in any greater quantity in the gray varieties than in the red ones.

Many of the more altered mica-gneisses have assumed a dark-green colour, owing to the chloritization of the biotite, but microscopic examination shows that they may be included in the same class as the typical unaltered ones. Chloritization of biotite.

These chloritized mica-gneisses have been frequently, though erroneously, spoken of as hornblende-gneisses by the earlier geological observers in this region, who were misled by their colour, and had not the advantages afforded by microscopical examination of the rocks. A remarkable feature of these gneisses is their comparative freedom from iron ores.

When pyrite occurs, it is almost always associated with large clove-brown sphenes.

In the case of the micaceous gneisses, *i.e.*, those in which biotite alone, or biotite and muscovite together constitute the predominating ferro-magnesian constituents, hornblende was observed in only two instances, and then in minute quantities. Scarcity of hornblende.

The almost total absence of augite from these rocks is to be particularly noted. Even in the basic hornblende-gneisses of the region, this mineral is very rarely, if ever, to be found.

A. *Biotite-muscovite gneisses*—(*Granite-gneiss*).—The rocks grouped together under this heading are, like the other gneisses, holocrystalline and granitic in their structure. Both biotite and muscovite are present as the chief, and in fact almost the only coloured constituents. These two micas occur intergrown with each other in aggregates of broad fresh plates. The specimens representing this rock-type are, apparently, not very numerous in the collection. Those examined are remarkably free from epidote, iron ore and titanite. Structure. Composition.

Orthoclase and microcline are the predominating felspars, and granophyric intergrowth of the quartz and felspar is a common feature.

B. *Muscovite-granite-gneiss*—(*Pegmatite in part*).—The rocks thus designated and classified, are of comparatively rare occurrence as strictly integral portions of the gneissic complex, and where present constitute the latest secretions from the original magma.

In reality they represent interfoliated bands of pegmatite, although of much finer texture than the rock to which that name is usually applied. In colour they are white, light-gray, or pale-pink, presenting glistening or pearly cleavage planes. Under the microscope they present the usual interlocking holocrystalline aggregate of quartz, orthoclase, plagioclase (oligoclase) and microcline, with a smaller amount of sericite (hydrous muscovite) arranged in long drawn-out scales, and plates which traverse the rock in curving and approximately parallel bands. A small quantity of epidote and zoisite in crystals and grains, some of which may be primary, is associated with small scales of sericite, the latter, at least, being one of the products of the incipient decomposition of the felspathic constituents. Occasional small flakes or scales of a much bleached biotite occur, some of which form a parallel intergrowth with the muscovite. The specimens examined have undergone extensive deformation, as a result of pressure subsequent to the cooling of the rock, and both felspar and quartz have suffered a somewhat marked granulation, while the surviving individuals of both these minerals exhibit wavy extinction rather perfectly. Some of the muscovite is doubtless of primary formation, although some has evidently resulted from the shearing of the felspar.

Composition of muscovite-granite-gneiss.

Granitite-gneisses.

C. *Biotite-granite-gneisses—(Granitite-gneisses).* Var. (*a*) Biotite-epidote-gneiss.—The combination of biotite and epidote as the principal coloured constituents, forms a well defined rock-type which has been found to be remarkably constant over large and widely separated areas, and is the one which is represented by the largest number of specimens.

Biotite-epidote-gneiss.

These rocks are undoubtedly of irruptive origin, and are, in fact, foliated granitites, thoroughly holocrystalline and granitoid, varying from coarsely to finely crystalline; the constituent minerals being, as a rule, equally developed on all sides.

Biotite-gneiss.

Var. (*b*) Biotite-gneiss. These are foliated, holocrystalline, granitic rocks in which biotite alone, or accompanied by very trifling quantities of secondary epidote, is the ferro-magnesian constituent.

In the specimens of this type of rock which have been examined, the mineral does not occur, as a general rule, in aggregates of broad plates, but in isolated independent ones, which have an approximately parallel arrangement, determining the foliation of the mass.

Biotite-cyanite-gneiss.

Var. (*c*) Biotite-cyanite-gneiss. This gneiss, though somewhat remarkable in its mineral composition, in that it contains cyanite, garnet, and graphite in addition to the biotite which chiefly characterizes it, does not present any evidence whatever, either in its microscopical structure or its field relations, of any other than an irruptive origin.

It is a perfectly fresh, holocrystalline, foliated granitic rock, and possesses in its structure no features which would at all suggest re-crystallization. It seems to be a peculiar local phase of the prevalent biotite-gneisses of the region, differing in no way from them as regards origin.

A somewhat similar gneiss from near Wahnapitae station, in the Sudbury district, has recently been petrographically described by Dr. T. L. Walker,* who, however, says little regarding its microscopical character and field relations, beyond assigning it to the Laurentian, and stating that he regards it as a "true gneiss" and not a crushed granite. Description of gneiss by Dr. Walker.

Var. (*d*) Hornblende-granitite-gneiss.—The rock thus classified differs but little in microscopical character from the ordinary micaceous form of the granitites, although usually darker in colour and more basic in appearance. It shows a transition on the one hand into granitite containing biotite alone as the coloured constituent, which is the prevailing type of these gneissic rocks, and on the other, into hornblende-granite-gneiss, which latter facies is of rather rare occurrence throughout the district. In all previous descriptions the hornblende-granite-gneiss has been reported as the variety most commonly present in the Laurentian, the mistake having undoubtedly arisen from the frequent chloritization of the biotite originally present in the prevalent granitite, the individuals showing the more advanced stages of decomposition bearing a marked macroscopical resemblance to those of the ordinary green trichroic hornblende usually noticed in these Archæan rocks. The rock presents the usual reddish or grayish colours, and, where highly differentiated, exhibits the usual interfoliation of lighter and darker coloured bands, although the lenticular areas or patches of the former are relatively less abundant and of smaller extent than those of darker hue. The structure of the rock is holocrystalline; it is composed of quartz, orthoclase, plagioclase, microcline, biotite and hornblende as the chief or essential constituents, together with a much smaller quantity of ilmenite (in part altered to leucoxene) magnetite? sphene, epidote, apatite and zircon, as accessory or accidental constituents; while chlorite, calcite, and sericite usually occur in more or less abundance as secondary products of decomposition. Hornblende is

Hornblende-granitite-gneiss.

Composition and structure

*Geological and Petrographical Studies of the Sudbury Nickel District. Quart. Journ. Geol. Soc., vol. LIII., p. 42, 1897.

the most abundant ferro-magnesian mineral in the more basic portions, while biotite predominates in the lighter coloured patches. The rock presents no unusual features as regards crush phenomena, the component individuals of felspar and quartz usually showing little evidence of having been subjected to any very considerable pressure subsequent to consolidation.

Hornblende-granite-gneiss.

D. *Hornblende-granite-gneisses.*—This facies of rock seems to be of rather limited and rare occurrence in the district under description, and the specimens from which the thin sections were prepared for purposes of study were obtained in close proximity to masses of basic pyroxenic or hornblendic material. Their composition and association has suggested that the rock may represent a commingling or transference of material through fusion of the substance of both rocks. The rocks thus classified resemble very closely the hornblende-granites, with which they are intimately related. The most common of the essential constituents are quartz, orthoclase, microcline, plagioclase and hornblende, with sphene, apatite, iron ore, zircon, epidote and garnet as accessory minerals.

The colour varies greatly, depending largely on the composition, the more basic portions being dark-greenish to almost black, while the acidic bands are grayish or reddish.

Certain of the more massive and homogeneous varieties of these rocks have a distinct flesh-red colour, with a greenish tinge given by the prevalence of the hornblende.

In common with the rest of the gneisses, these rocks have been subjected to pressure of varying intensity, resulting in the granulation of the quartz and felspar.

II.—Syenite Gneisses.

Syenite-gneiss

These do not appear to have many representatives amongst the rocks of the region. Those observed correspond to the mica-syenites of the massive plutonic igneous rocks and may be termed :—

Mica-syenite-gneiss.—This is a holocrystalline, foliated rock characterized by the almost total absence of quartz, and the presence of biotite as the principal ferro-magnesian constituent.

Orthoclase is the prevailing felspar in the typical examples, but in the one specimen which was examined a plagioclase (oligoclase or albite) was found to constitute nearly 50 per cent of the felspar present in the section.

These rocks are undoubtedly the foliated equivalents of the massive mica-syenites, which, as is well known, frequently contain a considerable quantity of albite in addition to the orthoclase and biotite.

III.—Diorite Gneisses.

Var. (*a*) *Quartz-mica-diorite-gneiss.*—Macroscopically, this rock is of a dark-gray, almost black colour, very evenly foliated, and presenting brightly glistening cleavage surfaces. Sometimes very narrow interfoliated bands are more acid in composition, and have a reddish or grayish tinge owing to the presence of a considerable quantity of felspar and quartz, more or less stained by hydrous oxide of iron. Diorite-gneiss

Both in the field and under the microscope, these are seen to merge gradually into the more basic varieties of the granite-gneisses, from which they differ chiefly in that the orthoclase is replaced by plagioclase as the predominating felspathic constituent, while hornblende, instead of biotite, is present as the principal ferro-magnesian mineral. Biotite, as well as quartz, is invariably present, the latter mineral occurring in considerable quantity, even in the most basic phases of the rock, while both these minerals are always abundant enough to characterize it. The constituent minerals are essentially identical with those noticed as present in the more basic types of granite-gneiss, differing only in the order of their relative abundance and importance. The coloured constituents. such as hornblende, biotite and sphene, make up the greater part of the rock, which is relatively much poorer in felspar and quartz, the most important and abundant minerals in the granite-gneisses. The essential constituents usually noticed are plagioclase, orthoclase, quartz, hornblende and biotite. Microcline is very often present in subordinate amount. Primary epidote, in very sharp idiomorphic crystals, embedded chiefly in unaltered biotite, and sometimes penetrated by wedge-like crystals of sphene or titanite, was frequently noticed. Of the accessory minerals, sphene, apatite and zircon are almost invariably present, while pyrite, magnetite, limonite, epidote and allanite likewise sometimes occur. These basic bands are undoubtedly integral portions of the same magma from which the more usual or prevailing granite-gneiss has solidified. Composition of the quartz mica-diorite gneiss.

Var. (*b*) *Dioritic Gneiss: Amphibolite.*—It has been thought advisable for the purposes of distinction to use this term "dioritic gneiss," not as implying any difference in origin, but simply denoting that the rock thus classified does not form an integral or highly differentiated portion of the same magma from which the ordinary gneisses have solidified. It frequently occurs interfoliated, and often in dyke-like forms, Amphibolite.

evidently representing portions of some pre-existing basic irruptive which has undergone excessive crushing, and consequent recrystallization, as a result of the subsequent intrusion of the associated gneissic rocks classified as Laurentian. Macroscopically, these rocks are fine-grained, very dark greenish-gray (almost black) in colour, with distinct foliation and schistosity. When broken, the fresh surfaces show brightly glistening crystals, and plates of hornblende and mica. The rock examined is composed chiefly of compact green trichroic hornblende and plagioclase. As is often the case with rocks which have undergone similar extensive recrystallization, the triclinic felspar present is very clear and glassy, showing a frequent and marked absence of the twinning or pressure lamellæ. When these are present, however, the extinction-angles shown are those characteristic of labradorite, while some of the unstriated grains may possibly represent orthoclase. The quartz present is proportionately very subordinate in quantity, and is often with difficulty distinguishable from the clear and sharply extinguishing felspar. The biotite present occurs in intimate association with the hornblende, sometimes forming parallel intergrowths with this mineral; garnet and ilmenite, the latter mineral often surrounded by sphene, are likewise present. In several instances, the same rock was traced directly and continuously into larger areas of practically unaltered gabbroic or diabasic material, of distinctly earlier genesis than the gneiss in which they are embedded.

Minerals of the Gneissic Rocks.

Minerals present in the gneisses.

The minerals observed in the acidic and basic gneissic rocks are the following:—

Quartz	Calcite	Limonite
Orthoclase	Sericite	Zoisite
Microcline	Apatite	Talc
Plagioclase	Titanite	Tourmaline
Biotite	Zircon	Allanite
Hornblende	Garnet	Rutile
Epidote	Magnetite	Cyanite
Muscovite	Hæmatite	Graphite
Chlorite	Ilmenite	Fibrolite
Pyrite	Leucoxene	Augite

Of these the quartz, orthoclase, plagioclase, biotite, hornblende, epidote and muscovite may be regarded as essential, and the remainder either accessory or secondary constituents.

Classification of Gneissic Rocks mapped as Laurentian on the Nipissing and Temiscaming Sheets (Nos. 131 and 138), showing their relations to the Normal Massive Types of Igneous (Plutonic) Rocks.

A. MASSIVE IGNEOUS (PLUTONIC) TYPES.			B. GNEISSIC EQUIVALENTS.	
ACIDIC DIVISION.				
I. GRANITE.	Granite, proper.	=	A. Granite-Gneiss.	
	Muscovite-Granite.	=	B. Muscovite-Granite-Gneiss.	
	Granitite.	=	C. Granitite-Gneiss.	
			I. Micaceous.	
			var. (a) Biotite and Epidote.	A_1 Fresh and unaltered. Epidote nearly all primary.* B_1. Crushed and altered. Much secondary epidote.
			var. (b) Biotite with little or no Epidote.	
			var. (c) Biotite, with Cyanite, Garnet, Graphite, etc.	
			II. Hornblendic.	
			var. (d) Hornblende and Biotite.	
	Hornblende-Granite.	=	D. Hornblende-Granite-Gneiss.	
II. SYENITE.	Mica-Syenite.	=	Mica-Syenite-Gneiss.	
BASIC DIVISION.				
III. DIORITE.	Mica-Diorite.			
	Quartz-Mica-Diorite.	=	Quartz-Mica-Diorite-Gneiss.	Var. (a) Quartz-mica-diorite-gneiss, integral and extremely basic portions of the same magma from which the more common granite-gneisses have solidified. Var. (b) Dioritic Gneiss=Amphibolite, representing interfoliated basic irruptives, which, of earlier genesis, have been crushed and recrystallized by the intrusion of the ordinary or prevailing gneissic rocks.

* Primary epidote is present in both A_1 and B_1, but in B_1 it is largely mixed with secondary epidote derived from the alteration of the felspar. Primary epidote is likewise very constantly present in the Quartz-mica-diorite-gneisses, the crystals being both sharp and perfectly developed.

Quartz.—This is, in general, a very abundant mineral in the gneisses of the district. Only in a few cases were granitic specimens observed in which the absence of quartz would lead to their being grouped with the syenites. It enters largely into the composition of the basic rocks, allying them to the quartz-diorites and quartz-mica-diorites. In its general character it does not differ from the ordinary granitic variety, but is, of course, much crushed, stretched and granulated in those gneisses which have been subjected to intense dynamic action. Quartz.

It appears to fill in the spaces between the felspars of the rock, and, consequently, to have crystallized out of the magma after they were formed. This is especially noticeable in many of the basic or dioritic gneisses. Distinct crystals of quartz have not been observed in the rocks examined, the mineral occurring in the form of irregular grains.

The quartz grains, as usual, always exhibit the effects of dynamic action in a much more marked degree than do the felspars. A granophyric intergrowth with felspar is of very common occurrence. Inclusions are frequent. Sometimes the quartz occurs in grains scattered through hornblende, the individual grains having no regular arrangement or orientation with respect to one another or to their host. Such a structure has been named "poikilitic" by the late Dr. George H. Williams.*

Orthoclase.—This is the most abundant of the felspars which occur in these rocks. It usually forms irregular grains interlocked with the other felspars and quartz, although in a few instances porphyritic individuals occur, which are sometimes twinned. It is seldom quite clear and fresh-looking, but usually turbid in appearance, and more or less filled with little scales of sericite and granules and crystals of epidote and zoisite, the products of its decomposition. Orthoclase.

In those specimens representing rocks which have evidently been subjected to intense dynamic action, the orthoclase shows a marked tendency to pass into microcline. Inclusions of the other minerals present in the rock are of frequent occurrence, and intergrowths with triclinic felspars were also noted. It is often stained with hydrous oxides of iron, giving brownish or reddish tints to the rock. In common with the other felspars, it has escaped to a large extent the results of dynamic action, rocks in which the quartz has been completely granulated frequently preserving large grains of the felspars which

*On the Use of the Terms Poikilitic and Micropoikilitic in Petrography; Journal of Geology, vol. I, No. 2, pp. 176-179.

show only a few cracks and a more or less pronounced undulatory extinction.

Microcline.

Microcline.—This is a very abundant constituent of the granitic gneisses, especially of those which have been greatly crushed and granulated. Teall has recently announced that the result of his investigations of the microcline in the older Deeside (Cairnshee) granite of the Highlands of Scotland "lend no support to the view that microcline may be developed from orthoclase by dynamic or any other action, but are in accordance with the theory of Michel Lévy and Mallard, that orthoclase is microcline in which the polysynthetic twinning is on a sub-microscopical scale."

Origin of microcline.

The constant relationship which exists between the quantity of microcline in a given rock and the degree of pressure to which the rock has been subjected, as brought out by microscopic examination, is of too marked a character to be ignored, and instances may frequently be observed, where, when a large individual of orthoclase has been peripherally granulated, the fragments detached from the parent individual show to perfection the typical cross-hatching of microcline, whilst the centre is quite free from striations and exhibits the ordinary characters of orthoclase. There is not, in such instances, a gradual transition from one structure to the other, the cross-hatching in the detached bit of granulated material next to the parent individual terminating as abruptly against the fractures which separate them from it as do the striæ induced by pressure in a plagioclase individual, against cracks traversing the crystal. Where evidences of pressure are unmistakably present, but fracturing has not actually taken place, the gradation may be seen from the normal orthoclase, through a "moire structure" to the typical cross-hatching. Plate IV, Figs. 2 & 3.

Thus, whether microcline and orthoclase be identical or dimorphous (a question which cannot be discussed here) the scarcity of the former in unaltered rocks, and its marked abundance in those which have been subjected to pressure, together with the peculiar manner in which it has been observed to occur in individual instances mentioned above, seems to prove rather conclusively that microcline structure at least can be, and is, produced in the felspar now known as orthoclase and not showing that structure, as the result of pressure. It seems, too, reasonable to suppose that, if orthoclase be microcline with a sub-microscopic twinned structure, we should find various gradations in the same section from the microscopically invisible structure, through exceedingly fine striation, to the distinctly visible, and sometimes quite coarse structure, characterizing what we call microcline.

Instead of this we find that, when a crystal which we call orthoclase is subjected to pressure, a peculiar wavy structure appears in it, analogous to the strain shadows of quartz as seen in the thin section; the grain or crystal, when carefully examined under the microscope, being evidently under strain and undergoing deformation. This wavy structure gradually merges into the typical cross-hatched one. In fact, many of the arguments advanced, and facts cited in favour of the theory that microcline and orthoclase are identical, seem to point strongly to the conclusion that this is not the case, but that microcline represents a re-arrangement of the orthoclase molecule induced by pressure.

Cases where areas of felspar with typical microcline structure occur, included in unaltered and uncrushed orthoclase individuals, may be regarded as analogous to intergrowths of the ordinary triclinic and monoclinic felspars.

Plagioclase.—In the granitic and syenitic gneisses, plagioclase is tolerably abundant, in the case of the mica-syenite-gneiss from Cross Lake, constituting nearly one-half of the felspar present. No direct chemical determinations have been made, but when the angles of extinction have been measured, these indicate that the felspar is either an oligoclase or an andesite. Plagioclase.

As a general rule, the proportion of the plagioclase present increases with the basicity of the rock, and it, of course, predominates in the diorite-gneisses of the region. In these rocks it is, apparently, chiefly a labradorite. It is usually well twinned, this twinning being due to pressure in many cases.

Alteration to calcite was frequently observed, also typical saussuritization of the more basic varieties, with formation of zoisite, epidote and sericite. Poikilitic and micropoikilitic structures are sometimes seen.

In some of the basic gneisses which may possibly have resulted from the metamorphosis of a basic irruptive, the felspar is frequently very clear and glassy, with numerous unstriated grains which are, however, probably plagioclase. It is somewhat difficult, in such cases, to distinguish between the glassy felspar and the quartz.

Biotite.—This is by far the most abundant ferro-magnesian constituent of the granitic and syenitic gneisses, and also enters quite freely into the composition of the basic varieties. The primary biotite occurs in two forms, as large, broad plates aggregated together, and as isolated smaller plates, having a general parallel arrangement in the rock. Biotite.

Crystals with perfect crystallographic boundaries were not observed. Mechanical deformations of the plates are well seen in the rocks which show the general effects of dynamic action.

In most instances, it is remarkably fresh and is intimately associated with epidote, large, fresh, isolated crystals of which are frequently inclosed in the unaltered biotite. In colour it is usually a deep reddish-brown, in some cases inclining to a copper-red, and is very strongly pleochroic, from pale straw-yellow to a deep reddish-brown. When more or less altered to chlorite it assumes various tints of green.

Occasionally, in the hornblende-granite-gneisses and diorite-gneisses, it is intimately associated with the hornblende. In those rocks which contain both micas, the biotite and muscovite occur intergrown with each other, the plates of each variety being sharply defined.

Frequently, however, by a leaching-out process, the iron has been so far removed from the biotite as to cause it to assume a very light colour, indeed in some sections it is difficult to determine whether certain individuals are to be regarded as bleached biotite or as original muscovite.

In addition to the biotite which is of undoubted primary origin, little scales of secondary biotite may often be observed developed along shear-planes in certain of the greatly crushed and stretched gneisses. The biotite holds numerous inclusions of apatite, zircon, etc., which are commonly surrounded by dark, pleochroic halos.

Hornblende.

Hornblende.—This appears to be a comparatively rare mineral in those granitic and syenitic gneisses which have been examined from this region. In two instances it is tolerably abundant, but in most cases where it has been observed, only one or two minute grains could be detected in a single thin section of the rock.

In the basic or dioritic gneisses it is of course a very abundant mineral. In these rocks it occurs as the compact variety chiefly actinolitic forms being rare. It forms, as a general rule, rather irregular individuals aggregated together, although occasionally some may be seen having well defined crystallographic boundaries.

Absorption.

It possesses good cleavage and is very strongly pleochroic. The absorption is usually $\mathfrak{c} > \mathfrak{b} > \mathfrak{a}$ generally $\mathfrak{a}$ greenish yellow $\mathfrak{b}$ =dark yellowish-green, and $\mathfrak{c}$ = deep bluish-green. Twinning is a common feature of the mineral.

The hornblende is always intimately associated with the biotite and epidote when these latter minerals are present in the rock. In several instances the extinction angle was measured and found to vary from $17\frac{1}{2}°$ to 19°.

Inclusions of felspar, quartz, zircon, apatite, titanite, etc., are very common and are frequently arranged in such a manner as to give to the hornblende-gneiss a typical micropoikilitic structure. Plate II., Fig. 1. As in the case of the biotite, the inclusions of apatite and zircon are often surrounded by well defined pleochroic halos. Alteration to chloritic and epidotic material was observed, accompanied by the deposition of carbonates.

No instances of augite cores occurring in the hornblende were noticed, nor any direct evidence of the latter mineral having originated from the former; although in some few instances this might be suspected, from the fact, that the interior of the crystal is of a paler colour than the exterior portion.

Epidote.—Next to the biotite, this is by far the most abundant of the coloured constituents of the granitic gneisses, and it also enters largely into the composition of the more basic hornblendic ones. In addition to the ordinary occurrence of the epidote as an alteration product, we have also the strongest evidence that it exists in a large number of cases as an original and important constituent of the rock mass. Epidote.

The manner in which the perfectly fresh crystals, possessing sharply defined outlines, occur inclosed by wholly unaltered biotite in rocks which have been subjected to only a slight degree of pressure, admits of no reasonable doubt as to their primary nature. An inspection of the accompanying plate, (Plate II., Fig. 2) will bring this point out very clearly. The mineral is usually of a bright yellow colour, very strongly pleochroic, and possessing the usual high relief and brilliant polarization colours, except in sections parallel to the orthopinacoid, which exhibit bluish and yellowish tints between crossed nicols. It occurs both in crystals and irregular grains, the former often having, as already stated, very sharply defined outlines.

The corrosion phenomena noted by Dr. Adams, in epidote from the Yukon River,* are shown to perfection in some of the individuals. The crystal sections are usually bounded by the prism planes M, r, and T. Good cleavages were observed parallel to M and T, the angle between them being about 115°. Corrosion phenomena

Twins are of common occurrence. The crystals occasionally contain cores of a pleochroic brownish substance which is probably allanite, but no thoroughly typical examples of that mineral were detected.

Nondescript cores, which may represent augite, surrounded by rims of epidote were occasionally seen in the thin sections. Secondary epidote, frequently occurs in the groundmass of the more altered rocks, associated with chlorite, as the result of the mutual reaction of the

*Can. Rec. Sc. vol. IV., pp. 344-358, 1890-91, also Annual Report Geol. Surv. Can., vol. III. (N.S.), Part I, Appendix V (N.S.), p. 237 B., 1887-88.

felspars and bisilicates. It also forms small crystals and granules in the decomposing felspars, together with zoisite, sericite and carbonates, as one of the products of their saussuritization. Many cases occur in highly granulated rocks, where it is almost impossible to say what is primary, and what secondary epidote. Frequently, however, in rocks which have suffered extreme crushing, and are filled with secondary epidote granules, large epidotes may be observed, broken and faulted like the other constituents, proving that they existed before the rock was subjected to the dynamic action.

Muscovite.

Muscovite.—Both primary and secondary muscovite occur in these gneisses, and it is often difficult in a particular instance to determine to which of these two classes the mica is to be referred. Frequently broad fresh laminæ of muscovite are intimately intergrown with deep-brown fresh biotite, and in such cases is undoubtedly of primary origin.

The variety of the mineral referred to here is muscovite proper, occurring in broad plates or laminæ, as distinguished from the fine scales of sericite resulting from the alteration of plagioclase, etc. It possesses the usual bright polarization colours and other physical characters common to the species, and no unusual features were observed in the specimens examined.

Chlorite group.

Chlorite.—(Taken as a general group name).—This is the common alteration product of the biotite and hornblende of these rocks. It polarizes in the usual dull bluish tints.

Many of the gneisses owe their green colour to this mineral, which gives them a very deceptive appearance, acid granitic rocks very often closely resembling, at first sight, some massive altered basic irruptive.

Pyrite.

Pyrite.—Is of common occurrence in all the gneisses, particularly in the more basic ones. The red and brown oxides of iron which so frequently stain the rocks can often be traced to this source.

Calcite.

Calcite.—This mineral is abundant where alteration of soda-lime felspars has proceeded to any extent. In such cases it forms large irregular, brilliantly polarizing patches throughout the thin section.

Its abundance in some specimens, *e. g.*, in the hornblende-granite-gneiss from the south end of Opimika Narrows, is rather remarkable, as this rock does not seem to have been greatly altered. In such instances it may possibly be of primary origin.

Sericite.

Sericite.—This is an abundant product of the saussuritization of the felspars, forming fine, brilliantly polarizing scales, intimately associated with zoisite, epidote, calcite, etc. Some of the material referred to as sericite in the description of these rocks may possibly be talc, as it is difficult to distinguish between these two minerals under the microscope.

Apatite.—This mineral is of frequent occurrence in the acidic and basic gneisses. It is mostly in the form of stout and short or long and slender prisms, but grains with extremely irregular, and more or less rounded outlines also occur. The large stout prisms are especially characteristic of the diorite-gneisses. Apatite.

Titanite (Sphene).—Remarkable crystals of this mineral were observed in some of the rocks examined. They are of unusually large size, deep clove-brown in colour, and intensely pleochroic, and, as is usual in such dark-coloured varieties, exhibit their brilliant interference colours to perfection. Twinning was frequently observed. Sphene.

The mineral is especially abundant in those rocks in whose composition hornblende occupies a prominent place. It occurs in irregular grains of varying size, as well as in the well formed crystals just mentioned. Little crystals were observed penetrating the epidote crystals and also included in hornblende and biotite. It frequently forms fine-grained granular aggregates of considerable size, and is present in nearly all the rocks described, both basic and acidic.

Zircon.—This mineral is also of widespread occurrence in the gneisses. The crystals are usually well developed, and often of large size. When embedded in the biotite or hornblende it is usually surrounded by a pleochroic halo. Zircon.

Garnet.—This is by no means as abundant a constituent of the gneissic rocks of this region as was formerly supposed, although in certain localities it is extremely plentiful. It occurs in the granitite-gneiss containing cyanite, and also in several of the more or less altered basic-gneissic hornblende rocks. It is usually in fresh irregular grains and aggregates, frequently of large size, much fractured, and of a light pinkish colour in thin sections. The optical anomalies which have elsewhere been frequently noted, were not observed in the present instances, all the grains appearing to be completely isotropic. Distinct crystals were very rarely seen. Garnet.

Magnetite.—As stated elsewhere, the scarcity of iron ore in the granitic gneisses is a remarkable feature in their composition. In a few instances isolated grains were tested and found to be magnetic. Magnetite.

Hæmatite.—This is frequently present in the form of thin plates with hexagonal outlines, and in irregular scales. It is often developed along the cleavage planes of the biotite. Hæmatite.

Ilmenite.

Ilmenite.—Generally speaking, this is the iron ore which is present in the diorite-gneisses, and is almost invariably accompanied by its alteration product, leucoxene. It may be regarded as one of the essential ingredients of these rocks. The peculiar brownish tints so often seen in the plagioclase, are probably very often due to dust-like particles of this mineral included in them.

Leucoxene.

Leucoxene.—This is always an alteration product of titanic iron ores or rutile. The grains of ilmenite are sometimes completely replaced by whitish or yellowish, almost opaque masses of this mineral. A peculiar cross-hatched structure was sometimes observed, probably due to sagenitic growth of rutile which previously existed in the ilmenite individual from which the leucoxene was derived.

Limonite.

Limonite.—The irregular deep-brown stains which frequently permeate the various minerals, especially the felspars, are probably in most cases, due to the presence of this mineral.

Zoisite.

Zoisite.—Accompanies epidote as the result of saussuritization of the felspars, usually in quite small individuals which present no unusual features.

Talc.

Talc.—In a few of the more squeezed and altered gneisses, scales were observed which seem to correspond in their general characters with this species, as distinguished from sericite, but it is difficult to discriminate between these two minerals.

Tourmaline.

Tourmaline.—Two or three columnar strongly pleochroic individuals of this mineral were observed in one of the gneisses examined.

Allanite.

Allanite.—Whilst not particularly abundant, many good examples of this mineral were observed, more especially in those granite-gneisses in which idiomorphic primary epidotes are plentiful. It occurs in the reddish-brown pleochroic individuals in the centres of epidote crystals with which it is in parallel orientation. These occurrences are of precisely similar character to those described by Hobbs in the Maryland granites.

Rutile.

Rutile.—This mineral was observed in a few instances in the form of very minute, slender needles penetrating the biotite.

Cyanite.

Cyanite.—Occurs in rather short flat-bladed crystals, which rarely show sharply defined faces in the prism zone, commonly forming irregular columnar individuals. A few of the smaller crystals show terminations, but with very rough faces.

The colour is usually of light-bluish or greenish, but occasional crystals show a deep blue centre with a white margin. Some individuals measure half an inch across and an inch in length. It is best developed in those portions of the rock which are free from biotite, and consequently of a lighter colour. In the darker portions of the rock it is frequently intergrown with the biotite. The individuals are often bent and hold many inclusions, particularly of pyrite, biotite, quartz and graphite.

Under the microscope the sections are transparent, and generally colourless, but patches of a light-blue colour occur here and there. These patches exhibit a pleochroism (light-blue to colourless) which is not noticeable in the colourless portions of the crystals. The cleavage parallel to M and T do not traverse the entire section as a rule. In longitudinal sections the parting parallel to P is also clearly shown. As is invariably the case, the cyanite is accompanied by garnet.

Graphite.—This mineral occurs in some quantity in the cyanite-gneiss, in the form of irregular flakes, rarely with rude hexagonal outlines. A few flakes were observed to be nearly a quarter of an inch in diameter. Graphite.

Fibrolite.—Only a few specimens of the cyanite-gneiss were collected from the cuttings on the Canadian Pacific Railway in the vicinity of Les Erables Rapids and Snake Creek, on the Ottawa River, and these show no fibrolite, but it is almost certain that this mineral, which accompanies the cyanite in the similar rock from near Wahnapitæ station, will be found associated with it in the area. Fibrolite.

Augite.—This mineral, as elsewhere noted, is almost, if not entirely, absent from those gneisses which have been microscopically examined. In certain specimens a few skeleton forms, entirely filled with alteration products, were observed, which may originally have been pyroxene, but this is by no means proved. The hornblende was carefully examined to see if there were any traces of pyroxene cores in it, but no certain evidence of this was obtained, although in some cases it was observed that the exterior of the hornblende individual was of a darker colour than the central portion. Augite.

GRENVILLE SERIES.

The name Grenville Series was the distinctive title applied in 1863* by Sir William Logan to the series of crystalline rocks so extensively and well exposed in the region on the north side of the Ottawa in the vicinity of the Augmentation and village of Grenville. These were referred to as Middle Laurentian and supposed to con- Origin of name.

*Geology of Canada, (1863), p. 839.

formably overlie the Lower Laurentian or Fundamental Gneiss. The rocks thus classified comprise a great variety of gneisses with which are associated considerable volumes of crystalline limestone, and a detailed map was published showing the distribution of the component bands.* Many reasons were adduced as evidence for regarding the whole series as greatly metamorphosed sedimentary strata. These proofs had reference chiefly to the banded or foliated character of many of the composing masses, believed to represent the surviving traces of the parallelism due to original sedimentation, the presence of large and important beds of limestone, together with the occurrence in some of these bands of forms described as representing organisms of low type. Subsequent examination in the field, supplemented by the detailed petrographical studies rendered possible by the recent perfection of the microscopic methods of research, have, however, revealed the fact that, while certain of the fine-grained, light-grayish, rusty-weathering gneisses are closely allied in structure and composition to ordinary shale or slate, other rocks, representing a very much greater volume of the whole series, are undoubtedly the foliated equivalents of the ordinary plutonic irruptives.†

Early misconceptions.

Logan's line of subdivision.

In the area covered by the accompanying map-sheets, the line of subdivision between what has usually been regarded as Lower Laurentian and the Grenville Series, was described by Sir William Logan, in 1844, as occurring somewhere in the vicinity of the Mattawa River. The supposed line of boundary was based on the occurrence at certain points of isolated masses of crystalline limestone, but these have since been found to be in intimate association with rocks which are believed, with some confidence, to be the foliated equivalents of ordinary granites and diorites.

Rocks of Grenville Series.

In the area under description, only one very limited occurrence of the fine-grained and evenly banded light-grayish gneisses usually associated with the Grenville series was noticed, consisting of a small band interfoliated with the ordinary reddish granite-gneisses, a little over two miles east of Rutherglen station on the Canadian Pacific Railway. The strike of this band is about N. 20° W., with a dip to the north-east at a high angle. The hand specimen represents a fine-grained evenly foliated, rusty-weathering, grayish, graphitic gneiss. Under the microscope, it is a fine-grained admixture of interlocking grains of felspar, quartz, and a rather pale-coloured bleached biotite, together with smaller quantities of pyrite, graphite, rutile, and a mineral closely

*Atlas, Geology of Canada, (1863), Map No. 1.

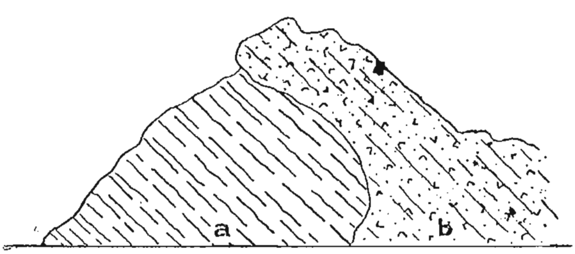
†Adams. A Further Contribution to our knowledge of the Laurentian, Am. Journ. Sci., July, 1895.

resembling zoisite in minute prismatic crystals, arranged in nests composed of aggregates of crystals and crystal fragments running parallel with the foliation. The rock has evidently been subjected to intense and long continued dynamic action, the foliation being pronounced, while the recrystallization has been so complete as to mask much of its original structure. It bears a marked microscopical as well as macroscopical resemblance to the sillimanite gneisses described by Dr. Adams.*

Crystalline limestone on Lake Talon.

The most important band of crystalline limestone noticed in the whole district, occurs at the foot of Lake Talon, an important expansion of the Mattawa River. The presence of this band was first noted by Bigsby† in 1820, and later in 1844, by Logan. Dr. Bell, in 1876, also gave a short description of its mode of occurrence.‡ The rock consists of whitish crystalline limestone with small thickly disseminated specks and patches of green serpentine. It is first noticed on the south side of the lake a short distance above the outlet, occupying the points along the shore, while the massive reddish granitite-gneiss rises into rounded hills behind. The limestone, as far as can be ascertained on account of the massive texture of the gneiss, occurs as an interfoliation, dipping S. 8° E. $<$ 25. Farther down, towards the chute, the rock contains a good deal of serpentine in addition to some other impurities, and occurs seemingly as a large irregular rounded patch in the gneiss. At the narrows, a short distance above the Talon Chute, the contact between the crystalline limestone and massive rather indistinctly foliated red granite-gneiss is well shown, the former dipping N. 74° E. $<$ 20° while the latter, with a nearly east-and-west strike overtops or flows over the mass of the crystalline limestone, the indistinct foliation of the gneiss conforming in general with the line of junction between the two rocks. See Fig. 1.

FIG. 1.



SKETCH SECTION SHOWING STRUCTURE OF CRYSTALLINE LIMESTONE (a) AND MASSIVE RED GRANITITE GNEISS (b) NEAR TALON CHUTE, MATTAWA RIVER.

*Annual Report, Geol. Surv. Can., vol. VIII. (N.S.) Part J.
†Shoe and Canoe. vol. I. London, 1850.
‡Report of Progress, Geol. Surv. Can., 1876-77, p. 207.

Crystalline limestone at Talon Chute.

At the Talon Chute, there are two channels by which the lake discharges into the gorge below. The largest of these channels is situated near the north side, while the southern one has been excavated along a band of ophicalcite, seventy feet in thickness intercalated with the gneiss and dipping in a southerly direction <25°.

Smaller bands and patches of crystalline limestone, likewise occur on three of the Manitou group of islands in the eastern portion of Lake Nipissing. On the west side of the most southerly of these islands, beds of a beautiful light salmon-pink crystalline limestone occur, containing radiating crystallizations of dark-green hornblende, black biotite, and yellowish-green epidote. The strike is about N. 80° E. and the angle of dip is about 65°. This is associated with the prevailing rather fine-grained dark-reddish and green granitite-gneiss.

Crystalline limestone on Manitou Islands.

On the east side of the Great Manitou Island (Newman Island) a few chains south of the north-east point, there is a layer or bed of pinkish limestone, weathering yellow, reddish and grayish. The strike of the dark-red and green granitite-gneiss is about S. 60° E. and the dip south-east <45°. On the west side of the most easterly of the Manitou Islands, about the centre of the island, beds and patches of pinkish and whitish limestone are embedded in the dark-red and green granitite which has a strike of S. 5° E. and a dip to the east <45°.

HURONIAN.

Origin of name.

The name Huronian, was adopted by Sir William Logan and Dr. T. Sterry Hunt in 1855,* to include the clastic rocks believed to overlie the Laurentian gneisses in the districts adjacent to Lakes Huron and Superior.

Use of term Algonkian unnecessary.

The area included by the present report, exhibits large tracts of country underlain by pyroclastic and epiclastic rocks identical in lithological character with those described as Huronian by Murray in 1856. It forms, in fact, the north-easterly extension of the same belt, which has been traced with practical continuity from what is generally termed the "typical" area on the north shore of Lake Huron. The inclusion of these rocks under the name "Algonkian," shows a tendency on the part of some geologists to revert to the erroneous grouping of Huronian, Animike and Keweenawan as integral portions of a single system or series of formations, in spite of the pronounced hiatus known even then to exist, though perhaps not appreciated to its full extent, by Sir William Logan. As has been pointed out by Dr. Dawson† and others, the proposed use of the term

*Esquisse Géologique du Canada. Paris, 1855, p. 29.

†Presidential Address to the Geological Section B.A.A.S., Toronto meeting, 1897

Algonkian in the same extended sense is both unnecessary and misleading, and it should therefore be deprecated. Its adoption disregards not only the zealous and accurate work of many trained observers over extended areas characterized by the presence of these Archæan rocks, and would also supplant a useful and well known term, of which the priority remains unquestioned, by a name which is at once needless and indefinite. No attempt has been made to correlate the rocks here described as Huronian with certain series or groups which have been lately and ably reported upon under the new conditions since the use of the microscope has made an accurate description of the various component rock masses not only possible but imperative. It is also regarded as premature as yet to anticipate the results of further and more complete microscopical and stratigraphical examinations of the Huronian, Grenville, Hastings, Keewatin and Coutchiching series.

No attempt made at correlation with other Archæan groups.

The Huronian rocks, which are extensively and widely developed in the north-western part of the region under description, naturally admit of a three-fold subdivision, the component members following one another in undisturbed succession, each showing a gradual and perfect transition upward into the succeeding member. The rocks occur for the most part in slightly undulating anticlinal and synclinal folds, except in the vicinity of certain large irruptive masses, where considerable disturbance as well as alteration is found, as a result of their intrusion. At the base of the series is a breccia-conglomerate, containing pebbles and fragments, often angular, though usually subangular or rounded in outline, of granitite, diabase, diorite, etc., embedded in a matrix composed of the same materials in a finer state of division, while the more minute interstices are filled up with scales and flakes of chlorite and sericite. Where this matrix forms a considerable portion of the rock, the abundance of these decomposition products gives a prevailing dark-green colour to the whole mass. This rock has in previous reports been referred to as "slate conglomerate" or "chloritic slate conglomerate," a name first proposed and used by Logan.* This coarse fragmental rock passes upward into a dark greenish-gray greywacké or felspathic sandstone, in which few if any fragments are macroscopically apparent. This in turn merges above into an exceedingly compact and fine-grained rock of essentially similar composition, which gradually assumes a banded and slaty character, the planes of cleavage, when present, corresponding in most instances with the evidences of original sedimentation as revealed by the colour stripings. Superimposed upon these, usually without any

Position and composition of breccia-conglomerate.

Greywacké.

Slate or shale.

*Report of Progress, Geol. Surv. Can., 1845-46, p. 67.

Quartzite-grit or arkose.

sharp line of division, although at times there is an abrupt change, is a quartzite-grit, made up chiefly of fragments of granitic quartz with some of felspar, all usually more or less rounded and contained in a felspathic matrix, now largely altered to yellowish-green sericite.

The rock is generally yellowish-green in colour, owing to the abundance of sericite, the scales of which are often macroscopically apparent in the matrix. On this account it has been usual to refer to the rock as a sea-green quartzite. Occasionally it is of a flesh-red colour, when it is with difficulty distinguished from ordinary granite. It occurs in massive much jointed beds, the stratification at times being shown only by a parallel disposition of certain coarser or conglomeratic bands. It is occasionally fine-grained but usually approaches the character of a grit or fine conglomerate.

Early opinions about the source of Huronian sediments.

Until very recently, it was a matter of general belief, based on previous descriptions and reports, that the source of such clastic material was to be traced to the breaking down of the gneissic or foliated crystalline rocks usually classified as Lower Laurentian. The writers repeatedly insisted that gneissic pebbles, distinctly referable to the Laurentian, formed the most abundant coarse fragmentary material in the basal beds of the Huronian. Later geological research in this and neighbouring Archæan areas has shown, however, that such statements are largely erroneous, as foliated fragments are only very occasionally represented and in most cases are entirely absent, while those of a somewhat coarse-grained aplitic granite make up the greater portion of many of these conglomeratic rock masses. The examination likewise of the line of junction between the gneisses and the granites constituting the Laurentian of this district on the one hand, and the breccia-conglomerates and slates of the Huronian on the other, has shown that the former were in a plastic or softened condition after the hardening of the Huronian sediments.*

Most geologists were inclined, despite these opposing facts, to believe that the Laurentian gneisses and granites constituted the original floor or basement upon which the Huronian sediments were deposited and from which their material was derived. The present attitude of these rocks, moreover, was explained as due to the instability of the earth's first-formed crust allowing and favouring a settlement of any overlying clastic material, accompanied as it must have been by frequent and repeated upwellings of the molten magma from beneath. These unsettled conditions were further accentuated by extensive fracturing

* Vide ante, also American Geologist, July, 1890, pp. 19-32. Bull. Geol. Soc. Am., vol. IV., pp. 313-332.

and crumpling as a result of the earth's secular refrigeration, all combining to bring about the conditions and phenomena now witnessed along the lines of junction between the Laurentian and Huronian rocks.

Pumpelly and Van Hise, description of contact near Thessalon.

Careful search has been made for localities in which the underlying basement might have escaped this seemingly wide-spread disturbance, but apparently in vain. Pumpelly and Van Hise* have described what they have called a basal conglomerate reposing upon a fundamental complex of crystalline schists and granite, as exhibited on two small islands near the north shore of Lake Huron, a short distance east of Thessalon, Ontario. A difference of opinion, however, exists concerning the interpretation of this section, and the fact that the granite from which the pebbles in the conglomerate are believed to have been derived pierces and alters the slaty rock overlying the conglomerate, seems to show clearly that the correlation of this granite with that constituting the pebbles in the conglomerate is decidedly at fault.†

Intrusive contact between Huronian and Laurentian not necessarily universal.

In spite, however, of the generally irruptive character of the line of junction between the Laurentian and Huronian, it was confidently anticipated by even those who believed in the intrusive cháracter of the Laurentian gneisses that, in some place an undisturbed contact would be ultimately found. The detailed geological examination of the region to the north-east of Lake Huron, carried on for the last ten years by the author of this report, has furnished abundant proofs of the pyroclastic character of the rocks composing the two lower members of the Huronian. The breccia-conglomerate, greywacke and slates evidently represented the graded forms resulting from the consolidation of volcanic ejectamenta showered out and spread upon the bottom of a shallow ocean, and there somewhat rounded and otherwise modified as a result of aqueous action. In many cases, however, these rocks are so intimately associated with materials resulting from processes of ordinary aqueous erosion and deposition, that, in most instances it is extremely difficult if not impossible to make a separation. The fragments contained in the breccia-conglomerate are, as has been shown, composed of rocks of igneous or plutonic origin and in no way distinctly referable to any Laurentian strata now exposed at the earth's surface in the same area, while the frequent intimate association of this coarse fragmental rock with large masses of diabase, gabbro and

Huronian made up of both pyroclastic and epiclastic rocks.

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*Am. Journ. Sci., III. vol. XLIII, pp. 224-232, March, 1892; also III. vol. XXXIV, 1887, pp. 207-216.

†Am. Journ. Sci., III. vol. XLIV., 1892, pp. 236-239; also Bull. Geol. Soc. Am. vol. IV., pp. 330-332.

granitite, cannot be regarded as merely accidental. The earlier part of the Huronian period in this district was evidently a time of intense and long continued volcanic activity, and the greater portion of the rocks representing this lapse of time are pyroclastic in character.

True sedimentation on a large scale seems only to have been ushered in toward the close of the period, and the quartzite-grits and conglomerates prevailing towards the summit of the series are very typical examples of epiclastic material.

A true basement or fundamental granite on Lake Temiscaming.

The relations found to exist between this arkose and an underlying fundamental biotite-granite or granitite, as exposed on either side of Lake Temiscaming in the vicinity of Baie des Pères, indicate its derivation to be a result of the disintegration and degradation *in situ* of the underlying granite, showing a gradual and uninterrupted passage outward and upward from the parent mass. The nature and import of this passage were the subject of an illustrated paper, prepared by the author and Mr. W. F. Ferrier and presented at the Toronto meeting of the British Association for the Advancement of Science in August 1897.* A short resumé of the interesting phenomena observed has already appeared in the Geological Magazine,† but the details, not only of the field relations of these rock masses, but also of the petrographical examinations will be found in that portion of this report dealing with the geological description of Lake Temiscaming. The relations between this granite and arkose are of rather unusual scientific interest, showing as they do the pre-Huronian existence of a basement or floor upon which these sediments were laid down and which in this portion at least has escaped the movements to which the Laurentian gneisses have been subjected.

The petrographical studies undertaken with the object of determining the origin, composition and minute structures of the various rock masses making up the bulk of the Huronian, have been so numerous and detailed that it is impossible in the present report to give at length the description of each separate slide, especially as many of these prepared from specimens obtained at widely separated localities, were afterwards ascertained to represent rocks presenting no essential points of difference. It will therefore doubtless be found sufficient to give a general description of each of the three members constituting the Huronian, at the same time pointing out the nature of the transitional sequence so frequently witnessed from one rock to the other.

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* On the Relations and Structures of certain Granites and Associated Arkoses on Lake Temiscaming, Canada, Rep. B. A. A. S., Toronto, 1897, pp. 656-660.

† Geol. Mag., New Series, Decade IV., vol. V., No. 1, pp. 39-41, January 1896.

Breccia-conglomerate.

The rock thus designated is identical with the "slate conglomerate" or "chloritic slate conglomerate" of the earlier reports of the Survey, described by Logan as following the Laurentian orthoclase-gneiss on Lake Temiscaming. The new name, as proposed, is preferred as it indicates at once what is now confidently believed to be the true nature and origin of the large and important rock masses to which it is applied. This rock, especially where the finer matrix is abundant, is usually of a dark-greenish or greenish-gray colour, the colour deepening in proportion to the quantity of the greenish decomposition products which may have been developed. The immediate outer coating weathers from yellow through brown to almost black, although certain surfaces not exposed to the continued action of the atmosphere retain a light olive-green appearance. Beneath this dark outer surface, is a layer, usually about one-eighth of an inch in thickness, composed of pale-yellowish decomposed material which evidently represents the usual saussuritic products resulting from the alteration of the large quantity of felspar present in the rock. As a rule, the rock is extremely massive, showing little or no evidence of lamination or stratification, while the coarser fragmental material is arranged in such a heterogeneous manner that it is exceedingly difficult to ascertain with any degree of certainty either the angle or direction of dip. Sometimes, however, it has a slaty or foliated structure as a result of pressure, and this is in most cases the only structural feature discernible. These planes, which evidence intense and long continued pressure, are inclined usually at very high angles, the strike corresponding in direction with the line of outcrop of neighbouring intrusive masses, while the irregular curving lines of foliation produced by the unequal resistance to pressure, simulate in a most marked manner the uneven lamination resulting from original bedding. It is, therefore, not surprising that in many descriptions of exposures of similar rocks, such a structure has been repeatedly mistaken for stratification, the descriptions asserting the frequent and usual highly tilted character of these rocks.

Breccia-conglomerate or slate conglomerate of Logan.

Colour and structure of breccia-conglomerate.

Although the slaty cleavage, especially in the upper portion of this rock occasionally corresponds with the original stratification, there is no necessary connection between the two. The hardness of this rock varies widely, the least altered or more quartzose varieties being exceedingly hard, while those exposures in which a large amount of chlorite and other greenish decomposition products have been developed are so soft that they can be readily scratched. Both as a massive rock and in its more imperfect forms of slaty structure, it exhibits the char-

Fragments making up breccia-conglomerate.

acter of a conglomerate, carrying fragments of various irruptive material which vary in size from the smallest pebble to some boulders a foot or even more in diameter. In some localities, the rock is so full of these fragments that very little of the finer interstitial matrix is apparent, while in other places only an occasional one is found. Usually the fragments are more or less perfectly rounded; often they are subangular, while in some outcrops these larger individuals present sharp and often re-entering angles. The breccia-conglomerate presents all the characteristics usually assigned to a rock resulting from the consolidation of an ordinary littoral deposit derived from the breaking down of an area of irruptive rocks of both acidic and basic composition. The wide area, however, over which the rock is distributed, the composition and outline of many of the larger individuals, as well as the frequent intimate association with large masses of diabasic and gabbroic rocks, are incompatible with such an interpretation of the manner of its formation.

Not littoral in origin.

It is often exceedingly difficult to distinguish between true conglomerates or those representing the solidification of extremely local shore deposits, and agglomerate-breccias which may have a much more widespread distribution, but in some instances the most typical conglomerate phase, containing perfectly rounded and seemingly water-worn fragments, has been traced directly and continuously into areas in immediate conjunction with the parent masses, where the contained fragments show no sign whatever of aqueous abrasion, the rock being a typical breccia. Many of the fragments moreover are composed of material which has probably been derived from beneath as a direct result of violent explosive action, as they cannot possibly be connected with any rock present at the surface in the region adjacent to these exposures.

Pyroclastic nature of breccia-conglomerate.

Composition of matrix of breccia-conglomerate.

The finer-grained portion, or matrix, of the least altered phase of this rock, possesses a rather typical clastic structure, although many of the fragments are often so irregular and angular in outline as to indicate clearly that they have not suffered the rounding or trituration to the extent that ordinary clastics of this kind exhibit. The rock is seen to consist mainly of granitic *débris*, the majority of the fragments being simple minerals; although coarser phases show occasional composite rock individuals. The minerals usually noticed are orthoclase, plagioclase, and, more rarely microcline, embedded in a still finer-grained ground-mass of these same constituents, together with chlorite, sericite, epidote and zoisite, and occasional granules and broken crystals of zircon, sphene and apatite. Biotite and more rarely hornblende, both largely altered to chlorite, may also be sometimes distinguished, but fresh individuals belonging to these species are rather uncommon. Fyrite is a very frequent and often extremely abundant constituent, distributed through the rock in irregular grains and masses, but sometimes also in brilliant and well striated cubes. In many instances it may be noticed in various stages of its decomposition to hydrated oxide of iron or limonite. Ilmenite is likewise very often present, both in grains and crystals, usually more or less altered to leucoxene, and occasionally exhibiting the characteristic "gridiron" form of this decomposition. Magnetite, in black opaque particles and crystals is also rather commonly represented. In several instances, broken fragments of crystals of tourmaline, showing the intense dichroism peculiar to this mineral, were detected. Occasionally also carbonate of lime is present as a secondary product of decomposition.

The quartz is usually in clear more or less rounded areas and is the ordinary granitic variety. It frequently shows, in a somewhat pronounced degree, the uneven or undulous extinction due to pressure. Some of the felspar fragments are rather fresh and glassy, but most of the individuals show incipient alteration, consisting of a somewhat marked turbidity arising from the development in them of the various products of decomposition to which the name saussurite has been applied. Most if not all of the sericite present in the rock has been derived from the alteration of the felspar, especially of the more minute fragments, many of these present in the finest ground-mass being wholly decomposed to this form of hydrous mica, together with epidote and zoisite. Fragments of felspar showing microperthitic intergrowth are rather abundant. By far the greater proportion of the chlorite, which is almost invariably present, has resulted from the decomposition of biotite, although some may have been derived from hornblende originally present. The sericite occurs for the most part in the minute scales or matted aggregates, although occasionally in large plates which are sometimes macroscopically apparant. The mineral varies from colourless to pale yellowish-green, showing brilliant chromatic polarization between crossed nicols. The chlorite and sericite usually serve as a finer interstitial cement filling in the spaces between the quartz and felspar grains. The epidote and zoisite occur in irregular granules and crystals, the former polarizing in brilliant colours, while the latter, which is usually in more perfect crystals, shows the deep bluish or yellowish colour characteristic of this mineral between crossed nicols. As a rule, composite fragments, made up of two or more minerals, occupying their original positions in the rock from whose waste they were derived, are rarely seen in this finer matrix, but with a progressive increase in coarseness of grain, such fragments gradually appear. As a rule, even

Quartz.

Sericite and chlorite.

Composite fragments.

when small, these rock-fragments possess a more rounded outline than individuals made up of simple minerals which are very frequently quite sharp and angular.

Larger fragments and boulders.

In this matrix or ground-mass just described, are embedded fragments, pebbles and sometimes even boulders of biotite-granite or granitite, hornblende-granite, diabase, diorite (?) quartzite and fine-grained slaty greywacké or hälleflinta-like rock, representing an extremely fine-grained mosaic of felspar and quartz. Many of these larger fragments, as is usual in similar squeezed rocks, are surrounded by a rim of sericite and epidote, while occasionally, where the mass has been subjected to intense pressure and pronounced pneumatolytic action, as on Ko-ko-ko Bay in Temagami Lake, the whole matrix has been altered to a hydromica schist infiltrated with secondary silica, while the pebbles have undergone considerable stretching and deformation. Granitite pebbles and fragments are by far the most abundant and are almost invariably present where outcrops of this rock occur. In occasional localities, individuals of diabase, which are next in point of general abundance, predominate over those of granitite. The granitite is usually of a distinct flesh-red or pink, sometimes reddish-gray and occasionally grayish colour.

Composition of granitite pebbles of breccia.

It is commonly rather coarse in texture and more rarely pegmatitic. Macroscopically it shows a preponderance of pinkish felspar, a much less proportion of grayish translucent quartz and a sparing quantity of a greenish ferro-magnesian mineral. A section prepared from one of the pebbles obtained from an exposure on Gull Rock Islands in Lake Temiscaming, showed the rock composing it to be greatly decomposed, the felspar turbid, filled with sericite, epidote and calcite and the bisilicates almost entirely altered to chlorite. Orthoclase apparently predominates, but plagioclase is abundant and microcline in small quantity also occurs. The quartz is the ordinary granitic variety, full of inclusions, and while possessing a somewhat wavy extinction does not show much further evidence of having been subjected to very intense dynamic action. A few little areas of granophyre were noted. The ferro-magnesian constituents originally present, were probably both biotite and hornblende, but these minerals have been so completely altered to chlorite as to mask their true optical characters. The former mineral doubtless predominated. The change to chlorite has been accompanied by the deposition of much secondary magnetite. Ilmenite is also present and is accompanied by leucoxene, while apatite is abundant.

Description of diabase fragments.

The diabase fragments so frequently present are usually very fine-grained, although sometimes so coarsely crystalline that the ophitic structure is distinctly discernible to the unaided eye. Occasional pieces still more coarsely crystalline and holocrystalline in structure may represent altered gabbros or diorites, but the ferro-magnesian minerals are all decomposed to chlorite. These pebbles are identical with those described as composed of a "greenish felspathic rock" in earlier reports. In every case examined they were found to be much decomposed. A thin section of a fine-grained pebble, also from the Gull Rock Island in Lake Temiscaming, shows the rock to have undergone great alteration, the felspar being saussuritized and the original augite decomposed to a pale-greenish chlorite. In spite, however, of this advanced alteration, the typical ophitic structure of diabase remains. Occasionally some of the felspar has a broad tabular habit causing the rock to approach the gabbros in structure. The irregular areas between the plagioclase laths are filled with a felted mass of pale green chlorite scales. Leucoxene, resulting from the almost complete alteration of the ilmenite originally present in the rock, is plentifully scattered through the section. Other sections examined, belonging to much coarser grained fragments, were of essentially similar composition, revealing the same advanced alteration. The laths of plagioclase, decomposed to a partially opaque gray saussuritic mass, penetrated a matted aggregate of pale-green chlorite scales representing the allotriomorphic areas of augite originally present.

The ilmentite has wholly disappeared, to be replaced by opaque grayish masses of leucoxene, showing the characteristic skeleton forms produced by the rhombohedral parting. Pyrite and occasionally pyrrhotite and chalcopyrite are constituents of these diabasic fragments and pebbles.

Other fragments present in breccia.

In addition to these pebbles and fragments of granitite and diabase, others representing a greatly crushed and stretched felspathic quartzite were noticed, containing also sericite and chlorite. Occasional fragments of a rock in which plagioclase and orthoclase are porphyritically developed in a fine-grained granular quartz-felspar groundmass were also observed. Besides these composite pebbles, there are very often fragments, usually sharply angular in outline, of both felspar and quartz, which when present alone give the rock a decidedly porphyrite appearance. Some of these pseudo-phenocrysts embedded in a dark-green chlorite groundmass were examined, the rock thus constituted representing the "country-rock" of Wright's mine on the east side of Lake Temiscaming. Some of these individuals proved to be felspar, chiefly plagioclase, which have a broad tabular habit, well striated and very turbid owing to somewhat advanced decomposition, while others are composite fragments of some porphyritic granitic rock with the large crystals of well striated plagioclase surrounded by finely granulated quartz.

Thickness and distribution of breccia.

As will be seen by a reference to the accompanying map sheets, this breccia-conglomerate is of very widespread occurrence in this district. On Lake Temiscaming it rises into hills nearly five hundred feet in height, in thick, almost structureless masses, although in large and well exposed sections, lines which evidently represent original bedding may be distinguished. The total volume seen cannot be much less than six hundred feet, which perhaps represents the greatest thickness attained by this rock, although the conditions under which it must have been deposited were necessarily so unstable that at no place can the basement, upon which it originally rested, be detected. The present nature of its contact with rocks which may possibly represent re-fused portions of this original basement, shows evidence of a considerable sinking down of the mass of clastic material into the molten or plastic magma beneath, so that it is manifestly impossible to state the true total thickness of what has been regarded as the basal member of the Huronian.

Transition upward to greywacké.

This breccia-conglomerate passes upward into a dark-greenish compact rock closely related in composition with the finer grained portion or matrix of the much coarser fragmental rock beneath. The transition upwards consists mostly in a gradual loss of the larger composite fragments.

Composition of greywacké

Although in certain places an occasional pebble of reddish biotite-granite may be noticed, sections of this fine-grained and compact greywacké or felspathic sandstone show an even-grained mixture of angular and subangular fragments, composed chiefly of quartz and orthoclase, together with, usually, a small proportion of plagioclase. (Plate II, Fig. 3). Microcline though sometimes present is of rarer occurrence. These pebbles are embedded in a much finer groundmass relatively insignificant in quantity, originally felspathic, but which is now composed of a confused aggregate of minute scales of yellowish-green sericite arising from its decomposition. A large amount of chlorite is present usually disseminated in irregular shreds and fragments, although sometimes also forming part of the finer interstitial material, while the abundance of this mineral gives the prevailing greenish tint to the rock. Epidote and zoisite are also commonly abundant, and occasionally calcite, all these representing secondary products of alteration. Pyrite, magnetite and ilmenite are also very common constituents, the last mentioned mineral usually showing somewhat advanced alteration to leucoxene. Zircon, sphene, apatite and brownish dichroic tourmaline, likewise occur, but are not by any means abundantly represented.

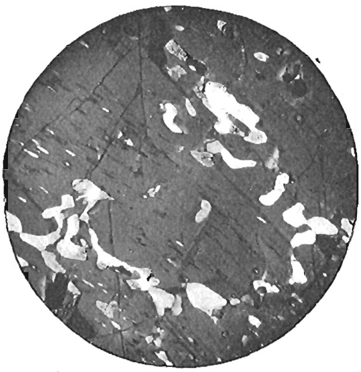


FIG. 1.

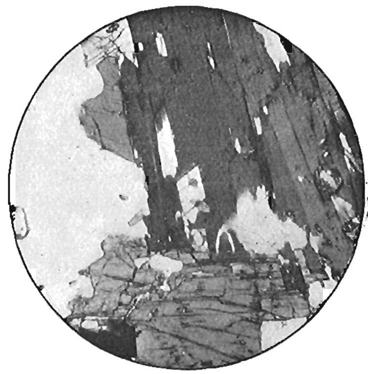


FIG. 2.

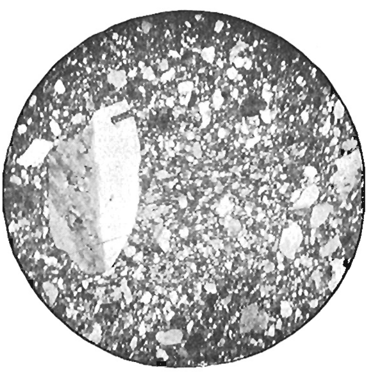


FIG. 3.

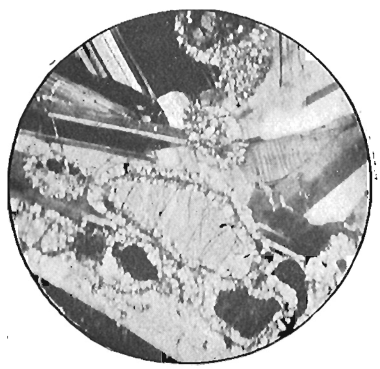


FIG. 4.

FIG. 1.—Micropoikilitic structure in hornblende of diorite—West Arm, Lake Nipissing. × 65.

FIG. 2.—Primary epidote in biotite of quartz-mica-diorite-gneiss—Gordon Creek, four miles from Long Sault, Lake Temiscaming. × 65.

FIG. 3.—Character and position of included fragments in typical greywacké—Little River, Lake Temiscaming. × 65.

FIG. 4.—Rim of chlorite, surrounding augite of diabase—Fanny Lake. × 52.

In ascending, this rock gradually becomes finer grained, at the same time developing a marked slaty structure parallel to certain colour bands which represent original bedding. This slate, or slaty greywacké as it may be called, (for in places large masses though exhibiting the colour striping are altogether devoid of any structure except that produced by jointing), varies greatly in thickness, and in occasional localities is not represented at all. The high hills found on the north-east corner of High Rock Island, as well as on the west side of Cross Bay and Sandy Inlet, show sections over a hundred feet in thickness, although in most cases the rock does not occur in such large volume. The colours occur in alternating bands showing a gradation from one to the other; usually of different shades of green with sometimes the addition of reddish-brown and black, thus producing a very beautiful striped rock. In some instances certain beds have been broken up, forming an autoclastic rock, which, when recemented, exhibits a beautiful mosaic of irregular though angular fragments. The constituents are essentially the same as described above, differing only in their finer state of division. The fragments as a rule show little or no evidence of water-action, being irregular and sharply angular in outline, in places forming an interlocking mosaic of quartz and felspar grains, some of which have evidently originated *in situ*, while other portions suggest considerable recrystallization which has certainly taken place in some instances.

Slate or slaty greywacké.

Autoclastic rock.

The structure in occasional instances is that of a microgranite, but usually, the clastic origin is at once brought out by the microscope. The component fragments are remarkably uniform in size and closely compacted together, with little or no finer interstitial material, while the products of decomposition such as chlorite, epidote, sericite and leucoxene are partially scattered, somewhat promiscuously, through the rock in the form of irregular grains and scales, while many are arranged in a more or less definite manner in irregularly curving lines or areas.

Microscopic structure of slate.

The microscope reveals at once the nature and difference in composition of the colour-bands that so frequently characterize the rock. The lighter green bands show a prevalence of quartz together with a less proportion of felspar, the latter being either fresh or showing only incipient sericitzation, while chlorite and iron ore are only sparingly represented, if at all. The darker green bands, on the other hand show a preponderance of felspar, much of which has undergone somewhat extensive saussuritization, which, together with chlorite, gives the prevailing darker green shade to this portion of the rock. The

Composition of slate.

Explanation of colour bands.

dark, almost black, lines or stripings are seen to be composed of an infinite number of small crystals and opaque particles of magnetite, together with a much larger proportion of ilmenite, which, despite its extensive alteration to leucoxene retains much of its original dark colour and opacity. The reddish-brown stripes are highly felspathic in composition and owe their colour to abundant disseminated hydrated peroxide of iron. These slates evidently in most cases represent the consolidation of what must once have been extensive beds of volcanic mud or ashes. In certain instances, as on the eastern shores of Lady Evelyn Lake and on Turner Lake, they merge into coarser-grained irregular banded or foliated tufaceous rocks, which occur in immediate juxtaposition with large plutonic masses, while in other cases, as on the east shore of Lake Temiscaming, to the north of Wright's mine, they are interbedded with coarse volcanic breccias or agglomerates made up of diabasic and quartz-felspathic fragments embedded in a paste composed largely of chlorite.

Quartzite grit or arkose.

In ascending, this rock gradually becomes much coarser in grain, finally passing into a quartzo-felspathic sandstone, although in certain places the latter rock was occasionally met with resting directly upon and merging downward into a basement composed of red granitite. This arkose is usually rather coarse in texture, in most places showing the characters of a grit, while certain bands or portions are conglomeratic. Many of the larger fragments in the conglomeratic phase of this rock represent very distinctly rounded or waterworn pebbles, the largest of which vary from an inch to two inches in diameter. These are composed, for the most part, of grayish-white, translucent, often much fractured quartz, and many of them are surrounded by a thin film of oxide of iron. Occasionally some pebbles of red quartz are present, and still more rarely others representing a "stretched" felspathic quartzite. Besides these there are greenish, grayish and pale-brownish, usually angular, or at most subangular fragments of an extremely fine-grained rock, seemingly identical in composition to many of the chalcedonic-like fragments embedded in the vitrophyre tuff described by the late Prof. G. H. Williams from Onaping, Ont.* Besides these there are small, often angular fragments of red and yellow jasper together with smaller pieces of both reddish and grayish felspar. These are embedded in a matrix composed largely of yellowish-green sericite, which, on account of its relative abundance gives the prevailing tint to the whole rock. The rock, as has been stated, represents almost altogether the consolidation of true detrital material derived from the

Description of fragments.

Composition of arkose.

*Annual Report, Geol. Surv. Can., vol. V. (N.S.), Part I, 1890-91, p. 74 F. Sections Nos. 35 and 42.

breaking down of granite, a portion of which is represented by exposures covering an area of nearly six square miles in the vicinity of the Old Fort Narrows on Lake Temiscaming, although some of the embedded fragments are rather typical of volcanic ejectamenta; thus evidencing the continuance of the explosive activity, though with much diminished violence, which characterized the earlier portion of the Huronian period. The nature and detailed description of the passage of the biotite-granite into this overlying arkose, is fully discussed in the geological description of the exposures encountered on the shores of the northern part of Lake Temiscaming.

Several varieties of arkose.

The least altered form of this rock is a rather coarse arkose, which upon a superficial examination bears a remarkably close resemblance to an ordinary irruptive-granite. The constituent grains, mostly angular in outline, consist of quartz, orthoclase, plagioclase and microcline, somewhat closely compacted together, with a very little intervening finer felspathic material which is undergoing decomposition to kaolin and sericite. The reddish colour is imparted to the rock as a result of the abundance of ferric hydroxide which fills not only the minute fissures but also stains the larger felspathic individuals. Other varieties which show no great degree of alteration or attrition and assortment through aqueous agencies, are distinguished macroscopically by being brownish, pale-pinkish or grayish in colour.

Composition of arkose on Lake Temiscaming

A rather typical specimen of the prevailing greenish variety or "sea green quartzite" as it has been called, obtained from a point on the east side of Lake Temiscaming (Boat-field Point) about half a mile east of the Hudson's Bay Co.'s old post, shows the rock under the microscope to have originally been composed of felspar and quartz. The quartz is in clear colourless fragments, sometimes with tolerably even outlines, but usually presenting very irregular ones, and the larger fragments are often made up of several interlocking grains. The felspar which was originally present, is now almost altogether converted into pale yellowish-green sericite which gives to the rock its prevailing colour. The sericite scales are usually exceedingly minute but occasionally their presence can be detected macroscopically. There can be little doubt that much at least of the felspar has been altered *in situ*. This alteration of the felspar to sericite is shown in a beautiful manner in the section. It has left very irregularly shaped cores in the centre of the felspar individuals. The field evidence shows in the most positive manner that the rock has had a clastic origin, but the materials, which must have originated in the immediate vicinity, show but slight evidence of having been waterworn.

White quartzite.

At the very summit, in occasional localities, (as on the west side of the north arm of Nonwakaming Lake as well as near High Pond on Maple Mountain to the west of Lady Evelyn Lake), this reddish or greenish arkose is overlain by thick massive beds of whitish or grayish-white quartzite. This rock is made up of angular or subangular fragments of ordinary granitic quartz filled with the usual inclusions, embedded in a finer mosaic composed of quartz fragments together with sericite. It is often much shattered and sheared, the sericite present (and which is most abundant along the planes of pressure-cleavage) being the result of intense dynamic action on the felspar originally present. This arkose, forming the topmost member of the Huronian in this district, varies greatly in thickness. In the vicinity of Lake Temiscaming, hills composed of approximately horizontal strata of this rock rise to a height of five hundred feet above the lake, while to the west of Lady Evelyn Lake and forming the bulk of Maple Mountain, the total thickness represented is nearly eleven hundred feet.

Thickness of Huronian.

The greatest total thickness attained by the Huronian formation in this district is nearly eighteen hundred feet, made up roughly as follows :—(1.) Breccia-conglomerate 600 feet. (2.) Slates and slaty greywackés 100 feet. (3.) Quartzite grit or arkose 1100 feet.

Diabase and Gabbro.

Diabase and gabbro.

Massive rocks of both the diabasic and gabbro types are frequently and intimately associated with both the epiclastic and pyroclastic rocks of the Huronian. Such rocks have often, in fact, been included as part of the Huronian system, although they appear indeed to be practically contemporaneous in origin in many cases, but they should not be counted as a part of the system when its thickness is to be ascertained. These basic intrusives apparently represent the deeper seated plutonic action, connected with the volcanic outbursts that gave rise to the ejectamenta which are so abundantly represented.

Magmatic differentiation

Many of the masses of this kind are intimately associated with, and merge gradually into, a rather typical flesh-red biotite-granite or granitite, while several of the exposures are pierced and traversed by irregular dyke-like forms and masses of pegmatitic material. This gradual passage into granitite can be directly and continuously traced in a number of instances in single outcrops. The most reasonable assumption is that all three rock-species, diabase, gabbro and granitite represent highly differentiated portions of the same magma which have solidified at temperatures corresponding with their composition.

These basic plutonic rocks characterize large areas, occurring for the most part as a series of irregular, though often somewhat rounded batholitic masses, which send off large arms or dykes to intersect the neighbouring stratified rocks. In certain localities, as on the south-west side of Round Lake (Wawiagama) a little beyond the western limit of the Lake Temiscaming sheet, as well as at Beaver Mountain, south of the mouth of the Montreal River, they appear to represent the consolidation of what may possibly have been intruded sheets or sills of molten material. This, however, could not be positively ascertained, as the covering of clastic rocks, if originally present, has been removed by subsequent denudation.

Occurrences of basic plutonic rocks.

These rocks, in the area here considered, usually possess a medium texture, although in many instances they are so coarsely crystalline that most of the principal constituents are plainly apparent. In general they vary from greenish-gray, through dark-green to almost black in colour, although in many of the coarser phases the prevalence of felspar with a distinct flesh-red colour, gives a prevailing reddish tint to the whole mass. In most places they have a massive much jointed character, and this, together with the extensive shearing action to which these rocks have been subjected, makes it exceedingly difficult to secure even a hand specimen of well shaped outline. In occasional localities, as at Manitou Rock on the west side of Lake Temiscaming, the rock shows a rude columnar or basaltic structure.

Basaltic structure.

Under the microscope, these rocks present a remarkably uniform mineralogical composition in the several separated masses, while the specimens obtained almost invariably exhibit, in a very typical manner, the ophitic structure which belongs essentially to diabase, although in some other areas, as well as in certain portions of the same mass, it sometimes shows the holocrystalline or granitoid structure of gabbro.

The least altered variety of the rocks of this class, is made up essentially, and almost wholly of plagioclase and augite, the former mineral being present in the usual idiomorphic lath-shaped individuals penetrating the allotriomorphic augite. From the extinction-angles, the plagioclase is near the basic end of the series—labradorite and bytownite. The mineral is sometimes rather fresh and glassy, although frequently it shows a marked turbidity, owing to the development in it of the usual saussuritic products of decomposition, while the augite, which when fresh is of a distinct reddish-brown colour, is as a rule partially decomposed to green trichroic hornblende. A few rather broad tabular unstriated individuals of felspar are usually present, and may possibly represent orthoclase. Reddish-brown,

Composition of diabase and gabbro.

strongly pleochroic biotite is found in irregular plates, but not in any excessive amount. Quartz is likewise a rather constant constituent, occurring in small clear irregular areas filling in the lesser interspaces between the felspar and augite. The ilmenite present very often shows the characteristic "gridiron" alteration to leucoxene. In certain instances, as at Quinn Point on the east side of Lake Temiscaming, the rock has undergone considerable decomposition, the augite being completely altered to green trichroic hornblende (uralite.)

Diabase of Quinn Point.

Most of this uralite is the usual compact dark-green variety, but some of it has assumed the actinolitic habit. In other localities, as on the Quinze River, the diabase has undergone still more advanced alteration, the whole rock-mass being converted into a rather typical hornblende-schist or amphibolite as a result of intense pressure. Traces of an ophitic structure still remain, showing clearly the original character of the rock, although in places this is masked by the extreme deformation to which the rock has been subjected. The process of the uralitization and decomposition of the augite is very interesting and instructive, showing first an alteration to the compact green trichroic variety of hornblende, the individuals presenting deep-coloured borders with pale interiors. This, with an increase in deformation, assumes the fibrous or actinolitic habit, which, in turn, is decomposed to chlorite, the individuals of the last-mentioned mineral retaining much of the marked pleochroism of the hornblende. Some of the plagioclase seems remarkably fresh, although the greater proportion is altered to opaque greyish masses of saussurite, the resulting epidote, zoisite and sericite being especially abundant in those portions of the rock which have yielded most to pressure. The ilmenite originally present, is often almost wholly converted to a brownish sphene which occurs in grains or aggregates scattered through the rock.

Gabbro of south-west arm of Lake Temagami.

A section prepared from a specimen representative of a small mass of highly altered gabbro that protrudes through the breccia-conglomerates and slaty greywacké on the east shore of the south-west arm of Lake Temagami, shows that the rock is now composed of felspar, quartz, pale-green fibrous chlorite, biotite and zoisite. The mutual reaction of the felspathic and ferro-magnesian constituents has been so pronounced, and the resulting decomposition products have in many cases wandered so far from their former positions, that the original structure is to a certain extent masked. Zoisite is a very abundant constituent of the rock as an alteration-product, occurring in irregular grains and crystals. Sphene is also quite abundant and has resulted from the decomposition of ilmenite originally present. Small cores of the unaltered ilmenite still remain. The biotite is of a pale-brownish colour as a result of the leaching out of a portion of its iron.

Diabase of Beaver Mountain.

The rock composing the upper and more precipitous portion of Beaver Mountain, or the "King of the Beavers" as it is sometimes designated, is a dark greenish-gray diabase, in which the ophitic structure is visible to the naked eye. It is much sheared and broken, the planes of cleavage and jointing being plentifully coated with dark-greenish minerals belonging to the chlorite group. Under the microscope, the rock is seen to be composed mainly of plagioclase and augite. The plagioclase, which from the extinction-angles is near the basic end of the series (probably bytownite), is usually pretty fresh, but some of the individuals are rather turbid, owing to the presence of decomposition products, while considerable areas are characterized by the presence of light-greenish sericite and yellowish-green epidote and zoisite resulting from the saussuritization of the felspar substance. The augite is as a rule fresh and occurs in allotromorphic masses pierced by the laths of plagioclase. It is reddish-brown in transmitted light, a variety frequently met with in diabases, and many of the individuals are characterized by the presence of innumerable rod-like interpositions (schillerization products.) Frequently it is noticed undergoing incipient alteration to compact pale-green trichroic hornblende. A considerable quantity of reddish-brown biotite is present in irregular plates and scales. A little quartz was also noticed, while both pyrite and an opaque iron ore, probably ilmenite, are present, scattered in irregular grains throughout the section. Besides these, comparatively large and irregular areas may be seen composed of a pale yellowish-green serpentinuous substance, associated with secondary calcite and often dotted with strongly refracting grains and elongated fragments of epidote, the whole showing aggregate polarization, Very often these irregular masses show the characteristic net-like structure so common in serpentine derived from the decomposition of olivine, although the small residual cores still remaining, in some cases have a lower double refraction than is usual in this mineral.

Basic intrusives in Laurentian.

Besides the masses above referred to, which are so intimately associated with the clastics of the Huronian, there are also similar basic intrusives incorporated with the Laurentian gneisses and granites, which clearly do not belong to the same magma from which these latter rocks have been produced, In most cases these appear to be of earlier generation than those associated with the Huronian, although no very positive statement can be made on this point. The gneiss in immediate conjunction is often more basic and hornblendic, seemingly showing a commingling by actual fusion of the two rocks along their line of junction.

Diabase of Expectation Lake.

Outcrops of a uralitic diabase marking the occurrence of a small area of this rock, were noticed apparently cutting and altering the granitite-gneiss exposed on the north-west shore of Expectation Lake near the south-west end. The diabase is much finer grained near the junction with the gneiss. The specimen obtained showed the rock to be a medium-grained, dark-green, basic eruptive, the diabasic structure of which can be seen in the hand specimens. The microscope shows it to be a remarkably good instance of a diabase in which the bisilicates have been almost entirely decomposed, while the plagioclase remains in a comparatively fresh, unaltered condition. The minerals now present are plagioclase, hornblende and chlorite (doubtless representing augite originally present) ilmenite accompanied by leucoxene, apatite and sericite. A few of the plates of chlorite look as if they may have been derived from biotite. The plagioclase is in rather broad lath-shaped sections which interlace, giving a coarse ophitic structure to the rock. It is well striated (both albite and pericline laws being represented) possesses very uneven extinction and has evidently been subjected to a considerable degree of pressure, many of the crystals being shattered. The augite originally present is now almost entirely altered to a pale yellowish-green chlorite. It has evidently passed through an intermediate stage of alteration to hornblende, as that mineral, of a pale bluish-green colour and fibrous, in which the alteration to chlorite is so far advanced as to almost entirely obliterate the optical characters of the hornblende, surrounds lighter, still more altered cores which doubtless represent the original augite. Magnetite resulting from the decomposition of the bisilicates, a little apatite, sericite and epidote occur as secondary products.

Adjacent rock.

This diabase is in contact with a dark-green, fine-grained, compact, foliated rock, sprinkled with little crystals of pyrite. Under the microscope, the ground-mass consists of a fine-grained mosaic of clear quartz and felspar, through which run little strings of a brown biotite, in fine brightly polarizing scales which are evidently of a secondary origin, and in places show an alteration to chlorite. Throughout this fine-grained material, larger grains of quartz and felspar (principally microcline) are distributed, which by their granulated appearance and very uneven extinction bear unmistakable evidence of the dynamic action to which the rock has been subjected. Large irregular grains of pleochroic epidote, colourless to pale yellow, frequently showing good cleavage, are abundant, as are also large clove-brown crystals of sphene. Crystals of zircon, fairly large, and frequently showing marked zonal structure are plentiful. Some pyrite and iron ore were also observed.

Basic eruptives of McDiarmid Lake.

Another mass of these basic eruptives that may be mentioned in this connection, is well exposed on the shores of McDiarmid Lake, the southern part of Breadalbane Lake and the islands and points chiefly in the central portion of Fanny Lake.

General appearance.

The rock is dark-green, almost black in colour, weathering rusty or brownish owing to the oxidation of the large amount of pyrite finely disseminated through it. Atmospheric agencies have likewise produced a rough, though somewhat finely pitted surface, owing to the decomposition and removal chiefly of the coloured constituents, leaving a reticulated surface formed by the felspar standing out in relief. The relations with the surrounding gneissic rocks of the Laurentian series seem to show its earlier genesis, and these foliated and much more acid rocks are rendered relatively more basic or hornblendic in the immediate vicinity of the line of junction, apparently as a result of the free interchange, through actual fusion, of the material of both rocks. The basic rock has usually a rather well marked foliation, which corresponds in general with the strike of the inclosing gneissic rocks. On McDiarmid Lake this strike is S. 24° E., the rock being nearly if not quite vertical, while on Fanny Lake the strike is N. 35° E. with a dip to the north-west of 85°.

Microscopic structures.

Under the microscope, this rock is seen to be a rather fresh diabase composed chiefly of plagioclase and augite. The plagioclase is unusually fresh and glassy, and well striated, both albite and pericline laws being represented. It occurs for the most part in rather broad, lath-shaped crystals penetrating the irregular individuals of augite. As a result of pressure, it usually exhibits a wavy extinction, is sometimes bent or curved and occasionally fractured and dislocated. The augite is of the reddish colour so often noticed in diabase and occurs in irregular polysomatic areas. These composite individuals or masses are surrounded by a narrow rim, of remarkably uniform width, composed of fibrous and radiating scales of pale-greenish chlorite, each separate scale being approximately at right angles to the outline of the unaltered portion. (See plate II., fig. 1.)

The augite is rather fresh, while the line of division between these "reaction-rims" and the unaltered portion of the individual is very sharp and abrupt. Associated with the augite and frequently completely inclosed by it are irregular plates and scales of a reddish-brown strongly pleochroic biotite. Sometimes it is considerably bleached while occasionally it is altered to chlorite.

*Annual Report, Geol. Surv. Can., vol. I. (N. S.), 1887-88, p. 155 F.

Basic rocks near Latours Mills.

On the west side of Lake Temiscaming nearly opposite Latours Mills, black, irregular, roughly weathering masses of a very basic rock may be noticed caught up in and penetrated by the associated granitite-gneisses mapped as Laurentian.

The hand-specimen examined is black in colour with glistening scales of mica abundantly developed through the mass. The weathered surface is rough and pitted, resembling a pumice-stone. Under the microscope, the component minerals are seen to be hornblende, biotite plagioclase, garnet and iron ore. The hornblende is green in colour, trichroic, and occurs in large areas composed of an aggregate of small individuals. Occasionally these aggregates show a pale interior with a dark-green border surrounding the masses. It is undoubtedly secondary in origin and some of it is actinolitic, and is the most abundant mineral in the section. The biotite is rather pale in colour owing to the removal of a part of the iron, and frequently shows pleochroic halos surrounding embedded fragments of the other constituents of the rock. The plagioclase is not nearly so abundant, and is very frequently almost opaque, from the inclusion of dark-brownish dust-like particles. The garnet is in irregular grains as is also the iron ore, which is probably magnetite. A somewhat rude ophitic structure can still be detected in the rock.

Occurrence of massive diorites.

Besides the foliated diorites that occur as integral and extremely basic portion of the prevailing Laurention gneisses, there are occasional and comparatively large irregular areas of massive diorite, which are apparently of earlier genesis than the foliated rocks with which they are associated. One of the largest of these masses noticed, occurs on the southern mountains to the south-west of the west point of Maski-

On Bear Bay.

nonge Island, on Bear Bay in Lake Nipissing. The mass has, roughly speaking, a diameter of a little over four hundred feet. A border of black mica-schist (probably a mica-diorite-gneiss) nearly three feet in width, separates this massive basic rock from the gneiss, the foliation of the diorite gneiss curving round the outline of the mass. The whole mass is penetrated by reddish quartzo-felspathic masses and dykes which are evidently extremely acidic portions of the same magma from which the gneisses have solidified. Fragments of the basic hornblendic rock are embedded in gneisses near the line of junction.

Microscopic character.

Under the microscope, this rock is seen to be a garnetiferous granite, being composed of plagioclase, orthoclase, quartz, hornblende, an orthorhombic pyroxene and garnet with smaller quantities of sphene and iron ore. It possesses a holocrystalline structure and shows only slight evidences of pressure in the uneven extinction of the quartz and felspar individuals. The felspars as a rule are quite fresh. The hornblende is usually in massive irregular individuals of a green colour and strongly pleochroic. Occasional individuals show good crystallographic outline Excellent examples of the micropoikilitic structure described by Dr. G. H. Williams * were observed. Thus certain areas of the rock are occupied by comparatively large individuals of hornblende which are crowded with irregular grains of quartz arranged without any reference to one another or to the matrix, and, which neither possess the complete independence of optical orientation characteristic of granular structure, nor the entire continuity of the separated portions of two interpenetrating crystal individuals.

The orthorhombic pyroxene, which is probably hypersthene, has a parallel extinction, is rather light in colour and has a feeble pleochroism, with light-yellowish to pale reddish tints. It is somewhat abundant and occurs in individuals having irregular outlines. The garnet is usually in large individuals full of irregular cracks. It is pale ruby-red in colour with characteristic high relief. The sphene is in irregular grains frequently imbedded in the hornblende. An opaque iron ore is rather abundant in the section examined.

GRANITE.

The rock to which this general name has been applied, is, for the most part, a biotite-granite or granitite according to Rosenbuch's classification. As the details of the numerous exposures of this rock are to be found in connection with the geological description of the lakes forming the series of canoe-routes which afford an access to or across these masses, it will only be necessary, in this connection, to give a very general notice of this rock, applicable alike to most of these separate occurrences. It is of a prevailing reddish colour, rather coarsely crystalline, the principal constituents being usually readily distinguishable with the unaided eye. In some localities it presents a very massive structure, while occasionally it shows a very distinct foliated texture. In several cases, notably in the area adjoining Spawning and Young Loon bays of Lake Temagami, occurrences of this rock present a very coarse, often porphyritic, variety, the phenocrysts being Carlsbad twins of orthoclase developed in a quartzo-felspathic ground-mass rather poor in ferro-magnesian material. Orthoclase is the most abundant felspathic constituent, although microcline and plagioclase are both present in considerable quantity, while quartz, which is as a rule proportionately less in amount than

General character of the granites.

* Journal of Geology, Chicago, vol. I., No. 2.

the felspar, is of the prevailing granitic variety full of glass and other inclusions. The coloured constituent is generally biotite which has either partially or wholly been decomposed to a pale-greenish chlorite, the individuals preserving much of the original marked pleochroism of the mineral from which it has been derived. Epidote and sphene are both very abundant and frequently in such large crystals and fragments as to be macroscopically discernable.

Greenstone masses in granites.

In the midst of all the large granite areas, considerable tracts are characterized by greenstone, while masses of this greenstone (diabase and gabbro) are frequently so intimately associated with the granite that separation, especially on the scale adopted on the accompanying maps, would be impossible. Dykes and masses of granite and pegmatite likewise accompany outcrops marking the large occurrences of diabase and gabbro. Although in most cases a marked and sharp contrast exists between the two types of rocks (acidic and basic), it was rather definitely ascertained that the rocks are very intimately related, and it seems quite evident that the dates of their respective intrusions are nearly synchronous, the basic types representing the first segregations of a magma which ultimately crystallized as granitite and granitite-pegmatite. On the other hand, these areas of massive granitite merge into foliated granites or gneisses which are usually indistinguishable from, and sometimes co-extensive with similar material described and mapped as Laurentian.

POST-ARCHÆAN ERUPTIVES.

Later eruptives.

Besides the huge masses of diabase and gabbro that are so intimately associated with the Laurentian and Huronian, most of which seems to be practically contemporaneous with these rocks, there are other intrusives occurring principally in the form of dykes, which cut the Laurentian gneisses, and are thus very obviously of later origin. The greater number of these occurrences possess sharply defined and approximately parallel inclosing walls, although some have filled irregular cavities of the pre-existing rocks, and thus possess more ill-defined contours.

Dykes near Les Erables.

The first of these which may be mentioned, was noticed on the east side of the Ottawa River between Les Erables Rapids and Snake Creek, the intrusive masses apparently piercing the associated granitite-gneisses. Macroscopically, the specimen examined shows a very coarse-grained dark-gray rock, with a reddish tinge given by the abundant presence of a wine-coloured almandine garnet. Under the microscope, the rock is evidently a very typical example of crushed and epigenized

Microscopic character.

gabbro. The minerals noticed as present in the microscopic section are plagioclase, unstriated felspar (possibly orthoclase), quartz, diallage hornblende, biotite, garnet, apatite, iron ore, pyrite, together with serpentine and chlorite occurring as secondary products of decomposition. The plagioclase, which is by far the most abundant felspar present, is much disturbed, bent and occasionally broken, while many of the surviving large individuals show in a very beautiful manner the uneven or undulous extinction due to pressure. Much of this mineral is quite fresh and glassy, although many irregular and often large spaces in the crystals are very turbid, owing to the abundant development of exceedingly numerous and minute scales of sericite and kaolin; these products of decomposition sometimes arranging themselves in plumose aggregates. The diallage, when free from impurities, shows a rather faint, though perfectly distinct pleochroism, from light-greenish to pale-reddish. Many of the larger individuals are rendered almost isotropic by the interposition, along the planes of parting, of an almost infinite number of minute brownish, more or less opaque, particles. All stages in the development of these schillerization products may be noticed, from individuals that are entirely free from such impurities to others which are perfectly crowded with them. Some of the diallage shows somewhat advanced decomposition to serpentine. The brownish-green trichroic, hornblende present, occurs for the most part in the form of "reaction rims" surrounding and resulting from the alteration of the diallage. The wine-coloured garnets, which, together with the colouring of the diallage, have been developed by the percolation of heated water (epigenetic action) occur in small crystals and crystalline fragments, often forming an irregular zonal area surrounding the bisilicate material. The biotite, which is present in comparatively small quantity, is of a deep reddish-brown colour and strongly pleochroic.

Details of structure.

On Iron Island, in Lake Nipissing, the prevailing gneiss is intersected by huge irregular masses of a dark brownish-gray highly micaceous trap. The specimens secured as illustrative of one of these occurrences near the south-west point of the island, show the rock to vary considerably in texture, some portions being fine-grained with a distinct approach to porphyritic structure, the biotite occurring in crystals with sharply defined hexagonal outlines; other specimens are much coarser grained, with the biotite in broad irregular flakes, and lacking the distinct porphyritic appearance of the fine-grained material. The rock weathers to a rusty brown colour, is greatly decomposed and filled with carbonates, causing it to effervesce freely with acid. The microscope shows that the principal minerals now

Eruptive masses on Iron Island.

Microscopic character.

present are biotite and garnet, with abundant iron ore, some accessory augite, a little hornblende (?) and masses of calcite, etc., which may represent in part felspars originally present, though none are now observable. Apatite is abundant in good-sized long prismatic crystals. The section of the finer-grained portion contained no garnet, while in the coarse-grained phase of the rock this mineral is exceedingly abundant. The garnet is of a peculiar yellowish-brown colour and resembles the melanite variety, while the coarse portion of the rock might be described as composed essentially of biotite and melanite garnet with some little accessory augite and perhaps hornblende. The rock is a most remarkable one and further investigation of fresher material might prove it to be a hitherto unobserved member of the mica-peridotite family.

Dykes on Manitou Islands.

Another interesting and rather rare species of dyke-rock was noticed on the most southerly of the Manitou Islands in Lake Nipissing. Near the southern extremity of this small island, dykes as well as irregular masses of an alnoite-rock cut the dark reddish and greenish granitite-gneiss representing the Laurentian. One of these dykes is about ten feet in width, running in a direction nearly east-and-west and intersecting the foliation of the gneiss almost at right angles.

Another occurrence showed a fissure about six inches in width filled with the same material. Murray* mentions the occurrence of intrusive masses of the same rock as seen on one of the islands in East Bay opposite Callendar station. The specimens of this rock consist of a fine-grained greenish groundmass in which are embedded large phenocrysts of biotite and augite, together with rounded greenish masses, which at first sight seem to resemble concretionary or pebble-like inclusions. On examination, these simulate rude prismatic crystals, but only the skeleton forms remain, filled with decomposition products, chiefly calcite, and that may possibly represent olivine, originally present. In the hand-specimens the large plates of biotite and phenocrysts of augite are especially noticeable, at once suggesting its probable close affinity to the alnoite first described by Törnebohm†, in 1882, from the island of Alnö, in Norway. The thin section, under the microscope, shows an exceedingly fine-grained and decomposed groundmass consisting of an intricate mixture of brightly polarizing scales of bleached biotite, chlorite, spicules and crystals of hornblende (actinolite), calcite, pyrite, iron ore and leucoxene, in which are embedded larger individuals of augite and biotite, the former almost wholly converted to hornblende and calcite, although the character-

Microscopic structure.

* Report of Progress, Geol. Surv. Can., 1653-56 p. 122.

† A. E. Törnebohm: Melilit basalt frin Alnö, Geol. Forn. 1 Stockholm Förh. 1882 p. 240.

istic skeleton forms remain. In this matrix are developed large though somewhat rude phenocrysts of biotite and augite. The large, individuals of augite show a perceptible, though somewhat indistinct pleochroism and are traversed with a network of cracks more or less filled with hornblende and calcite, products of its alteration and decomposition. They are as a rule surrounded by a rim of variable width composed of the usual hornblende (uralite), showing beautiful deep-bluish polarization colour between crossed nicols. The biotite is rather fresh, although some of the iron has been removed, and, as a consequence, exhibit brilliant chromatic polarization colour. The pleochroism, is strong from deep brownish-red to pale-yellow. The individuals have a hepidiomorphic outline, occurring in elongated plates and scales which show considerable optical disturbance as a result of pressure. The rock doubtless belongs to the group which includes the alnoites, monchiquites and fourchites but it is now so decomposed that its exact position cannot be determined. Closely related rocks have been described by C. H. Smyth, jr.,* from Central New York, and by Adams,† from Ste. Anne de Bellevue, Quebec, and from a point on the road between Ashcroft and Savona, British Columbia, three miles east of Eight-mile Creek. Type of the rock.

About five chains north of the last occurrence of this rock, on the west side of the same small island, beds of pink crystalline limestone occur containing more or less epidote, biotite and hornblende as impurities. The strike of the rock is about N. 80° E., while the dip is at an angle of 65°. A dyke varying in width from 9½ to 11 inches, of fine-grained, dark-greenish, almost black rock was noticed intersecting this limestone in a direction N. 4° W. Dyke cutting limestone.

Under the microscope the rock is seen to be greatly altered, consisting chiefly of microcline and hornblende, the latter evidently secondary in origin. The original rock, unaltered, was probably an augite-microcline one and thus allied to the vogesites. The hornblende occurs in elongated pale yellowish-green individuals considerably altered to chlorite and frequently forming sheaf-like bundles of crystals. A close study of the section reveals numerous examples of comparatively unaltered cores of the original augite. The felspar of the rock giving generally elongated sections appears to be principally microcline, although some plagioclase was also observed. It is turbid, being full of inclusions of hornblende, sericite, etc. Brilliantly polarizing secondary epidote is abundantly distributed throughout the rock. Microscopic character.

* American Journal of Science, April, 1892, August, 1893, and October, 1896.

† Ibid., April 1892; also Annual Report, Geol. Surv. Can., vol. VII. (N.S.), p. 388B. No. 79A.

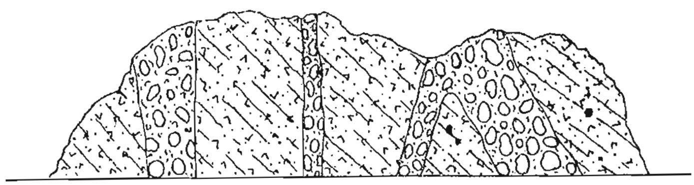
Dyke on Goose Islands.

On one of the smaller of the Goose Islands, at the extreme west end of the group, the pinkish granite-gneiss strikes N. 70° E., with a dip to the south < 50°. Near the north-west end a greenish dyke of fine-grained material about $1\frac{1}{4}$ feet in width, cuts across the whole end of the island running in a direction N. 58° E.

Dykes near Bonfield.

About three miles and a half north-east of Bonfield station (formerly Callander) a rock-cutting made during the construction of the Canadian Pacific Railway shows a good section of a massive granitoid gneiss pierced

Fig. 2.



North-east. South-west.

DYKES OF CONCRETIONARY DIABASE $3\frac{1}{2}$ MILES N. E. OF BONFIELD.

by several dykes of a rusty-weathering medium textured diabase. The rock has a marked concretionary structure, which is revealed as a result of ordinary weathering, the successive thin concentric layers of rock peeling off much like the coats of an onion. The dykes cut across the indistinct foliation of the associated gneissic rocks. Near the walls the dykes are very much decomposed and schistose, while the gneiss is baked and altered to a slight degree in the immediate vicinity. The largest of the dykes, near the south-west end of the cut, is six feet across with a branching arm about two feet in width. Another dyke near the north-east end of the outcrop is four feet in width, while the third is only about one foot in width. The rock composing these intrusions is readily attacked by atmospheric agencies and is more or less hollowed out in the adjacent hard gneiss. Dykes and masses of precisely similar material are exposed along the line of railway between Sudbury and the Murray mine, which in a thin section under the microscope is found to be a rather typical and fresh olivine-diabase. No petrographical examination was however made of the rock from the locality above described, as the specimens secured were lost in transit.

Similar dykes near Sudbury.

Rocks near Callander.

Along the line of the northern division of the Grand Trunk Railway, in the vicinity of Callander station to the east of Lake Nipissing, the various rock-cuttings show good exposures of a massive granitite-gneiss. As a rule, this is a medium-grained distinctly foliated granitic rock, in which the dark-coloured irregular strings and layers composed of the ferromagnesian constituents, (principally biotite), alternate with broader reddish bands of coarse-grained felspar and quartz in which lie little patches and strings of the darker material. Frequently the gneiss has a very distinct augen structure, the lenticles composed almost wholly of reddish felspar being sometimes as much as six inches in length by two or three in breadth. The strike of the rock varies from N. 20° W. to N. 20° E. with a prevailing dip to the east at a high angle, usually over 60°. In some instances the rock is quite massive, showing little or no evidence of foliation. These reddish granitoid rocks are intersected in several places, almost at right angles to the foliation, by irregular often branching dykes of comparatively fine-grained dark greenish-gray, sometimes almost black rocks. In the immediate vicinity of the line of contact, the gneiss exhibits a narrow selvage of much finer grained rock, showing the intrusive action of the dyke, while in some instances fragments of the gneiss have been caught up and incorporated in the body of the dyke. At the first cutting, about a quarter of a mile south of Callander, the rock is very massive and granitoid, but at the second, a well marked foliation has been developed, running N. 10° W. with an easterly dip at a high angle. This rock is intersected by two dykes, dark-green to almost black in colour, containing porphyritically embedded individuals of a black, bright, glistening mineral. The walls of the dykes are more or less irregular, often serrated and frequently presenting re-entering angles of fine-grained material which penetrates the mass of the neighbouring granitic rock. At the widest places the larger of the two dykes is about seven feet thick, while the smaller is about two feet. The dyke interrupts the foliation of the gneiss and near the contact both rocks are much finer in texture, while fragments of the gneiss are embedded in the dark-greenish rock. Under the microscope, the rock possesses a peculiar irregular granular structure, and the intergrowth of hornblende and felspar gives to the section a pseudo-granophyric appearance. The section is filled with a dense mass of little shreds of hornblende in a groundmass composed chiefly of broad plates of orthoclase. There are numerous large phenocrysts having centres composed of a pale-green diopsede-like pyroxene, altered on the outside to a green hornblende. Biotite is also plentiful in large fresh irregular plates full of inclusions. Titanite and apatite also occur. The whole section is sprinkled with iron ore, pyrite and granules of epidote. It is a very basic rock, near the syenite end of the peridotites and between these and the vogesites. It might be termed a hornblende-augite-minette.

Dykes cutting them.

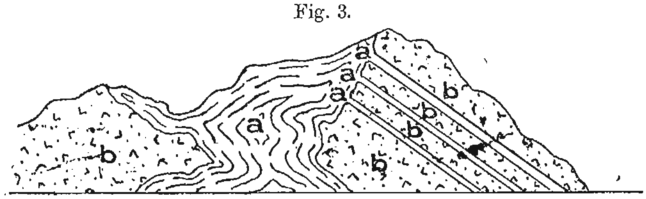
Relations of dykes to gneissic structure.

The next cutting, situated about a mile south of Callander, runs through a hill of a deep-reddish granitite-gneiss. At the north end of the cutting the foliation is quite distinct, this structural feature strik-

Branching dykes.

ing about N. 10° E. with an easterly dip <60°, but towards the middle of the cutting the rock is very massive, showing only indistinct foliation. This rock is pierced by irregular dyke-like forms of a massive, dark, greenish-gray rock, which shows a marked difference in texture, being fine-grained near the containing walls of the dyke and coarser toward the middle. There is a selvage of about an inch of fine-grained granitite near the contact with the darker rock. In some places these dykes have comparatively regular and straight walls, while in others they are of somewhat irregular outline. On the west side of

Fig. 3.



West side of cutting, one mile south of Callander, G.T.R.

SKETCH SHOWING DYKE-LIKE FORMS OF MICA-PHONOLITE (a) CUTTING GRANITE-GNEISS (b)

the track near the north end, three of the narrower dykes, in approximately parallel position, cut the granitite and are connected with the larger and more irregular body of the dyke. The whole section exposed is a little over a hundred feet in length. The finer grained portion of the dyke, near the walls, shows a very compact dark-green slaty rock filled with a multitude of joints, causing the rock to break into a large number of small, irregular rhombohedral fragments. Under the microscope it is seen to be much altered and very fine-grained. It is composed of a groundmass made up of a colourless isotropic substance, sprinkled all through with irregular patches and spots (micropoikilitic) of a mineral with higher refraction and very high double refraction which may be calcite, also occasional laths of a low double refractive mineral suggesting felspar. The section is also spotted with minute scales of green biotite. Augite, some of which is fresh, is present; but one phenocryst with inclusions of felspar was noticed decomposed to a serpentinous product. Considerable quantities of titanite, some ilmenite, leucoxene, pyrite, apatite, zircon, fluorite and lepidomelane are also present. The section represents an alkali rock, and is probably allied to the mica-phonolites.

Character of the rock.

Other dykes than these above described are also occasionally met with, but they have not been examined petrographically.

CAMBRO-SILURIAN.

Marine invasion of early Palæozoic.

The transgression of the sea far up the valley of the Ottawa during early Palæozoic times, has long been a well ascertained fact, and the character, thickness and fossil remains of the numerous and extensive Palæozoic outliers have been described. The marine invasion began with the shallow-water conditions indicated by the deposition of the conglomerate and sandstones of the Potsdam, and ended—so far as evidence is afforded by the exposures of strata below Mattawa—with the Utica. This submergence must have been gradual and of great duration, the ocean reaching its greatest depth and extent in this area about the close of the Trenton period, when a comparatively rapid re-elevation of the land took place, as indicated in part by the deposition of the Utica shale, and ending with the final emergence of the whole area to conditions of dry land.

It seems probable that the depression at present occupied by the Ottawa River, which in past geological time was of much greater extent and importance, formed, during the deposition of the Cambro-Silurian, a large gulf or arm of the sea, with transverse bays or inlets extending far into the interior of the Archæan plateau of Central Ontario along depressions which even then existed, and which are now occupied by the more important tributaries of the Ottawa. This arm of the sea certainly extended as far up the Ottawa as the Mattawa, and small exposures of arenaceous limestones which have escaped the forces of denudation occur at intervals in the immediate valley of the river between Pembroke and Mattawa. The comparatively deep-water conditions indicated by the deposition of these limestones, which were certainly of much greater extent and volume than at present appearing, furnishes strong presumptive evidence for believing that the sea was continuous in the form of a strait, through the valley of the Mattawa River, thus connecting directly with the vast interior basin of Western Ontario in which strata of similar age and character were being deposited. The Cambro-Silurian known to occur on the Manitou and Iron Islands in Lake Nipissing, are doubtless outliers of the belts of rocks of the same age which outcrop further to the west and south-west. Extent of Palæozoic sea.

To the north, up the main valley of the Ottawa, it is perhaps likely that the sea extended as far as the head of Lake Temiscaming and a short distance beyond, and that strata then deposited lie concealed beneath the Niagara limestones that outcrop on the shores and islands of the northern part of this lake. This seems the most satisfactory explanation that can be offered, at the present time, to account for the presence of numerous often large and angular fragments of Cambro-Silurian strata with embedded characteristic fossils, that are found lying loose at intervals along the shores of the Its northern extension.

northern part of the lake, and which certainly afford no evidence of having travelled any great distance from their source.

Chazy, Birdseye and Black River Formations.

Outliers of Iron Island.

On the west side of Iron Island in Lake Nipissing, beds of chocolate-brown and yellowish-gray, coarse sandstone or grit, occasionally becoming a fine conglomerate, rest unconformably on the upturned edges of the gneissic rocks classified as Laurentian. The rock is composed of loosely compacted and rounded grains of quartz more or less abundantly coated with hydrous oxide of iron with little or no interstitial material. The lowest beds are of a brown colour, with occasional lighter spots from which the iron oxide has been removed, while higher beds are yellowish-gray, also showing lighter coloured areas. When subjected to the action of the weather, curious subspherical rings suggestive of concretionary action appear on the exposed surface, but a close inspection shows no apparent difference either in composition or texture of the part where these are developed. The beds are of good thickness, but would be useless for building purposes on account of the loose and friable nature of the sandstone. Little or no calcareous matter is present, which is a rather unusual feature, as even the coarse arkose or conglomerative lying at the base of the Manitou Islands outliers contains a considerable admixture of carbonate of lime. Murray* mentions the finding of loose fragments of limestone with characteristic Chazy fossils that possibly overlies these sandstones, which may thus represent the basal portion of the Chazy formation.

Outliers of Manitou Islands.

The Manitou Islands, five in number, are situated about the middle of the wide open space in the eastern part of the lake. The largest and most northerly of these islands is about a mile in length from east to west, and is known as the Great Manitou or Newmans Island. The next in size and importance is the Little Manitou or McDonalds Island, while the other three are so small and insignificant that they have not been separately named.

The most southerly of these islands is somewhat less than a quarter of a mile long, but only a few chains in width. On the south-east side of the island is a dark-brown arenaceous limestone, containing angular or subangular fragments and pebbles of the subjacent gneiss. This rock is of no great thickness, and passes rapidly upward into a yellowish-gray arenaceous limestone. The whole section exposed is of small extent and thickness, the beds lying in nearly, if not quite, horizontal succession. The shore is strewn with large angular blocks of the

*Report of Progress, Geol. Surv. Can., 1853-56, p. 125.

coarse-grained, yellowish-gray, arenaceous limestone, containing many weathered and waterworn fragments of obscure cephalopod-like remains. These fragments, according to Dr. H. M. Ami, who has examined them, resemble the *Eudoceras multitubulatum* (Hall) from the Trenton and Black River.

McDonalds Island, or the Little Manitou, is about half a mile in length from north to south and of no great breadth. At the south-west corner is a small patch of yellowish-gray limestone, occurring in beds which have little or no inclination. The only fossil remains visible at this locality were fragments representing chiefly the siphuncles of orthoceratites together with crinoid stems and casts of supposed worm-burrows. Small outlying patches were also noticed beneath the surface of the water. On McDonalds Island.

About the middle of the island, on the west shore, the thickest exposure of the whole of these outliers is exposed. The total thickness is about thirty feet, the beds showing a gentle inclination to the west. At the base is a greenish or yellowish arenaceous limestone holding decomposed fragments and pebbles of the gneissic rocks beneath. This is overlain by a yellowish, arenaceous limestone, comparatively free from coarse fragmental material, which in turn gradually passes upward into gray limestones and shales holding numerous fossil remains. The orthoceratites are characteristic and numerous, and one specimen obtained must have belonged to an individual over six feet in length.

The following lists of fossils have been prepared by Dr. H. M. Ami from collections made by myself and my assistant, Mr. A. M. Campbell:—

Palæophyllum or *Columnaria*, imperfectly preserved.
Amplexopora, sp.
Coscinopora (?) sp.
Monotrypella quadrata, Rominger.
Pachydictya acuta, Hall.
Plectambonites (?) sp.
Zygospira recurvirostra, Hall.
Orthis tricenaria, Conrad.
Rafinesquina Cf. *R. alternata*, (Emmons).
Trochonema umbilicatum, Hall.

Small exposures of the basal conglomerate and overlying arenaceous limestone occur on the west side of the Great Manitou Island, these rocks dipping south $< 5°$, while on the south shore, near the old wharf, is a small outcrop of arenaceous limestone dipping east at a low angle. Fossils from Great Manitou Island.

From these exposures the following fossils were obtained :—

Stromatocerium rugosum, Hall.
Columnaria Halli, Nicholson.
Fragments of crinoidal columns not determinable.
Ptilodictya falciformis, Nicholson.
Rafinesquina Cf. *R. alternata*, (Emmons).
Zygospira recurvirostra, Hall.
Zygospira (?) sp. undet.
Lophospira bicincta, Hall.
" sp. type of *L. helicteres*, Salter.
Maclurea (?) sp. undet.
Actinoceras sp. Cf. *Actinoceras Bigsbyi*, Stokes.
Endoceras, sp.
Orthoceras, sp. Probably a new species of the type of *Orthoceras rapax*, Billings. This may be referable to the genus *Cameroceras*.

Trenton.

Trenton outliers.

Between Deux Rivières and Mattawa, are several small comparatively flat-lying exposures of sandstones and limestones resting upon the Laurentian gneiss close to the edge of the river, that are completely covered during times of freshet. The sections exposed are of no very great thickness or extent, the beds dipping in a southerly direction at a low angle. The most important of these outliers is the one situated on the north side of the river about four miles above Deux Rivières. The basal or sandstone beds formerly furnished material for the manufacture of grindstones of an excellent quality while local lime-kilns utilized certain portions of the higher beds exposed in this escarpment.

Fossils.

About six miles below Mattawa, two small outliers of a light-yellowish and purplish, gray-weathering arenaceous limestone are seen in the north bank of the Ottawa River, containing abundant fossils characteristic of Lower Trenton period. Besides the rock *in situ*, the beach in the vicinity of these outliers contain a large number of somewhat water-worn blocks of these fossiliferous strata.

The following list of fossils has been prepared by Dr. Ami from a collection made at this locality.

Receptaculites occidentalis, Salter.
Crinoidal fragments too imperfectly preserved for identification, but may belong to *Glyptocrinus*.
Prasopora Selwyni, Nicholson, (*Prasopora lycoperdon*, Vanuxem.)
Streptelasma corniculum, Hall.
Frondose monticuliporoid (section required for identification.)

Branching form of monticuliporoid.

Obscure monticuliporoid form, probably related to *Solenopora* (Cf. *S. compacta*, Billings.)

Strophomena incurvata, Shepard.

Rafiesquina alternata, (Emmons).

Orthis, sp. Cf. *O. tricenaria*, Salter.

Orthis (Dinorthis) proavita, W. and Sch.

Zygospira recurvirostra, Hall.

Young of *Murchisonia* (possibly *Lophospira bicarinata*, Hall.)

Fragment of trilobite too imperfectly preserved for identification.

SILURIAN.

Clinton and Niagara.

Character and affinities of the Silurian strata.

The rocks of this age, exposed on the shores and islands of the northern portion of Lake Temiscaming, have been of exceptional interest to geologists ever since their discovery and description by Logan in 1845*. Geographically, this outlying patch is so widely separated from any locality where rocks of similar age are now known to exist, that it has been a question whether it is indicative of an area of marine submergence connected with that in which the fossiliferous strata of Hudson Bay were deposited, or whether it was in some way connected with the Niagara basin to the south-west. It has been previously asserted that these rocks belong rather to the great northern trough connected with Hudson Bay, of which they are probably an outlier, and the absence of all strata of Niagara age in the region bordering the lower Ottawa has served to strengthen this belief. Although in lithological character and colour the rocks of similar age exposed on Temiscaming exhibit a marked similarity to the Niagara exposed further to the north, the rich and varied fauna characteristic of this outlier presents no corresponding resemblance, but rather a close analogy with the Niagara formation of south-western Ontario.

Fauna unlike that of northern Silurian.

It has been shown that a pronounced similarity exists both in lithological character and fossil remains between the Niagara of the Winnipeg basin and that exposed in the vicinity of the Churchill on Hudson Bay, although these areas are now widely separated, while both present organic forms that are entirely lacking in the Temiscaming outlier. These facts, therefore, seem to prove that the seas in which the Niagara sediments of the Winnipeg basin and of Hudson Bay were deposited were practically continuous, while both were separated from the Temiscaming basin and the region to the south-west.

*Report of Progress, Geol. Surv. Can. 1845-46, pp. 69-70. Geology of Canada (1863), pp. 334-336.

† Geology of Canada (1863), p. 334.

Strata in synclinal form.

The strata forming the Temiscaming outlier occur in the form of a shallow synclinal trough, occupying somewhat more than the breadth of the lake, which is here about six miles, and extending from the northern end of Moose or Bryson Island, north-westward beyond the confines of the present map. On both sides of the lake the rocks incline towards the water at varying angles, depending on the character of the shore-line; although in general the dip does not exceed 10°, and angles of lesser amount are far more common. On Mann or Burnt Island, as well as on the peninsula to the north, the limestones show a very gentle westerly inclination of between one and two degrees, while on Percy Island,* near the west shore, the rocks are very nearly if not quite horizontal. It is thus evident that any section made must of necessity be more or less ideal and any thickness based on the observed angles of the dip is sure to be misleading. The whole thickness exposed in any one section is somewhat less than 150 feet, and it seems certain that the total amount of the Niagara exposed on this lake cannot be greater than 300 feet, and may be considerably less. The occurrence of loose angular fragments and slabs of grayish dolomite, resembling that exposed in the vicinity of Lake Huron and Nipissing and containing characteristic Trenton fossils, has been noticed.† These are distributed at several points on the shores of the lake and specimens were collected from the north-east shore of Chiefs Island. Although their source has not yet been ascertained, the angular character of the fragments and their abundance shows clearly that this cannot be far distant. The lake is here over 200 feet in depth and it is just possible that below the Niagara limestone and concealed beneath the waters of the lake there exists an area of Cambro-Silurian rocks. This, however, can only be ascertained by boring, as no exposures of these rocks were encountered, although a diligent search was made with this object in view.

Possible area of Cambro-Silurian.

Conditions of deposition.

The relatively smaller quantity of conglomerates and sandstones, characteristic shallow water deposits, and the rapid alternation from these coarser clastics to the fine-grained limestones indicative of deep water deposition, point to a rather sudden marine invasion; while the comparatively great volume of strata remaining shows a prolonged submergence. The fine-grained character of most of the limestones show that their deposition took place in a quiet arm or extension of the sea, not affected by the open ocean, while the abundance and char-

* So called in honour of Captain Walter Percy of the steamer *Meteor* plying on this lake.

† Geology of Canada (1863), p. 335.

acter of the fossil remains are ample testimony of the genial character of its waters.

As exposed on the west side of Wabis Bay, in the north-west corner of the lake, the lower portion of this formation is composed of a loosely coherent sandstone or grit alternating with thinner beds of a fine conglomerate, with pebbles chiefly of Huronian quartzite, most of which have a thin coating of yellowish or brownish iron oxide, while the matrix consisting of similar material in a finer state of division, contains a slight admixture of calcareous matter. The actual contact between this and the underlying slate of the Huronian is not seen, although only a few yards intervene between the exposures of the two rocks. The existing relations can, however, be made out pretty clearly, for while the compact and rather massive slaty rock which here represents the Huronian occurs in exposures with more or less rounded or hummocky outlines, the arenaceous strata of the Niagara dip off or away from these hillocks at an angle of 5°. Conglomerates and sandstones.

At Haileybury, on the western shore of the lake, close to the water's edge and cropping out from the shingle is a small exposure of light-yellow fine-grained limestone, without visible fossil remains, dipping north-east 25°. The discovery of limestone with the general contour of the country in its vicinity, seem to suggest that a small patch of Niagara extends northerly along this shore towards Wabis Bay, being perhaps three miles in length by about a quarter of a mile in breadth, underlying the clay which here effectually conceals any rocks which may be beneath. Limestone near Haileybury.

Further south, on Percy Island, which is only a few chains in length and is separated from the western mainland by a very shallow and narrow channel, the rock exposed is a light-yellowish limestone, presenting a very uneven or cavernous surface as a result of unequal weathering. The strata are nearly if not quite horizontal and weather from yellow to brown or almost black, as a result of the iron present. Shells of various species of brachiopods are somewhat numerous. A number of the fossil remains collected, have been determined by Dr. Ami, as follows :— Fossils from Percy Island.

Clathrodictyon fastigiatum, Nicholson.
Favosites Gothlandica, Lamarck.
Syringopora verticillata, Goldfuss.
Crinoidal fragments.
Leptæna rhomboidalis, Wilckens.
Atrypa reticularis, Linnæus.
Meristella, sp.
Anoplotheca hemispherica, Sowerby.

Pterinea, sp.

Also branches of obscure Monticuliporidæ.

This fauna represents the Clinton or base of the Niagara or lower part of the Silurian.

Conglomerate on Chiefs Island.

The northern and western points of Chiefs Island, rise into comparatively high ridges of massive quartzose sandstone or quartzite-grit which present the usual rounded and glaciated outlines. Sheltered in the bay intervening between these two points is a small patch of boulder conglomerate, composed of sub-angular masses derived from the underlying quartzite. These are imbedded in a calcareo-arenaceous matrix composed chiefly of pebbles and finer material, the whole representing evidently a boulder-strewn beach covered by later sediments of the Niagara formation. The surface of the quartzite on which this conglomerate rests, presents the hummocky character so common in the case of the hard Archæan strata, the irregular cracks and depressions being filled by the conglomerate. Subsequent glaciation has removed much of the material, so that the exposure now presents a plane surface with a more or less net-like structure, the framework being represented by the finer arenaceous cement while the meshes or interstices are occupied by truncated sections of quartzite boulders as well as of the rounded hillocks of the solid rock beneath. Some of the boulders present in this conglomerate were evidently large concretions, as they exhibit concentric structure and weather very rusty owing to the disintegration of the large proportion of iron present. The finer cementing material, while relatively much smaller in amount than the peebles and boulders, is always of a greenish or yellowish colour and frequently contains corals and orthoceratites. The action of the weather has partially obliterated the glacial striæ on this finer matrix, but the sections of the quartzite boulders and hummocks exhibit these markings in great perfection.

Fossils from Chiefs Island.

On the south-western shore of Chiefs Island, is another small patch of a finer grained conglomerate, the pebbles of quartzite being less numerous and of much smaller size, while the matrix contains much more calcareous matter. The rock dips south-east $< 5°$.

A number of rather badly preserved fossils were secured at this locality, which have been named as follows by Dr. Ami :—

Halysites catenularia, Linnæus.

Columnaria, sp., with very irregularly disposed horizontal tabulæ.

Zaphrentis, sp.

Streptelasma or *Caninia*, sp.

Rhynchonella, sp.

Murchisonia, two species.

Euomphalus, very large species.

Discosorus. Cf. *D. conoideus*, Hall.

The above fauna represents the Clinton formation or lower portion of the Niagara.

On the east side of the lake, from the point south of Chiefs Island to within less than a quarter of a mile from Piché Point, the shore is occupied by a narrow fringe of the basal conglomerates and sandstones of the Niagara. The coarser beds are of the boulder conglomerates already described, representing simply a talus of angular and sub-angular fragments detached from the elevations in the immediate vicinity of the exposures, consolidated together by a finer grained arenaceous cement of a yellowish colour in which are also embedded fragments of corals and orthoceratites.

Outliers on east side of lake.

This boulder conglomerate passes upward into a fine conglomerate in turn replaced by a coarse grit, and becoming finally a yellowish rather friable sandstone. These beds run in long undulating curves, closely following the general outline of the underlying quartzite with a general westerly dip at angles varying from 10° to 15°. The action of the waves has in places caused this to disintegrate very unevenly leaving a rough pitted surface. At Piché Point and for some distance north, the Huronian quartzite is left entirely denuded of these deposits.

Basal conglomerate.

In the bay to the south of Piché Point and between this and Wright's silver mine, there are two small patches of thinly bedded light-yellow arenaceous limestone dipping in a southerly or south-westerly direction $<5°$, immediately south of Wright's mine is another small patch of similar arenaceous limestone dipping south-west $< 9°$.

Arenaceous limestone.

On the east shore of the lake, nearly opposite Bryson Island, there are two more small patches of the arenaceous limestone exposed at the shore, wrapping round the hummocks of Huronian quartzite and dipping in a southerly or south-westerly direction $<5°$. None of these small patches of limestone contained any visible fossil remains.

On Burnt or Mann Island, as also on the two smaller islands between this and Bryson Island (Oster and Brisseau islands), as well as on the high promontory separating Wabis and Sutton bays in the northern part of the lake, are exposed the limestones and shales that represent the deep-water deposits of this period. The limestone is of a pale-yellow or cream colour, weathering whitish, and varies in thickness from a few inches up to two feet or over. Some of the

Main limestone area.

beds are very fine-grained and of rather even texture, and it is possible that some parts may prove to be sufficiently uniform for use as lithographic stone. As a building stone it is of excellent quality. These limestones, on the north shore of the lake at Dawson Point, dip a little south of west at an angle of between one and two degrees, rising into cliffs of over a hundred feet in height on the west side of Sutton Bay, and forming a somewhat elevated rocky plateau with a gentle westerly slope, corresponding mainly with the angle of dip towards Wabis Bay. The east shore of Mann Island presents a somewhat similar, though much lower escarpment, while the western shore is a gently shelving beach, which at low water reveals considerable areas of the almost horizontal limestones. Some of the beds contain a considerable proportion of silica of a cherty character, and all the fossils are more or less silicified. The action of the weather causes them to stand out in relief and often displays their minute structures perfectly. A large collection of these fossils was made along the western shore of Mann Island, comprising the following forms as determined by Dr. Ami and Mr. L. M. Lambe :—

Building stone.

Fossils from Mann Island.

Bythotrephis (Chondrites) gracilis, Hall
" Cf. *B. palmata*, Hall.
Clathrodictyon fastigiatum, Nicholson.
Cyathophyllum articulatum, Wahlenberg.
Zaphrentis Stokesi, Milne-Edwards and Haime.
Favosites Gothlandica, Lamarck.
Alveolites Niagarensis, Rominger (non Nicholson).
Cladopora crassa, Rominger.
Syringopora verticillata, Goldfuss.
" *bifurcata*, Lonsdale.
Halysites catenularia, Linnæus.
" *compacta*, Rominger.
Lyellia affinis, Billings.
" *Americana*, Milne-Edwards and Haime.
Thysanocrinus liliiformis, Hall.
Dendrocrinus longidactylus, Hall.
Taxocrinus n. sp.
Lichenalia concentrica, Hall.
Phænopora expansa, Hall.
Trematopora sp.
Orthis (Dalmanella) elegantula, Dalman.
Orthis calligramma, Dalman.
Platystrophia biforata, var. *lynx*, Eichwald.
Strophomenoid shell, type of *Rafinesquina*.

Stropheodonta sp. (? n. sp.)
Leptæna rhomboidalis, Wahlenberg.
Atrypa reticularis, Linnæus.
" *intermedia*, Hall.
Trematospira sp.
Pentamerus oblongus, Sowerby.
Euomphalus alatus, Hisinger.
Murchisonia sp.
" *subulata*, Hall.
Discosorus conoideus Hall.
" *gracilis ?* Foord.
Orthoceras, *sp.*
" *sp.* Cf. *O. virgulatum*, Hall.
Orthoceras Cf. *O. Cadmus*, Billings. Cf. *O. sub-cancellatum*, Hall.
Actinoceras vertebratum, Hall. . *A. Backi*, Stokes.
Calymene Niagarensis, Hall. Probably identical with *Calymene Blumenbachii*, Brongniart.
Beyrichia, *sp.* Cf. *B. lata*, Hall.

PLEISTOCENE.

Main division of Pleistocene.

The Pleistocene history of this and adjacent regions seems to be in the main divisible into two parts. (1) That of great accumulation of snow and the production and maintenance of a confluent ice-sheet. This is believed to have been accompanied, if not caused, by a vast regional uplift, increasing in amount to the north-eastward. Following this came (2) a profound submergence, during which time the ocean invaded a large portion of the Ottawa valley, forming a marine gulf, rivalling in extent and depth similar encroachments made by the sea during portions of the Palæozoïc. The researches already made seem to show that channels may have connected that portion of the ocean covering the St. Lawrence and Ottawa valleys with that existent in Hudson Bay, while the marine invasion may even have been continuous over a vast inland basin represented at present in part by the area of the Great Lakes.

Subsidences measured by terraces.

Taylor, Chalmers, Gilbert, Wright, Spencer and others have been at work in this and neighbouring districts connecting and correlating the beaches representing the various stages of this submergence, but it is only possible within the scope of the present report to point out in the most general way some of the important results obtained. Taylor has shown that immediately following the retirement of the great ice-sheet which marked the first part of the Pleistocene, and to which reference will shortly be made, an important strait or arm of the sea covered the Mattawa and Temiscaming valleys, while later, as the flood subsided and the ice receded from parts of the area previously held by it, most of the waters of the Great Lakes emptied for a considerable time eastward into the Ottawa through the Mattawa valley. Beaches marking the successive stages in the subsidence are well exposed on the hillsides to the north and south of Lake Nipissing, especially in the vicinity of North Bay, where they were found and described by Taylor and Wright, while the valleys of both the Mattawa and Ottawa rivers present many evidences of having been occupied for a somewhat protracted interval by a stream rivalling, if not exceeding, the St. Lawrence in volume.

The confluent glacier.

In the present report, the existence is assumed of a vast superincumbent glacier, of which the chief gathering-ground, as indicated by existing striæ and distribution of drift material, was situated directly over the watershed between Hudson Bay and the St. Lawrence River. This hypothesis appears to offer the most satisfactory and comprehensive explanation of the various phenomena, while at the same time it is one in accord with views that have already received most general recognition among students of Pleistocene geology.

Glacial and interglacial periods.

Although thus generally agreed as to the agency producing the various results encountered, a considerable diversity of opinion exists among geologists as to whether the large number of observations already made can be adequately explained on the theory of one great ice-flow with minor oscillations or of several distinct epochs of glaciation, each with its own proper ice-mass and separated from one another by interglacial periods during which much milder climatic conditions prevailed. The information obtained from the examination of this district is not sufficient to afford a basis of argument in favour of either view. It is, however, easy to understand that while areas situated near the extreme border of the ice-sheet may have enjoyed comparatively long interglacial periods, during which the climate was of such genial character as to permit and favour the growth of a somewhat luxuriant vegetation, others, in regions further removed to the north-east and near the centre or centres of accumulation showed very little, if any, amelioration of temperature. The divergence in existing striæ observed throughout this district seems perfectly explicable on the theory of differing phases of one great glacier, with comparatively short intervening lapses of time during its temporary recession and subsequent re-advance.

As the position of these first-formed ice-masses would of necessity be largely determined by the position of the highest land then existent in this region, it is probable that very early in the Glacial period there were two main gathering grounds or centres of dispersion for such ice. These would be situated respectively in the area to the north-west of Lake Temiscaming, in the vicinity of the "Great Bend" of the Montreal River and the high quartzite ridges to the west of Lady Evelyn Lake, and on the high rocky hills known to exist in the vicinity of the height-of-land to the north-west of Lake Temiscaming. It is probable that early in the ice age these local centres sent out glaciers which flowed over the lower lands and valleys to the south and may have been the cause of some of the striæ observed on the rock-surfaces exposed in the valley of the Montreal River, as well as on the shores of Lake Temiscaming. Although it is possible that all such evidences may have been so obscured in the profound general glaciation which followed as to render their recognition and correlation, matters of extreme difficulty. We may suppose that local glaciers of the kind above referred to, increasing under favourable conditions, eventually coalesced as parts of one great ice-sheet, of which the distributing centre may have been gradually shifted eastward towards the neighbourhood of Opasatika and Labyrinth lakes on the canoe-route to Lake Abitibi. There is likewise sufficient evidence, afforded by a study of the later striations, that must have been caused by temporary re-advances in the waning ice-sheet, that this eastward shifting of the main gathering-ground must have slowly continued, while the final recession was almost directly north-east.

Where glaciers were first formed.

Traces of early glaciers.

It is now a well ascertained fact that the motion of ice is one resulting from its plasticity, resembling substantially the movement which obtains in an extremely thick and viscid fluid when spread upon any surface and a supply of fresh material constantly added. It is therefore obvious that any inclination, however slight, of the underlying surface or the interposition of natural barriers at or near the sources of supply were in the first instances the determining causes of the general direction of the ice flow. This onward motion once imparted, was continued and depended subsequently not so much on the nature of the land surface on which the glacier reposed as upon the general slope of the upper surface of the glacier which inclination was imparted as a result of the unequal accumulation of material at the centres of dispersion. To the north and north-east of Lake Temiscaming the various passes, or valleys leading northwards across the height-of-land are a little less than 1000 feet above the sea, although the rocky ele-

Conditions determining direction of motion.

vations in the immediate neighbourhood rise in general from 200 to 500 feet heigher, while some of the hills in the vicinity of Labyrinth and Opasatika lakes show an elevation of over 600 feet above the surrounding lakes. If added to the general slope thus obtained be taken, the rise consequent on a differential uplift gradually increasing in a northerly direction, the resulting slope would be sufficient to compel a somewhat rapid south-westerly flow in any glacier formed in this vicinity, while in addition it is probable that an ever increasing supply of icy material to the north-east, might so accelerate this onward motion that even the interposition of such formidable natural barriers as the deep gorge of Temiscaming must have been, with its steep opposing slope, only served as temporary checks.

Differential uplifts.

Transportation of material.

This great ice-sheet acted as an important agent of transportation, catching up and carrying forward large quantities of clay, sand, gravel and boulders from the higher elevations on the north to fill up the various inequalities of contour existing further south. The drift material, though varying very much in this region, is as a rule very coarse on the higher levels and on the hill-sides facing towards the south and south-west. On these higher levels the ground is very much encumbered by more or less rounded or subangular boulders which usually do not show transportation from any great distances; although by a careful comparison of the material of this drift, it was ascertained that many of these loose fragments had been carried as much as fifty or sixty miles, in a direction closely corresponding with the striation marking the maximum extension of the ice-sheet over this district. Thus, loose fragments of the buff-coloured limestone with characteristic nodular cherty matter, known to occur in a patch of somewhat limited area in the vicinity of the northern part of Lake Temiscaming, were found on Marten or Crooked Lake in the township of Gladman, a distance of over fifty miles from where such rock is now found in place. The distribution of these characteristic fragments which are an especially valuable criterion of the direction of ice-flow, on account of the known limited extent of this Silurian outlier, shows that the agency which affected their transportation had a direction of movement varying from S. 7° W. to S. 18° W., thus agreeing very closely with the most abundant and pronounced striæ. On Lake Nipissing, the various shales and greywackés characteristic of the Huronian exposed in the area of the Lake Temiscaming map-sheet, are rather plentifully represented among the loose boulders fringing the shores.

Distance of transport.

Direction of transport.

Stratified deposits.

The stratified sands and clays so abundant in the area to the north of Lake Nipissing, as well as those in the vicinity of the Veuve River, were probably deposited very rapidly from streams issuing from the margin or front of the retreating glacier, as was likewise no doubt the case with the thick and widespread deposits of stratified clay which forms such extensive flats in the region bordering the northern portion of Lake Temiscaming. The terraces characteristic of the occurrence of these clay deposits to the north of Lake Temiscaming, merely serve as mark accentuating the various stages or haltings in the ice-sheet, of which the margin was buried beneath the rising waters, thus permitting and even favouring such a mode of deposition of the englacial detritus. Especially along the course of the Ottawa and Temiscaming valley, the region exhibits frequent great accumulations of morainic *débris* marking the recession of the ice-lobe occupying this deep and important depression. These deposits from the drift-laden glaciers are described in some detail in the geological description covering the area immediately bordering these topographical features. Moraines.

Besides the removal and transportation of boulders, gravel and other material, there is abundant evidence everywhere of considerable abrasion of the surface produced by the passage of the ice-sheet across this district. Throughout the whole area covered by the accompanying map-sheets, most of the rocky elevations have been smoothed and in many cases even polished, while scratched or striated surfaces are also common. These striæ are usually long, more or less parallel scratches, varying in size from extremely fine lines which can often only be detected by very close scrutiny, to furrows several inches in depth and width. They have in general a somewhat constant direction except in the vicinity of deep and narrow valleys, where they frequently show considerable divergence from the average direction of the district. Many of these striæ consist of a series of irregular, curving and often faint scratches, as if occasioned by an uncertain or intermittent action while some of the deeper and more pronounced furrows exhibit irregular broken cavities at intervals in their course as though produced by a "bumping" action caused by hitches in the rocky implement producing them. Glaciation of rock-surface.

Ledges and ridges which have been long exposed to the action of the weather, usually reveal little or no evidence of such striation on account of the sub-aerial decay to which the rock has been subjected, while, on the contrary, rock exposures which have been but lately denuded of their overlying soil, as well as those portions of the rocky shores of the various lakes and streams exposed only between extremes of high and low water, usually exhibit such markings in great perfection. The various gneisses and granites of the Laurentian areas are so faintly Differences in preservation.

marked, if at all, that the direction of the striæ can seldom be ascertained with any degree of certainty. There seems no reasonable doubt that such markings were originally present, as under the favourable conditions already mentioned they are often plainly discernible, but as a rule prolonged atmospheric decay has so acted on exposed surfaces of these rocks that their surfaces have become roughened. On the other hand on exposures of Huronian rocks such as slate, greywacké, quartzite and especially diabase and gabbro, these glacial markings are very frequently to be observed in all their pristine freshness. In many localities, particularly in the area covered by the Lake Temiscaming sheet, there are two, three and even four sets of striæ on the same rock-surface, differing somewhat in direction and marking as a rule but slight changes in the direction of the ice-flow, during successive re-advances of the ice-sheet. The correlation of such striæ is usually exceedingly difficult and unsatisfactory, as the intervening lapse of time denoted by these divergences was doubtless of comparatively short duration.

Striæ in different bearings.

Probably due to different periods.

It is probable, as has been stated, that early in the ice age glaciers of the alpine type occupied the high hills of diabase and gabbro in the vicinity of the height-of-land immediately west of the canoe-route between Lac des Quinze and Abitibi, as well as on the high ridges of quartzite-grit to the west of Lady Evelyn Lake, of which Maple Mountain is the most prominent eminence. The striæ which have the closest correspondence with the general trend of the valley of Lake Temiscaming and the Ottawa River were possibly caused by such a local glacier, as these markings are earlier than those which trend to the east on the one hand or to the west on the other. The striæ marking the main advance of the ice-sheet in this region show a general trend of about S. 14° W., but many of the observations noted present a marked divergence from this general direction, especially those made in the vicinity of lakes and streams where these ice markings show an unfailing tendency to conform very closely to the direction of the inclosing valleys.

Change from south to south-west.

The earliest of these south-westerly ice markings are those which run nearly south, the direction of ice-flow showing a gradual change in the direction of successive re-advances, following temporary recessions, from a little west of south to almost directly south-west.

Striæ following valleys.

In the area covered by the northern and central portions of the Lake Temiscaming sheet, there are many lakes whose general trend makes but a small angle with the average direction of ice-flow while their containing valleys are narrow, rocky and steep. The northern part of Temagami, Waibikaiginaising and Wakémika lakes may be cited as examples where the glacial striæ show a general direction of a little east of south, in this respect showing the marked influence of topographical outline.

List of striæ.

In the subjoined list, which is necessarily brief and incomplete, consisting of observations made during an exploration whose primary object was to map out and report upon the various subdivisions of the Archæan rocks, an attempt has been made wherever possible to tabulate in regard to their age the various striæ observed. Where two, three, and even four sets are noted as occurring on the same rock-surface, the order in which they appear is believed to represent, with approximate accuracy, their relative ages from the oldest to the most recent.

List of Glacial Striæ.

Lake Temiscaming.

Wabis Bay, west shore of, on lot 10, con. V. Bucke Township ...	S 15° E S 45° W
Wabis Bay, east shore of, on lot 2, con. I. Harris Township.	S 19° E
Sutton Bay, north-east shore of, on lot 8, con. V. Harris Tp......	S 51° E
East shore, west of Abbika Creek, on lot 38, con. I. Guigues Tp..	S 81° E
Chiefs Island, east shore of	S 36° E S 66° E
Chiefs Island, north shore of	S 66° E
Chiefs Island, west shore of	S 14° E S 48° E S 54° E
East shore, on lot 31, con. I. Guigues Township	S 32° E
Piché Point, south of, on lot 12, con. I. Guigues Township.......	S 33° E S 46° E
East shore, north of Wright's mine, on lot 7, con. II. Guigues Tp.	S 23° E S 43° E
Wright's mine, (Lake Temiscaming Silver Mine) on lot 62, con. I.. Duhamel Township "Block A"..	S 21° E S 31° E S 60° E
Joanne Bay, east shore of, on lot 58, con. I. Duhamel Township..	S 28° E S 14° W
East shore, on lot 54, con. I. Duhamel Township................	S 26° E South
East shore, at Narrows with Bryson Island on lot 44, con. I. Duhamel Township..	S 21° E
East shore, opposite Drunken Island, on lot 31, con. I. Duhamel Township..	S 4° W
West shore on lot 14, con. IV. Lorrain Township................	S 4° W
West shore on lot 12, con. VI. Lorrain Township................	S 21° E
West shore on lot 11, con. VII. Lorrain Township.	S 12° W S 18° W
West shore, on lot 15, con. 1. Bucke Township..................	S 18° E S 26° W
Laperrière Bay, north shore of, ½ a mile east of old H. B. Co's post, on lot 7, con. II. Duhamel Township	S 21° E S 6° W
Islet near east shore about 1 mile south-east of Roche McLean.....	S 17° W S 32° W
Roche McLean, near west shore..	S 10° E
West shore opposite Roche McLean..	S 4° E
West shore 1½ miles north of Montreal River	S 4° W
West shore 1½ miles south of Montreal River	S 21° E S 19° W

List of striæ—*Cont.*

Quinze River.

Islet opposite North Temiscaming, P.O. Near south-east shore	S 21° E S 31° E
At second rapid above Lake Temiscaming	S 50° E
On new road to Lac des Quinze, 6 miles east of First Rapid on River des Quinze	S 47° E

Lake Temagami.

North East Arm, west end of portage to Caribou Lake	S 4°W S 14°W S 19°W
North East Arm, Island in south narrows, two miles west of portage to Caribou Lake	S 16°W
North East Arm, Islet near south shore, ½ mile south-east of Ferguson Island	S 16°W S 20°W
North East Arm, island east of Broom Island	S 14°W
North East Arm, point on south shore ½ mile south-east of Broom Island	S 9°W S 24°W
Ko-ko ko Bay, East shore of, 1½ miles south of north end	S 9°W
Ko-ko-ko Bay, Islet near centre, 2⅜ miles south of north end	S 14°W
Ko-ko-ko Bay, Islet near west side, 3⅜ miles south of north end	S 8°W
Ko-ko-ko Bay, East shore of, 3½ miles south of north end	S 6°W
Ferguson Bay, east side, near southern end	S 1° E
Ferguson Bay, point on west shore 1¼ miles south of Ferguson Point	S 6° E S 8° W
Sandy Inlet, point on south-east shore ½ mile east of Ferguson Point	S 1° E S 18° E
Sandy Inlet, north-east shore, near mouth of Annima-nipissing River	S 1° E S 18° E
Whitefish Bay, east shore, 1½ miles south of creek from Whitefish Lake	S 11° E S 4°W
Whitefish Bay, point on west shore ½ mile south-west of creek from Whitefish Lake	S 28° E
Whitefish Bay, islet in, nearly 1 mile south of creek from Whitefish Lake	S 1° E S 16° E
North Arm, Point on west shore, ¼ mile south of Deer Island	S 9° E S 14° E
South West Arm, island near north end of	S 19° W
South West Arm, east shore of, 2 miles south-west of Narrows Island	S 9° W S 19° W
South-west Arm, east shore of, 5 miles north-west of south end	S 4° W S 14° W
Islet, 1⅜ miles south-west of Hudson's Bay Cos post	S 4° W S 11° W S 29° W
Islet 1¾ miles east of Hudson's Bay Co.'s post	S 9° W
Islet near north end of Island Bay	S 1° E S 12° W S 29° W
Portage near south end of McLean Peninsula	S 4° W
High Rock Island, south-east shore of	S 24° W S 29° W

Cross Lake.

West shore of lake, 1½ miles south of Temagami River inlet	S 5° W
North point of island, 1¾ miles south of Temagami River inlet	S 3° W
East shore of same island, 2 miles south of Temagami River inlet	S 2° E S 7° W
West shore, ⅓ mile north of Temagami River inlet	S 13° W
West shore, 1¼ miles south of Temagami River inlet	S 2° E S 8° W
Small island near west shore 1¾ miles north of Temagami River inlet	S 11° W S 15° W
Point on west shore 1¾ miles north of Temagami River inlet	S 5° W

Area South-east of Lake Temagami.

List of striæ—*Cont.*

Island near south-east end of Jumping Caribou Lake	S 14° W
Marten Lake, south-west shore of, ⅛ mile north-west of north town line of McLaren	S 20° W
Islet in Red Cedar Lake, lot 6, con. VI., Thistle Township	S 2° W S 12° W
Tomiko Lake, north-west shore of, on lot 5, con. I., Fell Township	S 15° W
Moxam Lake, north-east shore of	S 4° W S 22° W S 29° W
Expectation Lake	S 22° W
Simpson Lake, at outlet of	S 22° W
Simpson Lake, islet near north-east end of	S 22° W
Mackenzie Lake, islet near east end of	S 22° W
Mackenzie Lake, east end of	S 14° W
Breadalbane Lake	S 21° W
Bush Lake (near headwaters of Ottertail Creek)	S 30° W
Poplar Lake, west shore of, on lot 2, con. III., Gladman Township	S 6° W
Kaotisinewaning Lake, south shore of, in Notman Township	S 7° W
Red Water Lake, west side of, nearly ¾ mile from outlet	S 20° W

Lake Nipissing.

Goose Islands	S 25° W S 30° W
Manitou Islands, most easterly islet of	South
Small island in Goulais Bay	S 15° W
Goulais Point	S 25° W
Small island opposite lot 3, con. C., Caldwell Township	S 19° W
North shore of, on lot 7, con. C., Caldwell Township	S 25° W
North shore of, on lot 11, con. C., Caldwell Township	S 25° W
Point on west shore	S 30° W
South-east shore of Bear Bay, opposite Maskinongé island	S 10° W
Deer Bay, south shore of (west arm)	S 20° W
North shore of, on lot 6, con. C., Springer Township	S 14° W
North shore of, on lot 5, con. C., Springer Township	S 12° W
North shore of, point 3½ miles east of Dukis Point	S 19° W
North shore of, point 4 miles east of Dukis Point	S 14° W
Clark (Sandy) Island, near western end	S 30° W S 35° W
Hardwood Islands, west end of	S 20° W
Island east of east end of Hardwood Islands	S 25° W
South Bay, east shore of	S 23° W

Lady Evelyn Lake and vicinity.

Point on north side of largest island in Lady Evelyn Lake, 3 miles south-west of Obisaga Narrows	S 4° W
Island in Lady Evelyn Lake, 3½ miles south of Obisaga Narrows	S 6° W
South-west shore Nonwakaming Lake, 3 miles west of inlet	S 5° W S 21° W
Island near east shore Nonwakaming Lake, about 2 miles north-west of inlet	S 3° W S 20° W
West shore Wakémika Lake	S 8° E S 22° E
South shore Wakémika Lake	S 3° E S 17° E
Turner Lake, south-east shore of	S 10° W

Area north-east of Lake Temagami.

Net Lake, east shore of, near north end	S 4° W
Loon Lake, south end of	S 3° W
Ko-ko-ko Lake, east shore of, ¼ mile north of outlet	S 18° W
Ko-ko-ko Lake, east shore of, 2¾ miles north of outlet	S 2° E S 3° W

List of striæ—*Cont.*

Tetapaga Lake, north shore of, 1 mile east of outlet	S 1° W
Turtle Lake, north shore of	S 1° W S 25° W

Vermilion Lake.

Turtle Lake, small island near north shore of	S 10° W S 15° W S 30° W S 52° W
Waibikaiginaising Lake, island near east shore of, 3 miles from south end	S 6° E S 9° E S 29° E
East end of portage between Summit and Friday lakes	S 8° E S 18° E
Friday Lake, west shore of, 1½ miles north of outlet	S 6° E S 16° E
Bear Lake, east shore of, 2 miles north of outlet	S 4° W
Island in Vermilion Lake, ½ mile south-west from north-east end	S 8° W

Wickstead (or Shabosaging) Lake.

On rocky islets, 1⅛ miles south-west of inlet	S 14° W S 27° W
On south-east shore, 1¼ miles south-west of inlet	S 27° W
On north-west shore, 2 miles south-west of inlet	S 24° W
On Rocky islet, 4¼ miles south-west of inlet	S 27° W.
At Narrows, 2½ miles north-east of outlet	S 14° W S 24° W
On islet near west shore, 4½ miles south-west of inlet	S 24° W S 34° W
On islet near west shore of big western bay, 4 miles south-west of inlet	S 19° W S 24° W
On west shore, 1 mile north-east of outlet	S 23° W S 31° W

Annima-nipissing Lake and vicinity.

West shore of bay on route to Mountain Lake	S 10° E S 2° E S 3° W
Island near centre of lake, 4 miles from north end	S 6° W S 37° W
West shore, 3½ miles from north end	S 9° W S 20° W S 29° W
Gull Rock Lake, north-east shore	S 20° W
Carrying Lake, south shore of	S 7° W S 20° W
Diabase Lake, south shore of	S 3° W S 18° W

Rabbit Lake and vicinity.

Rabbit Chute on Matabitchouan River, at outlet of lake	S 1° W S 8° W
West side, ¼ mile south of Rabbit Chute	S 3° W
Burnt Point, on west side of south end of Outlet Bay	S 3° W S 8° W S 33° W S 38° W
South-east shore, 1 mile north-east of Rabbit Point	S 13° W
Point on east shore, ¼ mile north of Rabbit Point	S 2° W S 13° W S 35° W S 42° W

List of striæ—*Cont.*

Island in Rabbit Lake, opposite Rabbit Point	S 5° W
Ross Lake, south shore of	S 4° W S 22° W S 29° W
White Bear Point, on west shore White Bear Lake	S 3° W
Island in White Bear Lake, near north-east corner	S 8° W S 15° W S 40° W

Montreal River and vicinity.

South end of Mountain or Round Lake	S 42° E
On islet in river, 1 mile below Mud Lake portage	S 22° E
At Fountain Falls	S 17° E
Island near west shore, near north end of Sharp Lake	S 40° W

ECONOMIC GEOLOGY.

Gold and Silver.

Gold and silver.

Throughout the whole of the large area coloured as Laurentian on the accompanying map-sheets, very coarse aggregates of quartz and felspar with more or less mica, known as pegmatites, are of frequent and often rather extensive occurrence. In origin they are distinctly igneous and intrusive and in many localities are dyke-like, often branching and cutting across the foliation of the gneissic rocks, although in other instances they occur as coarse-grained bands or belts interfoliated with the finer grained granite-gneisses. These acid bands sometimes become finer grained and not infrequently shade imperceptibly into the mass of the gneisses with which they are associated.

Reported discovery of gold in pegmatites.

Early in 1887 the town of Mattawa was startled by the report of the discovery of gold in considerable quantity in a large number of these quartzo-felspathic masses cutting the gneissic rocks in the immediate vicinity. An examination was undertaken of these so-called gold-bearing quartz-veins, and a number of samples taken to represent nine of the principal localities were submitted to Dr. Hoffmann, Chemist and Mineralogist to the Survey, which when assayed furnished only negative results in the case of both gold and silver. The following table shows in a concise manner the results thus obtained* :—

Locality.	Description.	Gold.	Silver.
Mattawa, hill on north side Ottawa River.	Quartz and felspar (pegmatite) large samples from five different localities..	None	None
Hill on east side Ottawa River 3 miles north of Mattawa.	Quartz and felspar in mica schist.	None	None
3 miles west of Mattawa and ½ mile north of McCool's mill.	Quartz with a little felspar. Large samples from three different localities.	None	None

*Annual Report, Geol. Surv. Can., vol. III. (N.S.), 1887-88, pp. 30-31 T. Assays Nos. 22-30.

Quartz veins Lac des Quinze.

About the same time, samples from apparently segregated veins of quartz, containing more or less disseminated sulphides and cutting what has been mapped as Laurentian gneiss in the Lac des Quinze region, were obtained by Mr. C. C. Farr of Haileybury, Ont. These were sent to the Geological Survey and handed to Dr. Hoffmann whose assays showed only traces of the precious metals. The following table condensed from Dr. Hoffmann's report will show the result of his examinations and assays* :—

Locality.	Description of Specimen.	Weight	Gold per ton.	Silver per ton.
Route to Abitibi, 8 miles S. Height-of-land.	Chalcopyrite and quartz.	1½ oz.	Trace	None
R. A. Klocks Limit, north shore Lac des Quinze.	Pyrite and pyrrhotite and quartz.	4½ "	"	"
Lac des Quinze, north-east end.	Pyrite in quartz with ferric hydrate.	8 "	"	Trace

Quartz assays, Lake Nipissing and vicinity.

In addition to these, samples of quartz containing in some case pyritous material were sent to the Director of the Geological Survey, but their assays by Dr. Hoffmann did not afford any encouraging results as far as regards their gold and silver contents. These samples were from Lake Nipissing and the region adjacent and the results of their examination in the laboratory of the Survey may be referred to as follows† :—

Locality.	Description of Specimen.	Weight.	Gold per ton.	Silver per ton.
Sturgeon R. (branch of) N. of Badgerow Tp.	Finely crystalline galena and chalcopyrite with a little quartz.	6⅝ oz.	very distinct traces.	15·75 oz.
Small island in Lake Nipissing.	Chlorite-schist, mica-schist, gneiss and calcite with a little pyrrhotite and pyrite.	2 "		·116 "
Vein crossing inlet, W. end Lake Nipissing.	Rust-stained quartz & gneiss.	8 "	none	none
Great Manitou Island, Lake Nipissing.	Felspar and quartz with molybdenite and pyrite.	¼ "	"	"
Two miles W.N.W. of North Bay.	Rust-stained quartz with pyrite.	4¼ lbs.	"	"

Character of veins in Huronian rocks.

In the area characterized by the presence of Huronian rocks and their associated eruptives, a large quantity of whitish or grayish

*Annual Report, Geol. Surv. Can., vol. III. (N. S.), 1887-88, part T, analyses Nos. 11-13.

†Annual Report, Geol. Surv. Can., vol. II. (N. S.), 1886, part T, analyses Nos. 53. Vol. IV. (N. S.), 1888-89, part R, analyses Nos. 82, 84 and 86.

translucent quartz is an almost invariable accompaniment of any extended exposure of rock. This quartz is seen to represent segregations of secondary silica filling in the various cracks and fissures caused by the profound orographic movements through which these strata have passed. Sometimes this vein-quartz is in the form of lenses or eyes occupying various small gaps or openings in the rocks, these gradually increasing in size until lenticular masses of quartz of considerable dimensions are formed. In some cases these masses run for considerable distances and approximate in character to true fissure veins, although large and typical examples of such veins are exceedingly rare in this region. Both in their horizontal and vertical extensions these "gash-veins" are exceedingly irregular, and in no case noticed can any great reliance be placed on their persistence in any direction. Calcite and dolomite often occur in association with the quartz of such veins, with varying quantities of pyrite, chalcopyrite and galena; while sphalerite and hæmatite (micaceous iron ore) are occasional constituents. The quartz is very often more or less cavernous or cellular, owing to the oxidation and partial removal of the sulphides originally present. Where pyrite has been abundant the quartz is more or less rusty, while the various cavities are partially filled with ochreous material. On the other hand, where copper-pyrites is the more abundant, the quartz is more or less stained and coated with green and blue carbonates of copper. Occasionally the galena shows a thin coating of carbonate of lead (cerussite) where exposed to atmospheric action, and Dr. Hoffmann makes a note of its occurrence at the Macinac lead-vein on Haycock's location, east side of Lady Evelyn Lake, one and a quarter miles south of the outlet.*

found in them.

Their origin.

In origin, many of these quartz veins, and especially the larger ones, are connected with the eruption of the large masses of diabase and granite that invade the stratified slaty rocks, and often they are either on the line of junction between these two rocks or occupying breaks and fissures in its immediate vicinity, produced during the eruption of these igneous rocks. Occasionally, such secondary veins of quartz occur in irregular fissures in the diabase itself.

Veins on Lady Evelyn Lake.

Some of the most important of such veins noticed, occur on the "Mattawapiki," as the last stretch of Lady Evelyn Lake before reaching the Montreal River, is called. The western shore of this portion of the lake is composed of diabase, that rises abruptly from the surface of the water and often from steeply sloping or perpendicular cliffs. The contact between this rock and the slates is concealed for

* Annual Report, Geol. Surv. Can., vol. IV. (N.S.), 1888-89, part R, analysis No. 60.

the most part by the lake, the eastern shore being altogether composed of a very distinctly banded greenish slate, which also rises into rather important elevations, having apparently been protected to a considerable extent from denudation by the proximity of the more unyielding diabase. The contact, for a short distance, runs inland along the western shore, leaving a comparatively narrow strip composed of the slates, which are seen to have been much shattered and broken up by the intrusion of the diabase. Some considerable masses of segregated quartz were here noticed filling irregular cavities and fissures produced during the eruption. Associated with the quartz is more or less calcite, and in this gangue were noticed galena, copper-pyrites, iron-pyrites and zinc-blende. The banded slates on the eastern shore dip in an easterly direction at an angle of about 18°, and associated with and cutting these are similar segregated masses or "gash-vein," in which galena is the prevailing constituent. The property on which these veins are situated is owned by Messrs. Klock and Haycock, and is locally known as the Haycock mine or location. A considerable amount of development work has been done, looking chiefly to testing the quality and extent of the ore-bodies, but the inaccessability of the locality would be a sufficient hinderance to any further operations, unless the deposit should prove of an exceptionally rich character. Assays of representative samples from these and similar veins exposed in the immediate neighbourhood, have been made in the laboratory of the Survey, which may be summarized as follows* :—

Haycock location.

Assays.

Locality.	Description of Specimen.	Weight.	Gold pr ton.	Silver per ton.
W. side Lady Evelyn Lake, near outlet.	Quartz with a little calcite and chalcopyrite	1 lb. 5oz.	Traces	2·04
E. side Lady Evelyn Lake, 1¼ miles S. of outlet.	Galena with a little quartz and calcite.	6lbs. 12 oz.	"	8·75 oz.
W. side Lady Evelyn Lake, 1½ miles S. of outlet (north vein).	Quartz with a little chalcopyrite, galena and zinc blende	2 lbs.	None.	0·117 oz.
W. side Lady Evelyn Lake, 1½ miles S. of outlet (south vein).	Quartz with chalcopyrite....	2 lbs.	"	None.
W. side outlet Lady Evelyn Lake (west vein).	Quartz with calcite, dolomite, serpentine and chalcopyrite	1 lb. 12 oz.	"	"
Island at Narrows, 3 miles S. of outlet of Lady Evelyn L	Quartz with chlorite........	13 oz.	"	"

Cockburn location, Cross Lake.

The Cockburn location or mine covers several small islands in Cross Lake, near the inlet from Temagami Lake. On these islands,

*Annual Report, Geol. Surv. Can., vol. IV. (N. S.), 1888-89, part R, analyses Nos 59-64.

several masses of segregated quartz are exposed, but these apparently have no great regularity or persistence. The largest of these so-called veins is situated on the west side of an island about a quarter of a mile in length, about half a mile south-west of Temagami River. The island is composed of a greenish-gray, greywacké, slaty in structure, which has undergone considerable alteration, and sericite is rather abundantly developed, especially on the planes of cleavage. The pressure or foliation planes, which are here apparently the only structural features displayed by these rocks, have a strike N. 16° E., and an inclination eastwards $<71°$. The quartz fills an irregular fissure in the slates, is about five feet in width, has a strike of N. 38° E., and an underlie towards the south-west $<45°$. Galena, iron-pyrites, copper-pyrites and malachite were all noticed imbedded in the quartz. Samples taken to represent the average of these were examined in the laboratory of Survey with the following results* :— Assays.

Locality.	Description of Specimen.	Weight.	Gold per ton.	Silver per ton.
		lb. oz.		
Island in Cross Lake near outlet....	Quartz with galena and chalcopyrite	1 10	none	·175oz.
Cross Lake....	Quartz with chalcopyrite...	9	.058oz.	·058oz.
Cross Lake (same loc. as last)	Quartz with galena....	¾	trace	23.333oz.

Mr. P. A. Ferguson of Mattawa owns three mines or locations on Lake Temagami, known respectively as A, B and C. At location A, situated on the east side of Sandy Inlet in the northern part of the lake, the rock is for the most part a massive dark-green medium-textured diabase, much of which is broken up; the irregular cavities being filled with quartz and calcite, with which are associated yellow epidote and small dodecatedral crystals red garnet. One of the veins from which considerable material had been taken was noticed near the water's edge and contains in addition to the minerals mentioned above, a little iron-pyrites and copper-pyrites. The vein is very irregular and only about a foot in width and thus too small to constitute a workable deposit. At location B, situated on the north shore of the north-east arm of Lake Temagami, about two miles east of the portage into Caribou Lake, the rock is a pearly grayish-green sericite-schist, striking N. 68° E. and dipping northwards $<70°$. Associated with this is a lenticular mass of light-gray rusty weathering dolomite, containing reticulating veins of quartz, that stand out on weathered surfaces. Chiefly at the contact between these two rocks, is a considerable deposit of iron-pyrites, Ferguson location, Lake Temagami.

*See Annual Report, Geol. Surv. Can., vol. IV. (N. S.), 1888–89, part R, analyses Nos. 54, 57 and 58.

with a little copper-pyrites and arsenopyrite (?) Location C, is on an island now known as Ferguson Island, to the south-west of this point and consists of iron-pyrites in association with sericite schists.

Assays.

Assays of specimens taken as representative of these three deposits, gave the following results in the laboratory of the Survey* :—

Locality.	Description of Specimen.	Weight.	Gold per ton.	Silver per ton.
Ferguson Location A, Sandy Inlet L. Temagami.....	Quartz with little pyrite and chalcopyrite...........	11lbs.	trace	trace
Ferguson Location B, north-east Arm L. Temagami.	Quartz with finely disseminated pyrite	5lbs.	none	.233oz.
Ferguson Location C, Is'd. in N.E. Arm L. Temagami	Rust-stained sericite schist with pyrite..........	15oz.	trace	·116oz.

Veins on Denedus Island, Lake Temagami.

The Denedus Islands near the entrance to Muddy-water Bay on Lake Temagami, and so-called after a well-known member of the Temagami band of Indians, is another mining location, owned by Mr. James Holditch of Sturgeon Falls. On the two large islands composing this group, the rock is a dark greenish-gray felspathic sandstone or greywacké, sometimes slaty in structure but usually massive. The rock is much broken up in places, and the irregular cracks and cavities thus formed are filled with gray translucent quartz, with which is usually associated more or less pinkish dolomite. Occasionally these fissures are so large as to include considerable masses of quartz On the west island a quartz vein about two feet in width, occurs with a southeasterly strike containing both iron- and copper-pyrites. A somewhat larger segregated mass of quartz occurs on the island to the east, with similarly disseminated grains and fragments of iron- and copper-pyrites and occasionally a little galena. Assays of specimens from both these islands were made in the laboratory of the Survey with the following results† :—

Assays.

Locality.	Description of Specimen.	Weight.	Gold per ton.	Silver per ton.
		lbs. oz.		
Denedus Islands (east vein).	Quartz with a little chlorite and dolomite..........	2 6	none	none
Denedus Islands (west vein).	Quartz with chlorite chalcopyrite and pyrite.....	3 6	trace	trace

Veins on Temagami Island.

Large masses of iron-pyrites, associated with pyrrhotite, copper, pyrites and magnetite, occur on the east side of Temagami Island in

*Annual Report, Geol. Surv. Can., vol. IV. (N. S.), 1888-89, part R, analyses Nos. 69-71.

†Annual Report, Geol. Surv. Can., vol. IV. (N. S.), 1888-89, part R, analyses Nos. 79-80.

Lake Temagami and on the south-east shore of Vermilion Lake, to the north of the north-east Arm of Lake Temagami. Samples of these were assayed for gold and silver, but with negative results in both cases. Subsequently Mr. E. V. Wright, who had located the Vermilion Lake property had the ore assayed for nickel, but less than one per cent of this metal was found. The following statement gives the results of the assays made* :— Assays.

Locality.	Description of Specimen.	Weight.	Gold per ton.	Silver per ton.
		lb. oz.		
Temagami Is'd. (east shore).	Pyrite, chalcopyrite, magnetite, with chlorite......	4 2	none	none
Vermilion Lake............	Pyrite in chlorite-schist and quartzite	13	"	"

On Matthias Island, about two miles north-east of the Hudson's Bay Co.'s post on Bear Island in Lake Temagami, a quartz vein with a somewhat uniform width of about eight feet was noticed. The quartz is white and translucent, filled with rusty cavities and a little copper-pyrites, iron-pyrites, malachite and ankerite were noticed Although so promising in appearance, assays made in the laboratory of the Survey show neither gold nor silver.† On Matthias Island.

At the Guay mine, in rear of the Township of Fabre, on the east side of Lake Temiscaming, according to Mr. J. Obalski, of Quebec, a considerable amount of copper-pyrites has been found. This, associated with and disseminated through diabase, probably an extension eastward of the mass which reaches Lake Temiscaming at Quinn Point, shows on assay according to Mr. Obalski, gold, ·02 oz., and silver, 1·56 oz. per ton of 2000 lbs. Guay mine.

Other specimens examined in the laboratory of the Survey during the progress of the exploration, from veins and masses of quartz that Ores assayed from various localities.

*Annual Report, Geol. Surv. Can., vol. IV. (N. S.) 1888-89, Part R, analyses Nos. 78 and 52.

†Annual Report, Geol. Surv. Can., vol. IV. (N.S.), 1888-89, Part R, analysis No. 53.

are of less importance either on account of the negative or small results obtained, or the limited extent of the masses themselves, are enumerated below*:—

Locality.	Description of Specimen.	Weight.		Gold. per ton.	Silver. per ton.
		lbs.	oz.		
N. end of Lake Temagami..	Pyrite in quartz and calcite (from 10 ft. vein).		7¼	Trace	None.
Little River, 1 mile E. Lake Temiscaming.	Grayish opaque quartz with a little pyrite.	2	10	None	"
Point E. of outlet Hay Lake, N.-E. arm Lake Temagami	Quartz with a little chlorite and chalcopyrite.	1	14	Trace	·290 oz.
N. shore, N.-E. arm, ¾ mile W. portage, Lake Temagami.	Quartz with traces of iron and copper.	1	3	None	None.
Montreal River, 6 miles from mouth.	Red and white quartz with a little chalcopyrite.		14	Distinct trace.	"
E. shore Ferguson Bay, Lake Temagami.	Calcite with a little chlorite and chalcopyrite.	1	11	None	"
Small islet in Whitefish Bay, Lake Temagami.	Quartz with pyrite in felspathic sandstone.	4	3	Trace	Trace.
Islet ¾ mile W. of Temagami Post.	Quartz with a little dolomite and chlorite.		6	None	None.
Two miles N.-W. of Temagami Post.	Quartz with chlorite and a little pyrite.		8½	"	"
Island near S. end S.-W. arm Lake Temagami.	Rust-stained quartz with a little pyrite.	1		"	"
Mountain Lake, Montreal River.	Rust-stained quartz with pyrite and chalcopyrite in diabase.	1	⅛	Trace	Trace.
Portage near S. end of Lake Temagami.	Quartz with chlorite and dolomite.	2	11	None	None.
Island 1¼ miles N.-E. Temagami Post.	Rust-stained quartz with a little ilmenite.	1	7	Trace	"

Comparatively little exploration as yet.

Although the results given in the above tables are not very encouraging, it must be remembered that the assays were made from material obtained during the progress of an exploration over a wide stretch of country in which only limited opportunities were afforded for examination and selection while only those quartz masses were visited which were noticed exposed at or near the shores of lakes embraced by the survey or in localities otherwise accessible. No systematic attempt has ever been made at prospecting throughout the greater portion of the district, although a few enterprising individuals have looked over part of the area in the hope of finding some unusually rich mineral deposit. A large portion of the area covered by the Huronian rocks in the north-western part of the region, is thickly covered by forest, composed chiefly of evergreens, which conceals much of the surface, rendering

*Annual Report, Geol. Surv. Can., vol. III. (N. S.), 1887-88, part T, analysis No. 32.

†Annual Report, Geol.Surv. Can., vol. IV. (N. S.), 1888-89, part R, analyses Nos. 10, 72, 73, 75, 77, 65, 67, 68. 87 81 66

any attempt at prospecting difficult. The inaccessibility of the region has also generally prevented any extended examination by prospectors, but the recent survey of the Nipissing and James Bay railway and the proposal to run this line northward from North Bay to the east end of Lake Temagami, has again drawn attention to this region as a promising mining field. The Huronian belt of rocks is the same that traverses the Sudbury mining district to the south-west, while similar associations of slate and greywacké broken through by diabase, gabbro and granitic intrusions, furnish conditions equally favourable to the presence of metalliferous sulphides or gold-bearing quartz-masses now known to exist in the vicinity of Wahnapitae Lake, immediately adjoining the Temiscaming sheet to the south-west.

Conditions like those at Sudbury.

One of the most important of the mineral deposits in this district, both on account of its comparative accessibility and the character and size of the ore-bearing body, is what has usually been known as the Lake Temiscaming silver or lead mine (Wright's mine) comprising portions of lots 61, 62 and 63 of range I., in the Township of Duhamel, in what are called Blocks A and B, on the east shore of Lake Temiscaming.

Wright mines, Lake Temiscaming.

Although, this deposit was brought to notice by Mr. E. V. Wright, of Ottawa in 1877, the existence of ore at this place was known long before, for on a "Map of North America,"* based on D'Anville's map, and published about 1778, the small bay on which it is situated is named "Anse à la Mine."

Discovery.

In the vicinity of the mine, the rock is the breccia-conglomerate forming the basal member of the Huronian in this district, the pebbles or fragments of which are chiefly of granite, diabase or other eruptive rocks, embedded in a greenish, chloritic, slaty matrix, which owing to pressure appears to curve around or enfold the inclosed fragments.

Association.

The deposit occurs in a brecciated or shattered belt of the rock, composed of angular or subangular fragments, the interstices being filled by galena with occasionally a small quantity of iron-pyrites together with more or less pink dolomite. Although this zone is about eighty feet in breadth and contains a varying quantity of galena throughout, only about six feet can be said to carry the mineral in workable quantity, and even this with considerable admixture of gangue and rocky matter. The rock immediately adjoining and inclosing the deposit, has a decidedly porphyritic appearance, crystals and fragments of white felspar and grains of transparent quartz being embedded in a fine-grained greenish matrix. Under the microscope, this fine-

Character of deposit.

*See Map No. 5, Mills' Report on Boundaries of Ontario, Toronto, 1873.

grained groundmass is seen to be composed of finely granulated quartz and felspar together with a considerable quantity of chlorite and sericite in fine scales. Through this are scattered the larger fragments which are apparent to the eye. Some of these are composite fragments of some porphyritic rock, with large crystals of well striated plagioclase and finely granulated quartz. Whilst the majority of the quartz-fragments bear evidence of having been subjected to considerable pressure one large subangular grain extinguishes very evenly and shows little or no trace of disturbance. The plagioclase individuals have a broad tabular habit, are well striated, very turbid, and apparently constitute the predominant felspar, although unstriated felspar was observed. Ilmenite, accompanied by leucoxene, is rather plentiful, some of it is entirely altered to the latter mineral.

Assays.

Samples of the ore were sent to the Geological Survey in 1877, and Dr. B. J. Harrington states* that a specimen of the galena entirely free from gangue, gave, by scorification, silver 18·958 ounces to the ton of 2000 lbs. Another specimen received about the same time, but containing a good deal of rocky matter, gave, silver 11·66 ounces to the ton, while a third specimen taken about fifty feet from the above gave, after careful separation of the gangue, silver 18·229 ounces to the ton. The mean of two assays by Dr. Hoffmann gave, silver 13·58 ounces to the ton with a trace of gold; by Prof. J. T. Donald of Montreal, silver $21.17; by Dr. Baptie of Ottawa, silver 23 ounces; by School of Mines, London, 13 oz. 14 dwt. 10 grs. per ton of 2240 lbs. and lead 52 per cent. The percentage of silver in the galena itself was 26 oz. 7 dwt. 21 grs.

Average silver content.

The silver content of the pure galena would therefore seem to vary from 18 to 24 ounces to the ton of 2000 lbs., but the large intermixture of rocky matter would considerably lessen these results. Iron-pyrites has been found intimately associated with the galena, and occasionally considerable quantities have been encountered in working the deposit. This is doubtless the source of the gold usually present in the ore.

Exploratary work.

Work was begun on this deposit in 1887, under the management and ownership of Mr. E. V. Wright, of Ottawa, but only preliminary development work was undertaken. During 1888, however, work was carried on very energetically, and a shaft was sunk to the depth of about 100 feet, while concentrating machinery was set up and it was proposed to smelt the ore on the spot. Various obstacles have stood in the way of the successful development of this mine, chief of which has always ben

* Report of Progress, Geol. Surv. Can., 1877-78, pp. 51-52.

its distance from railway communication and the consequent difficulties in shipment of ore or concentrates.

For several years work went on in a rather desultory fashion, but in 1890 the Mattawa Mining and Smelting Co. of New York, took hold of the property and an extensive and costly plant for the proper handling of the ore was installed. The main shaft was increased in depth to over 100 feet, and two drifts were made to prove the extent of the deposit, while a diamond-drill boring carried to a further depth of 75 feet, proved the existence of the galena to a total depth of 140 feet. Operations were carried on energetically till March, 1891, when work was suspended. During the summer of 1896, work was again resumed, chiefly with a view of further testing the property and it is hoped that the recent completion of the branch line of the Canadian Pacific Railway to the foot of Lake Temiscaming may lead to continuous working. The main shaft is now sunk to a depth of nearly 200 feet, and it is reported the mineral shows no diminution in either quantity or silver content.

Nickel, Copper, Etc.

Ores containing pyrrhotite and copper-pyrites.

The Huronian belt of rocks, characterized by the presence of great deposits of nickeliferous and cupriferous ores in the Sudbury district, runs with unbroken continuity through the Temagami and Temiscaming districts. Diabases and gabbros apparently identical in their composition and appearance are present over large areas, but so far no very large deposits of pyrrhotite and copper-pyrites have been found. On the west side of Temagami Island, as well as on the south-east shore of Vermilion Lake, considerable masses of these sulphides are present, but the assays made show only a very small percentage of nickel. Copper-pyrites is an almost invariable constituent of the diabasic masses and in places pyrrhotite is equally abundant, and it is highly probable that systematic prospecting may develop large deposits containing nickel and copper.

At the Guay mine, in rear of the Township of Fabre, the specimens of copper-pyrites gave, according to Mr. Obalski, 0·72 per cent of copper, and ·08 per cent of nickel.

The inaccessibility of the region, however, and the abundance of these nickel and copper bearing sulphides in close proximity to the main line of the Canadian Pacific Railway, in the Sudbury mining district, many excellent deposits of which have not yet been developed, prevent any extended search in the Temagami and the Temiscaming districts.

Iron.

Occurrences of iron ore.

No deposits of iron ore of economic importance have as yet been found in this district, although both magnetite and hæmatite are rather abundantly distributed. Wherever noticed, the quantity has been too insignificant, or the associations such that the material seen could not be utilized with any degree of profit. Magnetite occurs in patches and small masses in the red granitoid-gneiss exposed in the neighbourhood of the Chute des Paresseux on the Mattawa, in the township of Olrig. On the west side of Keepawa Lake, a short distance north-west of Gordon Creek outlet, a dark-gray gneiss containing a considerable proportion of magnetic iron ore occurs, and a quantity of this ore was mined and taken to the Wright mine on Lake Temiscaming for use as a flux in the smelting of the galena. The ore, however, is too lean and silicious to be of commercial importance.

At Keepewa Lake.

On Iron Island, Lake Nipissing.

On Iron Island, according to Mr. Murray,* "small masses of specular iron ore are common to most of the rock in the island and in the crystalline limestone, there is a very great display of it. For a breadth of about forty yards along the cliff on the east side, the rock holds masses of the ore of various sizes, sometimes running in strings of an inch thick or upwards, elsewhere and at other times accumulating in huge lumps, some of which probably weigh over half a ton. The beach near the outcrop is strewed with masses of all sizes, from great boulders weighing several hundred pounds to small rounded pebbles not bigger than marbles. The limestone with which the iron-ore is associated is frequently cavernous, and the crevices and smaller fissures are thickly lined with crystals of blue fluorspar and red sulphate of barytes or cockscomb-spar. Crystalline limestone crops out on the opposite or west side of the island, and, judging by the strike of the north side, it must correspond with that holding the iron-ore on the east. The same minerals were found disseminated through the rock and strewed upon the beach. At the extreme south-west point of the island the rock is again crystalline limestone, and a long beach running out from it to the westward is perfectly covered with boulders of specular iron-ore. Iron-ore occurs also at the south-east point of the island, although not in such great abundance and only in detached masses strewed upon the beach."

Ore not abundant.

Several parties have searched rather thoroughly over this island and most, if not all, of the iron has been carried off and shipped away. The interior of the island is a veritable jungle, and the shore is lined with an almost impenetrable thicket of scrubby cedar. Several small pits were noticed which had been sunk near the north-east corner of

*Report of Progress, Geol. Surv. Can., 1853-56, p. 123.

the island, but the amount of ore secured apparently did not warrant any further outlay of time or money, and it seems pretty certain that this ore is nowhere present in workable quantity. At the time of the writer's visit early in the spring most of the beach was submerged.

Magnetic iron-ore, interlaminated with bands of red, gray or black silicious, slaty rock was noticed in several localities, and in such considerable quantity as to constitute deposits of workable size, but the abundance of intermixed silicious matter is probably such as to render them practically valueless. One of these deposits is situated on the south-eastern end of a group of three islands near the eastern shore, about three miles from the southern extremity of the South-west Arm of Lake Temagami. The exposure seen consisted of alternate bands of light- and dark-gray quartzite, the dark bands being composed almost wholly of grains of magnetite. It is curiously contorted, but has in general a dip N. 7° E. <45°. In immediate contact with this to the south, is a band of disintegrating greywacké and chlorite schist, dipping N. 9° E. <55°. This is filled with pyrite, which has evidently been the chief cause of its decomposition. The local attraction of the magnetic needle was so great at this point as to render the compass practically useless.

Iron on south-west arm, Lake Temagami.

Near the west end of Turtle Lake, to the north of the north-east arm of Lake Temagami, there is a somewhat similar deposit, consisting of alternating reddish and black bands of hæmatite or jaspery iron ore and magnetite, with some olive-green shale. The strike of the deposit accords with that of the sericite-schists in the immediate vicinity, being N. 74° E. with a dip northwards < 70. In this neighbourhood also the compass was much affected.

On Turtle Lake.

A third locality in which magnetite in similar association occurs, is on the Quinze River, on the tenth portage from Lake Temiscaming. Mr. W. McOuat thus describes the deposit: *" The portage is on the south, or left hand side of the river, running in a direction about south-east to a small lake in a narrow ravine, and is not more than a quarter of a mile long. The iron ore crosses the portage near the upper or south end. It occurs in the form of layers from the thickness of paper to about an inch, and is interlaminated with similar layers of whitish, gray and dull-red fine-grained quartzite. The iron-ore constitutes probably from a fourth to a third of the whole, and as the thickness of the whole band is about thirty feet, the whole thickness of the layers of iron ore would probably not be less than eight feet. The band was traced along the strike for about a hundred yards. Magnetic oxyde of

On Quinze River.

* Report of Progress, Geol. Surv. Can., 1872-73, p. 131-132.

iron was observed under similar conditions at several points on this portage, and on the next above, but in much smaller quantity."

On Vermilion Lake.

Magnetic iron ore also occurs, but mixed with sulphides, on the south-east shore of Vermilion Lake and on the east shore of Temagami Island, in Temagami Lake. Hæmatite (as micaceous iron ore) occurs as a rather common constituent of the many quartz veins cutting the Huronian throughout the northern part of the area, but it has nowhere been found in deposits of sufficient extent to be of economic value.

Occurrence of native iron in perthite.

Although of no economic importance, it will be of interest in this connection to note here the presence of native iron imbedded in the crevices of some specimens collected on Mr. McMeikin's farm, about 4½ miles east of Mattawa. This occurrence of native iron, to which Dr. Hoffmann's attention was first drawn by Mr. R. L. Broadbent, was observed in some specimens collected as samples of perthite and amazon-stone on lot 7, con. B, of the township of Cameron. The following is a description by Dr. Hoffmann:

Description by Dr. Hoffmann.

*"The perthite, consisting of interlaminated brownish-red to reddish-brown orthoclase, and reddish-white albite, contained here and there inclusions of a grayish-black, massive, pebbly magnetite, partially altered, manganiferous magnetite, affording a dark-reddish brown streak.

"Portions of the felspar showed marked signs of weathering, the albite more especially being more or less kaolinized. Imbedded in the kaolin, also in the dark reddish-brown limonite in immediate proximity to it, were observable numerous spherules of a steel-gray colour and metallic lustre. These spherules varied greatly in size, a few measuring as much as a millimetre in diameter, the greater number, however, being of far smaller dimensions, and many of microscopic minuteness. They were almost perfectly spherical in shape, strongly magnetic, very hard, indenting and scratching a hardened steel mortar; brittle, when pulverized emit a distinct phosphoretted odour; immersed in a solution of cupric sulphate, become coated with a film of metallic copper. They were readily attacked by hydrochloric acid with evolution of hydrogen and a strong odour of phosphine, leaving an insoluble residue consisting of light-brownish coloured spherules which on ignition become perfectly white. These spherules, which form the nuclei of the metallic-looking grains, have, apparently, a concretionary structure.

Analysis.

"Mr. Johnston found the metallic spherules to have a specific gravity at 15·5° C. of 7·257 and a composition as follows:—

* Annual Report, Geol. Surv. Can., vol. VI. (N.S.), 1892-93, p. 23 R.

Iron	90·45
Manganese	0·75
Nickel	trace
Sulphur, Phosphorus, Organic matter	undet.
Insoluble, non-metallic, residue	7·26
	98·46

"Cobalt and copper were sought for and found to be absent. He found the insoluble non-metallic residue to contain 88·77 per cent of silica, a little alumina and ferric oxide—not estimated, a very small quantity of lime and possibly some magnesia.

"This occurrence recalls to mind that observed by me in a specimen of Huronian quartzite from the north shore of St. Joseph Island, Lake Huron, Ont.*

Limestone and Lime.

Limestone on Lake Temiscaming.

On Lake Temiscaming, the Niagara formation so abundantly exposed on the islands and shores of its northern portion affords an unfailing supply of excellent building stone, in blocks of large dimensions if required, while its fine and even texture as well as its colour recommend it strongly for such purposes. The Anglican church at Haileybury, on the west side of Lake Temiscaming, is being wholly constructed of material procured from exposures of this limestone on the east shore of Mann or Burnt Island. For purposes of making quicklime, the more thinly bedded fossiliferous portions seem to be most suitable as furnishing the purest and best lime with least expenditure of fuel.

On Lake Nipissing.

The Manitou Islands, in Lake Nipissing, especially Macdonald or Little Manitou Island, have furnished limestone which was used to advantage during the construction of the Canadian Pacific Railway. An excellent lime-kiln was noticed on Macdonald Island, which had evidently been used extensively. To the east of Mattawa, and between this place and Deux Rivières, a good deal of lime has been manufactured for local consumption, as also near the foot of Talon Lake on the Mattawa River. In the former instance the various outliers of Trenton limestone have supplied the material, while in the latter a band of crystalline limestone has been made use of by the incoming settlers. This band of limestone would furnish a very pretty serpentine marble or ophicalcite.

When calcined, the deposit of marl covering the greater portion of the bottom of Emerald Lake to the west of the Opimika Narrows, on

* Trans. Royal Soc. Can., vol. VIII., sect. III., p. 39, 1890.

Lake Temiscaming, would furnish a nearly pure and very white lime well adapted for mortar and other purposes. For such purposes the marl should be moulded into bricks which, after drying, may be burnt in a kiln. It might also be employed for whitewashing farm and other buildings.

Granite and Gneiss.

Building stones.

During the construction of the Canadian Pacific Railway, the grayish evenly foliated gneissic rocks, often easily procurable in large blocks, were used for bridge-piers and culvert work with satisfactory results. Many exposures capable of yielding both gneiss and granite of excellent quality may be found at intervals along the line of railway.

On Temiscaming Lake, in the vicinity of Baie des Pères, there is a very beautiful deep flesh-red granite, in which the more or less rounded outlines of the disseminated grains and fragments of grayish translucent quartz give the rock a fine conglomeratic or prophyritic aspect. It is not known, however, whether this granite can be obtained sufficiently free from joints.

Throughout the entire area the frequent and large masses of granite exposed, as well as the more massive and granitoid portion of the rocks classified as Laurentian, would furnish building stones of good quality, but only the more readily accessible localities of such rocks can be supposed to possess any importance.

Flagstones and Slates.

Flags.

The better qualities of slate do not occur extensively in this region, but some portions of the strata constituting the slaty or middle member of the Huronian, present very fine-grained and fissile beds which are firm and strong; although most of the specimens seen are rather thick for roofing purposes. Search might reveal some localities where suitable material occurs in sufficient abundance to be of economic importance. Many portions would however seem to be well adapted for flagging.

On the east side of Lake Temiscaming between McMartin Point and Latour's mills, the shore-line for several miles is formed of vertical cliffs of very evenly banded or foliated micaceous gneiss. The layers are extremely regular, fissile and of suitable thickness to yield flagstones of the very best quality and of almost any size.

Lithographic Stone.

Lithographic stone.

Some of the finer-grained beds present in the Niagara outlier on Lake Temiscaming, exposed on Mann or Burnt Island as well as at

Dawson (Wabi) Point on the mainland to the north, exhibit portions which were thought to be suitable for lithographic purposes. Some quarrying was done on the west shore of Mann Island, and lately a company with headquarters at Vankleek Hill commenced operations in the vicinity of Dawson Point with a view to securing suitable material if possible. So far, however, the specimens procured are not sufficiently uniform in texture, but it is still possible that lithographic stone of economic value may be discovered. Further examination of these beds with this object seems desirable.

Felspar.

Although this mineral is abundantly distributed as one of the most important and characteristic constituents of these crystalline rocks, only a very small proportion is found pure enough and in sufficiently large masses as to be employed for industrial purposes. To be of value, the deposits must be readily accessible and must contain the mineral in large cleavable masses easily freed from other associated minerals or impurities by a rough cobbing before shipment. Felspar.

There are many large pegmatite dykes close to the line of the Canadian Pacific Railway throughout this district, which might be examined with a view to obtaining supplies of felspar. Some of these near Nosbonsing station seemed to furnish abundant and very suitable material.

Felspar is chiefly employed in the manufacture of porcelain and pottery.

Shell Marl.

Deposits of this kind are frequently found below accumulations of peat, the marl in these instances being, therefore, of not very recent formation, but in other cases it is found to be still in process of deposition, covering the bottoms of shallow ponds or lakes.

Emerald Lake, about five miles west of the Opimika Narrows, is at the head-waters of one of the branches of Opimika Creek, which reaches Lake Temiscaming from the west immediately above the Opimika Narrows. This creek, as well as the lakes which it empties, are remarkable for their clear water. Emerald Lake itself is comparatively insignificant in size, being only about half a mile in length, by a quarter of a mile in greatest width at the southern end, gradually tapering towards its outlet at the northern extremity. The lake is in a small valley from eighty to one hundred feet in depth. At the Shell marl on Emerald Lake.

south-east corner is a very shallow bay, affording entrance to a stream which is fed by a number of large cold springs that rise at the base of an amphitheatre-like gully, at the base of steep banks composed mainly of sand and gravel. The water of the bay, although so shallow, is very cold even during the hottest days of summer, while the whole bottom is covered with a deposit of shell marl of unknown depth. That this depth is considerable there is no reason to doubt, as the soundings made with long poles failed to reach the bottom of the deposit. Besides this bay the whole lake contains marl deposited on the bottom, while the pebbles and boulders near the outlet show a considerable coating of this loosely coherent, earthy carbonate of lime. The water of these springs is evidently calcareous, and is found to be slightly aperient.

According to Mr. J. F. Whiteaves, who has examined the specimens of fresh water shells obtained from this locality, the species represented are *Sphœrium sulcatum* (Lam.), and *Planorbis trivolvis* (Say) var. *macrostomus* (Whiteaves).

Analysis. A sample of the marl examined in the laboratory of the Survey was found to have the following composition* :—

Hygroscopic water (after drying at 100° C.)	1·06	per cent.
Lime	48·32	"
Magnesia	0·04	"
Alumina	0·07	"
Ferric oxide	0·08	"
Manganous oxide	Traces	
Potassa	Traces	
Soda	Traces	
Carbonic acid	38·01	"
Sulphuric acid	0·07	"
Phosphoric acid	0·02	"
Silica, soluble	0·10	"
Insoluble mineral matter	8·62	"
Organic matter, viz.: vegetable fibre in a state of decay, and products of its decay, such as humus, humic acid, etc., and possibly a little combined water	4·79	"
Total	100·12	"

" Assuming the whole of the lime to be present in the form of carbonate, trifling quantities of which are, however, present in other forms of combination, the amount found would correspond to 86·28 per cent of carbonate of lime. The insoluble mineral matter was found to consist of " :—

*Annual Report, Geol. Surv. Can., vol. VII. (N.S.), 1894, p. 31 R.

Silica	6·24	per cent.
Alumnia and ferric oxide	1·51	"
Lime	0·29	"
Magnesia	0·08	"
Alkalies (?)	0·50	"
Total	8·62	

Marl is often used as a fertilizer, and deposits such as that exposed at Emerald Lake should be of value locally for this purpose.

Grindstones and Whetstones.

Some of the material contained in portions of the beds of coarse sandstone and grit, found near the base of several of the Palæozoic outliers, would probably be suitable for the purpose of making grindstones. A quarry was opened many years ago on one of these arenaceous beds exposed above Deux Rivières which furnished some excellent grindstones. Where the layers are not thick enough for this purpose, they would furnish whetstones of very fair quality. Where too hard and compact, these stones answer only for a short time, when first used, soon becoming too much polished. Grindstones.

Portions of the very fine-grained, banded slates and greywackés so frequently met with throughout the northern and north-eastern part of the district may probably afford material suitable for hones and whetstones.

Clay for Bricks and Earthenware.

Clay suitable for the manufacture of bricks, extends over a very large area in the northern part of Lake Temiscaming, from the vicinity of the combined mouths of the Montreal and Matabitchouan rivers, northwards far beyond the confines of the present map. The bricks for the large convent and church built by the missionaries of the Oblat order at Baie des Pères were made there. In the vicinity of North Bay, and extending thence some distance beyond Verne, brick clay is readily accessible, although sometimes concealed by the presence at the surface of varying thickness of yellow sand. A brickyard was in successful operation at North Bay for some years, and if the local demand were sufficient it would no doubt be re-opened. Some of these beds of clay might also furnish material applicable for the manufacture of coarse earthenware, but so far no clays fit for the finer kinds of pottery have been found in this region. Clay.

Mica.

Both biotite and muscovite are among the commonest constituents of the various Laurentian gneissic rocks, but although thus widely dis- Mica.

tributed their presence in this association is not of economic importance. The numerous and often large pegmatite dykes that cut these Laurentian rocks give promise, in places, of affording a supply of mica in sheets sufficiently large and in such quantities as to be available for economic purposes. The southern portion of the Township of Calvin is perhaps the most important of these localities, but so far the muscovite obtained, representing the material exposed at or near the surface, has been too inferior in quality to command a price commensurate with the cost of mining. The opening up, however, of a large portion of the south-eastern portion of the area of the Lake Nipissing sheet for settlement, may bring to light other masses of pegmatite producing good mica.

Asbestus.

Asbestus.

This mineral has been found in the district. One of these localities is situated near the west shore of the "Mattawapika" on Lady Evelyn Lake, on the Haycock mining location. It is also known to occur to the north-east of Baie des Pères, but the deposits thus far discovered are not very extensive.

Graphite.

Graphite.

This mineral, so abundant in the Laurentian area further to the south-east, is of rather rare occurrence in the region under descriptions and although doubtless present as an occasional constituent of some of the gneissic rocks, its presence was only noticed at one locality, where it occurs disseminated in minute grains and scales throughout the biotite-cyanite-gneiss exposed near the shores of the Ottawa in the vicinity of Les Erables Rapids and Snake Creek. Its presence in a rock-mass has often been referred to as evidence of its sedimentary origin, but in this instance there seems to be no doubt whatever that the rock containing it is a rather unusual phase of the biotite-gneiss, and as such is to be considered as a foliated plutonic mass.

Apatite.

Apatite.

This mineral, though abundant as an accessory or accidental constituent of many of the crystalline rocks occurring in this region, has not yet been found in deposits possessing any commercial value. The only locality where it was noticed in such quantity as to be recognizable without the aid of the microscope, is on the property of Mr. Emery Racicot, on lot 4, con. VI., of the township of Ferris, a short distance from Nosbonsing, a flag station on the Canadian Pacific Railway. A pegmatite dyke is here exposed, composed chiefly of very pure and coarsely cleavable flesh-red orthoclase, with which is associated a much smaller quantity of black biotite often in large cleavable fragments. The dyke is about six feet in width, has a direction a little west of north, according with the foliation of the garnetiferous hornblende-gneiss with which it is associated. The apatite occurs very sparingly, generally in small well developed prismatic crystals imbedded chiefly in the biotite. Some of the crystals noticed presented the following combination of faces: ∞ P. P. OP. ∞ P2. Most of the crystals were too fragile, on account of their long exposure, to admit of their being liberated without breaking from the material in which they were inclosed. The felspar in this and other dykes in the near vicinity is very pure, and large pieces, many pounds in weight, could be readily secured without any admixture of foreign matter.

Fluorite.

Fluorite or fluor-spar is found in large cleavable masses, associated with orthoclase, microcline and perthite in the large pegmatite dykes that cut the biotite-gneisses in the township of Cameron, about four miles and a half east of Mattawa. The fluorite is of a light-greenish colour, but like the felspathic constituents of these dykes, is very much stained and infiltrated with ferric hydrate, which fills the numerous cracks and fissures present in the mineral. Fluorite.

Molybdenite.

The presence of this mineral, as an occasional constituent of quartz veins, has been noticed in the district immediately surrounding Lake Nipissing. It is stated to occur in considerable quantity to the north of Talon Creek, on the Mattawa River, although its presence there was not verified during the progress of the examination of the region. Molybdenite.

Steatite.

This mineral, usually a decomposition product of basic pyroxenic or hornblendic rocks, is not very commonly met with, but specimens were obtained of tolerably pure material from the west shore of Lake Temiscaming, about four miles south of the Montreal River. Steatite.

Amazon-stone and Perthite.

These two minerals are intimately associated with one another, constituting much of the felspathic constituents of some pegmatites which Ornamental stones.

cut a readily disintegrating biotite-gneiss, that outcrops on lot 7, con. B, of the township of Cameron, about four miles and a half east of Mattawa. Four openings have been made, of the nature of small pits or shallow trenches, extending only a few feet below the surface. The largest dyke is about five feet in greatest width, running north-east and south-west. The railway line is about 200 yards to the north, while the Ottawa River passes about 500 yards to the south of the exposure. The openings were made for apatite, and work on the property was abandoned when this material was not found. The amazon-stone, when fresh, is of a very beautiful deep bluish-green colour, but owing to its proximity to the surface much of the material is more or less stained, and the minute crevices are filled with ochre. This defect would doubtless soon disappear in depth. Some of the material secured at the insignificant depth reached by the present workings is remarkably good, and is suitable for cutting and polishing.

Openings made.

The perthite which is intimately associated with the amazon-stone at this locality, is a pale flesh-red aventurine felspar, shown to consist of a fine interlamination or parallel intergrowth of albite and orthoclase. The alternation of the darker-coloured flesh-red orthoclase with the paler albite, and the accompanying brilliant aventurine reflections produces a beautiful stone when cut and polished.

Cyanite.

The occurrence of this mineral *in situ* in Canada was first noticed by the writer in 1890, in a cutting on the main line of the Canadian Pacific Railway, about half a mile east of Wahnapitæ station. Here it occurs in flattened blade-like crystals and fragments, in association with a reddish almandine garnet in a mica-diorite-gneiss. The crystals usually conform to the foliation, but sometimes they occur in groups and clusters disposed at varying angles to the schistosity. In the more basic portions of the gneiss, the crystals are darker in colour, and have undergone in places rather extensive cracking and deformation as a result of pressure. In the more acid or pegmatitic portions of the rock, the cyanite is much lighter in colour and occurs in stouter prisms. Fibrolite (sillimanite) also occurs in this locality, developed chiefly along certain crevices in the gneiss. It is fibrous or finely columnar in structure, and is traversed at right angles to the fibres by numerous fine cracks. Sometimes it occurs in curious irregularly radiating or plumose aggregates. The colour when fresh is of a pale bluish-gray.

Cyanite.

During the examination of the Ottawa River above Mattawa, cyanite was again noticed as a constituent of the biotite-gneiss exposed in the cuttings on the Temiscaming branch of the Canadian Pacific Railway in the vicinity of Les Erables Rapids and Snake Creek. Here also it occurs in long, thin-bladed crystals in association with red garnet, and is in many places so abundant a constituent of the gneiss as to characterize this rock. The crystals are usually light-bluish or greenish, but some show a beautiful deep azure-blue centre with white margins.

Fossil Corals.

The particularly fine fossil corals of the Niagara outlier exposed on the shores and islands of the northern portion of Lake Temiscaming, which have undergone in most cases complete silicification, would doubtless not only command a ready, though somewhat limited sale as specimens, but when polished would form an attractive ornamental stone for certain purposes. The west side of Mann Island exhibits abundant specimens of this kind. Fossil corals.

Springs.

The region, as a whole, is not characterized by abundant springs, although occasionally some large ones are encountered. Opimika Creek, reaching Lake Temiscaming from the west immediately north of the narrows of the same name, is chiefly fed by springs, as is also Latour Creek, which enters the same lake on the west side about four miles above the Old Fort Narrows. Both these streams are remarkable for the coldness and clearness of their waters, and for the fine specimens of brook trout to be found in them. A fine large spring rushes down the hill immediately behind Thompson Bay, below the Opimika Narrows, on the east side of Lake Temiscaming, about half a mile east of the old Hudson's Bay Co.'s post. Another spring of good water flows down at the head of Les Erables Rapids on the Ottawa. As the country becomes settled many new springs will be found, but the abundance of good water contained in the many lakes and streams of the region, renders the presence of springs much less important, although as a rule the water in these lakes is rather warm for drinking purposes during the summer months. During a considerable portion of the summer, the presence of a large number of minute greenish or yellowish particles, often so abundant as to form a scum at the surface or around the margins of the lakes, renders the water of many of them more or less unfit for drinking purposes. The waters Springs.

of the springs that feed Emerald Lake, at the head of one of the branches of Opimika Creek, have already been referred to. They are the only ones known to possess therapeutic qualities.

REGIONAL DESCRIPTION.

THE OTTAWA RIVER AND LAKE TEMISCAMING.

General Features.

Length of river included.

As may be seen by a reference to the accompanying map-sheets, a considerable length of the Ottawa is included by them. From the north-east bay of Lac des Quinze, where it enters the Lake Temiscaming sheet, to the mouth of the Mattawa (which for convenience has been included in the southern sheet) the distance is about 142 miles. Three large lakes occur in this distance, which may be regarded simply as expansions of the stream.

Its course and lakes on it.

The most northern of these expansions, known as Lac des Quinze, is very irregular in outline, with several long arms or bays running in various directions, but the most direct line of communication through the lake measures about twenty-two miles. This lake is separated from Lake Temiscaming by a short stretch of water known locally as the "Quinze River," noted for its wild and dangerous rapids, and which in its eighteen miles of length falls a distance of two hundred and sixty feet. Lake Temiscaming, into which this stream empties, is sixty-seven miles long from the mouth of the Quinze to the head of the Long Sault Rapids, while Seven-league Lake, which commences at the foot of these rapids, adds a further length of seventeen miles. While it would thus appear that the river, strictly speaking, embraces only about thirty-eight miles of this whole distance, it may be stated that a considerable proportion of that generally included as lake should in reality be considered as portions of the river proper. A large part of these water-stretches exceeds but very little, if at all, the average width assumed by the river when not obstructed by rapids, while at several points a swift current is present, denoting a small though appreciable change of level.

River-like lake stretches.

Thus Seven-league Lake, in its lower portion, is only about a quarter of a mile wide, while in the upper part it never exceeds half a mile. In this lake a light current can usually be detected, showing a total fall in the whole length of about a foot during the ordinary low water of summer; but during times of freshet this current is augmented, and the total fall is increased to a little over two feet.

Lake Temiscaming itself, as noted in the appendix, shows a difference in level of a foot from the head of the Long Sault Rapids to the wide portion above the Old Fort Narrows, while the lower portion of the lake south of the mouth of the Montreal River, is quite river-like. This difference in level is maintained by three very pronounced contractions. The most northerly of these is at the Old Fort Narrows, where the lake is pinched in between two bold hills of gravel, leaving a channel a little less than 800 feet wide at ordinary stages of the water. At the Opimika Narrows, about thirty-five miles further, a still more pronounced current flows through a strait which at one place is less than 200 yards in width. This current, formerly known to the old voyageurs as "La Gabrè" shows a descent of fully half a foot. At Presquîle, about a mile north of the head of the Long Sault, the third contraction occurs, and here again a considerable current may be noticed, but not so strong as at the Opimika.

The Ottawa, from the north-east bay of Lake des Quinze, has a general direction a few degrees south of west as far as the head of Lake Temiscaming. At this point, however, it suddenly changes, and from the head of this lake, as far as the mouth of the Mattawa River, the stream flows about S. 30° E. In places there is a decided divergence from this general course, caused by local bends, which are especially characteristic of the upper portion of the river, but from Lake Temiscaming to the Mattawa, the river follows an unusually uniform and deep valley, and any bends which do occur are in the nature of large curves. General direction of river.

The upper part of the river, above Lake Temiscaming, occupies a very pronounced valley, and the hills around Lac des Quinze present the usual rounded or dome-like outlines so distinctive of areas underlain by the Archæan gneissic rocks. Except on the northern portion of the lake, where they are unusually bold, ranging from 200 to 300 feet in height, the hills are as a rule low, averaging less than 100 feet. The Quinze River, which usually breaks across the strike of the inclosing rocks, occupies an original, but not very pronounced depression. When Temiscaming is reached these conditions undergo a decided change; and the valley, especially in the lower portion, is fiord-like in aspect. From the Mountain Rapid to the mouth of the Mattawa, the river breaks across irregular ranges of hills, which rise very abruptly from the water to heights of from 400 to 600 feet, while the shores on either side of Seven League Lake, which are as a rule bold and rocky, preserve a rather constant elevation of from 200 to 300 feet. In the construction of the Lake Temiscaming branch of the Canadian Pacific Railway along the rocky Character of valley.

eastern bank, this was so steep and abrupt that it was found necessary in most instances to make large rock-cuts, the road skirting the shore.

Montreal River to Long Sault.

From the mouth of the Montreal River to the Long Sault Rapids, the banks on both sides of Lake Temiscaming are extremely bold, and, as a rule, rocky, and frequently for several miles present unbroken cliffs. The hills on both the Ontario and Quebec sides of the lake rise very steeeply from 350 to 600 feet, with but few minor and unimportant breaks where some of the larger streams flow in. Throughout the whole of the distance from Mattawa, the tributary streams all show a very abrupt descent to this valley. Above the mouth of the Montreal, the topographical outline changes somewhat suddenly, and the shore, though still in many places steep and abrupt, is not continuously so; while wide and open valleys covered with drift separate the still high hills. The west shore of the lake is especially steep and regular, and until Haileybury is reached no flat of any appreciable extent occurs. Near the north-west corner of the lake, large and comparatively level tracts exist that extend far beyond the boundaries of the accompanying map, and are fast being opened up for settlement.

West shore.

East shore.

The eastern, or Quebec shore, presents many deep and important indentations and although numerous high and exceedingly rugged hills occur, they are for the most part separated from one another by flats of clay. These have in many instances been cleared and are at present occupied by prosperous farmers, the soil being good and yielding abundant crops.

Head of Lake Temiscaming.

The depression occupied by Lake Temiscaming extends in a north-westerly direction, but becomes divided into two subsidiary valleys by the flat limestone promontory terminating in Dawson or Wabis Points. These valleys are occupied by the two important tributaries known as Wabis Creek and the Blanche or White River.

Soundings by T. Guerin.

It has always been known that the Ottawa River is, in many portions of its course, very deep, but no accurate information regarding its depth was published until Mr. Thos. Guerin, C. E., examined that part of the river above Mattawa.* Those soundings were, however, few in number and confined chiefly to Seven League Lake, although a few were obtained in the vicinity of Chiefs Island on Lake Temiscaming. Mr. Guerin states that Seven League Lake was sounded in several places, the depth obtained being generally about sixty feet. In one place it was 397 feet, but in no place was it found to be less than thirty feet deep. The sounding-line on Lake Temiscaming was unfor-

*Annual Report, Minister of Public Works, 1884-85, pp. 106-107.

tunately only 120 feet long, and on continuing the soundings south of Chiefs Island it soon failed to reach the bottom.

During the progress of the Geological Survey several calm moonlight nights were spent in sounding Lake Temiscaming. These soundings were commenced at the Opimika Narrows, where the deepest water was found to occur in close proximity to the western shore which is here steep and rocky. The bottom is composed of coarse gravel and boulders, and the lead showed a narrow and tortuous channel whose greatest depth was forty-five feet. Soundings by Geological Survey.

Four more soundings were taken in going north, in the next mile, showing a gradual deepening with a gravelly and ultimately a sandy bottom. These soundings were respectively 55, 47, 75 and 111 feet. About midway between Main Channel Islet and the west shore, the channel is 65 feet deep, while that between this island and the eastern shore is only 55 feet. It is evident that there exists at this point a considerable bar, due to the deposition of morainic or drift material, of which Main Channel Islet (wholly composed of boulders) forms the culminating point. Opimika Narrows to McMartin Point.

From this place to within half a mile of McMartin Point, three soundings were taken, showing an increase first to 95 feet, then 139 feet and 183 feet, while three soundings taken at this point showed 211 feet in mid-channel, and 198 and 127 feet, the latter being within 200 yards of the western shore. Opposite McMartin Point, the lake again appears to shallow somewhat, and the deepest sounding near the centre was 157 feet, while half way between this and the western shore it shallows still further to 130 feet. Again it would seem that this shallow portion is caused by an accumulation of morainic *débris*, of which McMartin Point forms the shoreward extension.

All of the above soundings showed a bottom composed of very fine gravel or sand. To the north of McMartin Point, the lake deepens rapidly and maintains a very uniform depth as far as the mouth of the Keepawa River. About a mile north of McMartin Point, the depth noted was 425 feet, while still further north, opposite Latours mills, in mid-stream, the depth found was 460 feet. This great depth was maintained close to either shore, for a sounding taken within ten chains of the western shore showed 455 feet while one taken an equal distance from the eastern shore was 320 feet. About a mile further north, the lake is 423 feet deep and again in mid-channel opposite the Buffalo Rock it is 430 feet deep. The deepest sounding made was taken a little over a mile south of the Keepawa River, about the middle of the lake, the depth being 470 feet. Going northward, the lake shallows, McMartin Point to Keepawa.

and opposite the mouth of the Keepawa is only 362 feet deep. Throughout this interval of great depth, from McMartin Point northward, the whole bottom was found to be covered by a soft, unctuous, gray clay or ooze into which the lead sank a foot or more.

Keepawa to Montreal River.

The depth ascertained at the mouth of the Keepawa remains uniform to within a mile of the combined mouths of the Montreal and Matabitchouan rivers, where it is 347 feet. Northward, the lake gradually shallows, and opposite the mouths of these streams has been partly filled up by an extensive deposit of sand and gravel that forms the bottom in this neighbourhood. These streams cannot, however, account for the vast accumulation of loose material which is here evidently present, for the lake is over a mile wide, and for more than a mile in length has been filled up by a deposit varying from 100 to 150 feet in depth. Further, the lake shallows considerably to the north of these streams, while the reverse would have been the case if the whole of the material had been brought down by them. This extensive bar has probably been deposited in the first place as a lateral moraine, in the shelter of the bay in the rocky hills that occur at the mouths of these rivers, while the material subsequently transported and laid down by the streams, has reformed and modified these deposits, producing the somewhat wide delta now found.

Montreal River to Old Fort Narrows.

Opposite the mouth of the Montreal River, the depth of the lake in the middle is 275 feet, while about three-quarters of a mile further north this again decreased to 256 feet. Still further north, the lake deepens rapidly, and two miles north of the Montreal River the soundings showed a somewhat uniform depth of 400 feet. A little over half a mile south-east of Roche McLean, the lake is 378 feet deep, while opposite the north end of Quinn Point it is 370 feet. Here again a bar composed of boulders and clay with a little sand extends from the north-east end of this point for nearly a quarter of a mile, with only about five feet of water at ordinary summer level. In the centre of the large open space to the north of Quinn Point, the lake is 348 feet deep, while in the middle of the Narrows, opposite Pointe à la Barbe, it is only 170 feet deep. In the open space opposite the mouth of the Little River it is 175 feet deep, thus showing a rather uniform depth in this portion.

Morainic deposits at Narrows.

The Old Fort Narrows is a very decided contraction occasioned by two bold hills of sand, gravel and boulders. The deposition of the material at this point was evidently determined by a pre-existing rocky narrows, the higher portions of which may be seen protruding from the surrounding mantle of sand and gravel. During the retirement of the ice-sheet up the valley of the lake, a large amount of morainic material was deposited at this place, thus still further reducing the channel. In the channel, immediately opposite the Hudson's Bay Co.'s old store, the first sounding showed a depth of 31 feet, which was gradually increased to about seventy-five yards from the west shore; while less than thirty yards from the west shore the depth was found to be 46 feet. To the north, the lake gradually deepens, first to 88 feet about an eighth of a mile north of the Narrows, and finally to 120 feet about half a mile north. In the opposite direction, or southwards, on the other hand, the lake deepened first to 65 and then to 130 feet within less than an eighth of a mile.

There seems, therefore, to be no warrant for the supposition that this barrier of sand, gravel and boulders extended at one time completely across the lake, for, if such had been the case, it appears probable that the removal of this material would have resulted in the accumulation of a considerable deposit immediately south of the Narrows, which is not found, as the descent on the south side is much steeper, in fact nearly as steep as the angle of repose, under the conditions, for gravel and sand.

No soundings in northern part of lake.

Our soundings did not extend further to the north, and although the western shore-line is still very steep and abrupt, it is not probable that the great depth characteristic of those areas to the south of the Narrows is maintained in this direction, although occasional localities with considerable depth may doubtless be found, presumably in the neighbourhood of the western shore.

Times of high- and low-water.

The highest water in this part of the Ottawa is in general occasioned by the melting of the snow in spring, and occurs usually about the latter part of May, while the time of low-water is during September or October, according to the setting in of the autumn rains. During the summer months, the Ottawa is remarkably and quickly affected by very heavy or long continued rainfalls. In ordinary seasons this difference in level varies from twelve to fourteen feet, but in 1887, and again in 1894, Lake Temiscaming and this portion of the Ottawa showed the astonishing difference of twenty-one feet between the two extremes of high- and low-water. Both of these years were, moreover, remarkable for an extremely heavy snowfall during the preceding winter, thus furnishing conditions for an extraordinary spring freshet, while the succeeding summers were notable for excessive and long continued drought, and the lowest water occurred during the month of September.

Difference in fall of Long Sault Rapids.

One of the most marked effects occasioned by this difference in level, is the corresponding difference in the fall of the Long Sault Rapids that separate Lake Temiscaming from Seven League Lake, and the accompanying increase in the fall of the rapid at the outlet of the latter, known as "The Mountain." During times of low-water the fall in the Long Sault Rapids is almost fifty-five feet, while at high-water it is only forty-nine feet. On the other hand, during times of freshet, the Mountain Rapid has a fall of seven feet, while at low-water there is only a fall of a little over three feet. During the same time Seven League Lake has a total fall of two and a-half feet in times of high-water, and at low-water there is only a fall of half a foot from the north to the south end. These seeming anomalies are thus explained by Mr. Thomas Guerin :*—"The Long Sault * * * is divided at its head by an island into two channels, the level of the bottom of the eastern channel being about seven feet below that of the bottom of the western channel which becomes dry at low-water. * * * The outlet from Seven League Lake is at the Mountain Rapid, and the capacity of the channel here is less than the united capacities of the two channels, which constitute the outlet from Lake Temiscaming. Hence the latter channels during high-water pour a greater quantity into Seven League Lake than the outlet of the latter is able to discharge, thus causing Seven League Lake to rise, while Lake Temiscaming falls so that the difference of level must be least at high-water. Again when the level of Lake Temiscaming falls so low as to render the western channel dry then the outlet from Lake Temiscaming will be confined to the eastern channel, which is nearly of the same dimensions as the outlet of Seven League Lake, but as the area of the latter lake is many times less than that of Lake Temiscaming, its level must fall faster and the difference of level must be greater at low-water than at any other time."

Explanation by Mr. Guerin.

Discharge.

The rate of discharge from Seven League Lake was measured by Mr. Guerin at the current immediately above the Mountain Rapid, on the 21st of August, 1884, and found to be 16,383 cubic feet per second. From a comparison of the levels then prevailing, it was calculated that the rate of discharge during times of high-water would be 25,100 cubic feet per second, and during low water 14,800 cubic feet per second.

Trend of Ottawa Valley.

The trend of the Ottawa Valley, from its confluence with the Mattawa to the foot of Lake Temiscaming, is nearly north-west, making a considerable angle with the direction of the foliation of the

* Annual Report, Minister of Public Works, 1884-85, pp. 107-108.

gneissic rocks along its banks. At the mouth of the Mattawa a sharp elbow is formed, the valley below that river turning nearly east, in close correspondence with the foliation of the gneisses and coinciding in direction with the depression occupied by the Mattawa River. The sharpness of this elbow is further accentuated by the fact that, for several miles above this point, the course of the Ottawa River is nearly north-and-south.

Rapids, Mattawa to Lake Temiscaming.

The river from Mattawa to the foot of Lake Temiscaming is interrupted at intervals by heavy rapids, three of which occur on the first fourteen miles, while the Long Sault, seventeen miles further up, is six miles in length.

La Cave.

The first rapid, four miles above the Mattawa, is now known as La Cave. It is about half a mile in length, and is divided into two leaps, the lower of which was formerly known as La Cave, while the upper portion was called the Demicharge Chaudron, or Chaudière. The The combined fall is nearly ten feet, divided into two nearly equal parts. The river between the Mattawa and La Cave Rapids averages about a quarter of a mile in width, although in one or two places where bays are present, this width is nearly doubled. Antoine Creek is the main tributary in this interval, coming in from the west and draining in its course the larger portions of the townships of Mattawa and Olrig, its source being in some small lakes situated in the south-western part of the township of French.

Les Erables.

From La Cave to the next rapid, known as Les Erables, is a little over three and a half miles, while the width averages about a third of a mile, and occasionally somewhat less. Les Erables Rapids are a little over half a mile in length, with a descent of nearly thirteen feet. Latour Island, at the foot of this rapid, and almost in the middle of the current, shows a large number of pot-holes worn out in the rock. All stages in the process may be seen from the incipient canals, where the eddies have commenced to wear down along the jointing planes that cut the rock, to holes ten feet in diameter. In a few instances several holes are seen to have been so greatly hollowed out that they ultimately joined at or below the surface.

Cotton Creek enters from the east a short distance below the foot of Les Erables Rapids, forming a beautiful cascade as the water tumbles over the rough ridges of gneiss which impedes its progress. This stream drains a number of lakes, of which Lake Memewin, situated about four miles to the east of the river, is the largest, being four miles long, and very irregular in outline. Scarcely three miles and a half intervenes between Les Erables and The Mountain, where the

The Mountain Rapid.

whole volume of the river flows through a narrow channel, obstructed by rocky reefs and islets. About a mile above Les Erables Rapids another stream enters from the east, with a steep descent into the valley of the Ottawa. This stream, now known as Snake Creek, drains a number of small lakes, the largest of which is Snake Lake, while the head waters are in a small lake, from which only a short portage is necessary to reach Obasking Lake. It thus formed a portion of the old winter route, which left the Ottawa River at the mouth of this creek and reached Lake Temiscaming a short distance below the Opimika Narrows. About a mile below the Mountain Rapid one of the highest hills was ascended and found by aneroid barometer to be 520 feet above the surface of the water. The average height of the hills on either side would, therefore, be little less than 500 feet.

Snake Creek.

Seven League Lake.

Seven League Lake, is a stretch of navigable water nearly seventeen miles in length, extending from the head of the Mountain to the foot of the Long Sault Rapids. The banks in most places are steep and rocky, and one or two places, perhaps, deserve special mention. Devils Garden Bluff, on the east side, presents a sheer precipice of gneissic rocks, and receives its name from the fact that a patch of wild onion grows near its summit. Above this, on the west side and only a short distance below the foot of the Long Sault Rapids, there is a sharply accented hill thickly overgrown with small pine trees, which, from its marked resemblance to the characteristic headgear of the Canadian "habitant," has always received the designation of "La Tuque." This is a rather important and well known land-mark.

Streams entering East Creek.

Three important tributaries enter Seven League Lake. The first of these, known as East Creek, has its source near the eastern limit of the southern map-sheet, and is thus not more than seven miles long, reaching about six and a half miles below the foot of the Long Sault. The next stream, however, which enters on the west side about half a mile further north, is much larger, and named Jocko River, after a half-breed of that name. Formerly the stream was known as the Siconaguisipi or Blackstone River, a name appearing in Sir William Logan's report on the region, although on his manuscript map it is designated as the Porcupine River. The main branch of this stream heads in a lake about two and a half miles long, bearing the same name, and situated about the centre of the township of Osborne, a little over twenty miles in a straight line from the outlet. Its northern branches drain the northern parts of Osborne and Garrow townships, and also a considerable area of unsurveyed land between these townships and Nevin's base-line. The southern branches drain almost the whole of

Jocko River.

Its southern branch.

the townships of Stewart and Lockhart, this area being but slightly less than seventy square miles. The river has carried down a quantity of loose material, which fills up a large area of the lake in the vicinity of its mouth. It flows through a steep, narrow valley, and in debouching on the lake the channel makes a sharp bend northward through the gravel and sand, thus forming what has often been called a "square fork." This delta is 200 yards wide and about a quarter of a mile long, and may owe its origin partly to glacial accumulation and deposition. If it occurs as a result of stream action, it evidences a river of much greater volume than that which now occupies this valley.

Obashing River.

The Obashing is the third stream of importance entering Seven League Lake in a bay on the east side, close to the foot of the Long Sault Rapids. The lower portion of this stream meanders through a sandy flat, which extends inland for some distance. The upper portion of the stream, however, is exceedingly rough and rapid, showing a total fall of about 300 feet in a distance of scarcely three miles. It affords an outlet to a large number of lakes in the region to the south of Keepawa Lake, the largest of which is Obashing Lake. The name is of Chippewa origin, and refers to the narrows which divide the lake into two very nearly equal portions. It covers an area of about eleven square miles, and measures ten miles from east to west, with an average width of from one to three miles. Two large tributaries enter the eastern end of the lake, the most northerly being known as the Otter River.

The Long Sault Rapids.

The Long Sault Rapids separate Seven League Lake from Lake Temiscaming, and are caused by a great accumulation of very coarse gravel and boulders, many of the boulders, at the head of the rapids, are exceedingly large, measuring from twelve to fifteen feet in diameter. The rapids are usually very narrow and crooked, and a little over six miles in length. Very little rock *in situ* can now be seen, although it is evident from the topography that the detritus was deposited in a pre-existing shallow narrows. On the east, or Quebec side, the drift material forms a comparatively level space, varying from a quarter to half a mile in width, along which the railway-line is constructed. With skilful canoemen, it is customary to run the Long Sault Rapids in the larger voyaging canoes, but five portages and tracking lines are necessary when an ascent is made. The three lower portages are on the east side of the stream, and the two upper ones on the opposite bank.

McDougall and Gorden Creeks.

Two streams fall into the Ottawa at the Long Sault, one from either side. McDougall Creek, which flows in from the west at the Crooked Rapid, takes its rise in some small lakes about ten miles to the north-west, and Gordon Creek enters about a mile below the head of the Long Sault. Logs are brought from Keepawa Lake by an artificial channel into Gordon Creek, down which they are run. The total fall of Gordon Creek, from Keepawa Lake, is about 300 feet, nearly 250 feet of which is below Pike Lake in a little over a mile.

Lower end of Lake Temiscaming.

Lake Temiscaming is usually regarded as commencing at the head of the Long Sault. The name means literally "at the place of the deep dry water," doubtless referring to the existence of the extensive clay flats in the north-eastern portions of the lake which are sometimes dry. The lake is sixty-one miles long in a bearing N. 26° W., with an area of about 125 square miles. From the head of the Long Sault to the Narrows the lake is about a quarter of a mile wide, but at the foot of the Narrows it increases in width to about a mile, on account of Thompson Bay, situated on the east side. Both shores are steep and high, and in several places there are almost perpendicular cliffs over 200 feet in height. On the Ontario side especially, the hills are covered with a good growth of pine, almost to the water's edge, which effectually conceals the rock beneath. A portion of the Quebec side, between the Narrows and Schooner Island, has, however, been almost denuded by fire of its original forest growth, and exposes the rough and broken ridges of gneiss. Schooner or Ship Island evidently represents the apex of a bouldery shoal, as no evidence of a rock *in situ* could be found. Presquîle, about a mile above the head of the Long Sault, has been designated as an island, and although comparatively deep bays approach close to one another on the north and south sides, a small neck of land unites the so-called island with the eastern shore. It evidently represents an older accumulation of morainic material which in so many places block the channel of the river.

Length and area.

Forest growth.

Morainic islands.

Opimika Narrows.

The Opimika Narrows, are about two miles in length, and very crooked and contracted towards the northern end. High rocky hills form the immediate coast-line on the west side, but on the east side the shore is composed of sand, gravel and boulders, forming a flat over a quarter of a mile wide to the base of the rocky hills. The greatest contraction is towards the north end, where the shore-lines are only a little over a hundred yards apart. Two creeks enter the Ottawa at the Opimika Narrows. The largest one, now known as White Creek, drains two or three small lakes between this point and Keepawa Lake, the largest of which, White Lake, is over half a mile in width, and two miles in length; the eastern end approaching within about three miles of Keepawa Lake. The other creek is known as Green Creek, and enters from the west side, draining some small lakes in that direction.

Above the Opimika Narrows the lake widens almost immediately, and from this point as far north as the mouth of the Montreal River it has an average width of from three-quarters of a mile to a mile. The shores are very bold, often exhibiting nearly vertical precipices of rock for many miles at a stretch. Occasionally small portions of the shore-line are composed of sand and gravel, but high trees rise almost immediately behind. McMartin and Ouellette points are small, low, projections running out a small distance into the lake and are composed wholly of sand and gravel except in the case of McMartin Point, where some of the solid rock projects through this loose material. In the vicinity of McMartin Point, a considerable amount of stiff grey clay was noticed, and a bank of this contains a large number of very irregularly shaped calcareous nodules, but no fossil remains were found in them. The hills on either side of the lake are from 300 to 500 feet above the surface of the water, and the highest, known as the King of the Beavers, rises to a height of about 600 feet. These hills evidently form the edges of an undulating plateau which extends inland on both sides, and in which the valley of the lake has been excavated. Buffalo Rock is another well known topographical feature, consisting of a rocky precipice on the west shore of the lake, and so named from a mass of vegetation upon it, which has a fancied resemblance in outline to a buffalo. Narrows to Montreal River.

Six tributaries may be mentioned which flow into the Ottawa between the Opimika Narrows and the mouth of the Matabitchouan River. The first of these is Opimika Creek that enters a beautiful sandy bay on the west side, known as McLaren Bay, about half a mile north of the Narrows. The water of Opimika Creek is extremely clear and cold, abounding in speckled trout. Although its actual source is in a small lake about nine miles to the south-west of the Narrows, it derives most of its water from two lakes some four miles to the south-west, which are supplied by a series of large springs. One of these lakes is called Emerald Lake, and is remarkable for containing a deposit of shell marl which is described in that portion of the report treating of economic geology. The small pond at the head of the stream is 580 feet, by barometer, above Lake Temiscaming. Tributaries entering this part of lake. Opimika Creek.

About three miles further on, Ottertail Creek reaches the lake from the west. This stream forms a portion of a route to the west. The main or southern branch takes its rise in a small lake, some twenty miles to the south-west in the township of Hammell, within a mile of Spruce Lake, at the head of the Tomiko River. About a mile above McMartin Point, a small stream enters from the east, draining White Beaver Lake, Ottertail Creek.

and three miles south of the mouth of the Keepawa River, another small stream enters which is notable as being the old Indian portage-route to Lake Keepawa.

Keepawa River.

The next stream is the Keepawa River, forming the outlet to a great number of large lakes, many of which are outside the boundaries of the present map. The largest of these lakes is of course Lake Keepawa, which is nearly thirty-two miles in a straight line from north to south and, with its intricate shore line of bays, covers an area of 120 square miles. The Keepawa River is nearly nine miles in length, with a total fall of about 300 feet, and has a number of powerful rapids and chutes in its circuitous course. At the mouth is a very fine chute. The Matabitchouan and Montreal rivers, which enter the lake at the same place, are elsewhere separately described.

Shores north of Montreal River.

North of the Montreal River, Temiscaming Lake gradually widens. The western coast-line continues to be rather even and unbroken and is also as a rule steep and rocky. At the Crows Nest Rock, opposite Bryson Island, as well as at Manitou Rock opposite Mann or Burnt Island, there are sheer precipices, that extend for several miles varying from 150 to 200 feet in height. The east side of the lake shows more irregularity in outline, and large areas of level land exist, from which, however, bold hills rise in places. There is much more cultivable land in the aggregate, than the often rocky character of the lake-shore would indicate.

Islands.

Below the Old Fort Narrows there are only a few small and insignificant islands. Roche McLean, so named after an old North-west Company fur-trader, as well as the island north of Pointe à la Barbe, are both connected at low-water with the western mainland by narrow bars of sand and gravel. Moose Rock is a huge boulder of breccia-conglomerate, about thirty feet in diameter, situated some four miles south of the Narrows. North of the Narrows, there are several islands, of which the most important are Bryson or Moose Island, Burnt Island and Chiefs Island, the latter being a well known topographical feature. It is high and rocky, and at low-water is connected at its eastern end with the mainland by a bar composed of boulders and clay; although, during the early part of the season, there is often sufficient water to permit of the passage of the steamer. To the north-west of the island a similar bar exists, which, at low-water, prevents the steamer proceeding any further, although the channel inside is quite deep. The presence of this boulder barrier is probably due to its deposition, in part at least, in a crack or rift in the glacier, that evidently occupied the valley of the Blanche River towards the close of the glacial period.

Chiefs Island.

The northern part of the lake, from the Old Fort Narrows to the mouth of the River des Quinze, has more the appearance of a lake than any portion further south. The deepest water is to the west of Mann and Bryson islands, and is the route usually followed by the steamer. At ordinary summer level it is impossible for a steamer drawing six feet of water to pass between Bryson Island and the Quebec mainland, and the lake for a long distance outward, opposite Wright's mine, is comparatively shallow. Kelly, or, as it is now called, Priests Bay, where the chief settlement of the district is situated, presents a long stretch of gently sloping clay flats, extending out from the shore opposite the village of Baie des Pères, and, usually, towards the end of August and in the month of September there is not more than five feet of water at the end of the long wharf, so that for a considerable portion of the season the steamers are compelled to anchor fully half a mile from shore, and lighter their passengers and cargo. Priests Bay.

The north shore of the lake is divided into two deep bays by the high rocky promontory terminating at Dawson or Wabis Point. The high limestone table-land of which this forms a part, is over two miles in width, presenting a very steep escarpment of light cream-coloured limestone facing eastward and running in a N. N. W. direction beyond the borders of the map. Wabis Bay is a little over two miles wide and three miles in depth, receiving at its head the waters of Wabi Creek, at the mouth of which is situated the promising settlement of Liskeard. Wabis Creek is a stream of considerable importance, rising beyond the north boundary of the map and draining a large area of arable land to the north-west, most of which has recently been laid out in townships and subdivided into lots. The borders of Wabis Bay are in general low, with a marshy fringe along its north-west shore, while the water is extremely shallow and the shore difficult of approach except by means of the very crooked and narrow channel which the stream has hollowed out on the hard clay bottom. The north-eastern part of the lake is divided into two bays known as Sutton and Paulson bays, separated from one another by the low marshy delta marking the mouth of the Blanche and Quinze rivers. The greater portion of Sutton Bay is a low sandy flat almost completely dry at low-water. Northern shores of lak Wabis Bay. North-eastern Bay.

When the lake is at its ordinary summer level, there is scarcely a foot of water covering the extensive clay flats in the vicinity of Chiefs Island except in the various channels which the steamers entering in this vicinity have hollowed out. During low-water, occurring in September of 1887 and 1894, the greater part of these clay flats was exposed, the water being confined to these comparatively narrow channels. Three Shallows near Chiefs Island.

large tributaries enter the lake in this neighbourhood and a fourth, known as Abbika Creek, about eight miles in length drains the western portion of the township of Guigues. The largest of these streams is the one which really constitutes the upward extension of the Ottawa River, now known as the Rivière des Quinze or Quinze River. The other two, in the order of their importance, are the Blanche or White River and the Otter River, often also called Ottertail River especially on the maps issued by the Crown Lands Department of Quebec. Only about five miles of the lower portion of the Blanche River is shown on the Lake Temiscaming map-sheet, the source of the stream being in Round Lake, is situated about forty-four miles from its mouth in a north-westerly direction, but following the river the distance is nearly sixty miles. The waters of the Blanche River enter the lake through four somewhat intricate channels, between three low marshy islands, formed by the large amount of loose material deposited annually by this stream. Two of these islands, known as Wright and Rousselet islands, are of considerable size. The deepest channel is called the Chenal du Diable, and is navigable for small steamers at high-water. The next channel further south is known as the Crow Channel and is fairly deep, but the other two channels, which are more in line with the upward course of the stream, are almost completely choked with sand and other detritus, so that they can scarcely be navigated by canoes during ordinary stages of the water.

Rivers.

Blanche River.

About five miles from its mouth, the depth of the river varies from sixteen to twenty-four feet, and the width from 320 to 400 feet, and at a distance of twenty miles from its mouth it is 220 feet wide and eight feet deep. Here a small rapid occurs, with a fall of about two feet, but above this is a quiet stretch of water for nearly six miles further. It will thus be seen that, at low-water, the river is navigable for a distance of twenty-five miles for steamers drawing under three feet, while at its highest stage this distance is increased to over thirty miles. The Blanche River has cut its channel through a thick deposit of drift material, composed chiefly of clay, and the sections thus furnished are probably the best in the whole district. The valley consists of a series of four or five rather extensive flats or terraces, rising, one above the other, to the north-west of the lake, and evidently forming the continuation northward of the depression occupied by Lake Temiscaming. Near its mouth, the banks of the river are quite low, and subject to inundation, with large areas of tamarac and spruce swamp. As the stream is ascended, however, the banks gradually increase in height, and thirty miles inland they are more than one hundred feet above the level of the stream. Twenty-five

Navigable part of river.

The valley.

miles from the lake, the banks are eighty or ninety feet high, and furnish a good section, which is as follows in descending order :—First, two or three inches of vegetable mould, then about a foot of reddish-brown sand merging into a gray clay, and below this, again, a bluish clay, which extends to the base of the cliff, forming the bed of the stream. Bluish clay is exposed, according to McOuat,* in the bed of the river all the way to Round Lake, but about half-way up is overlain by a rather coarse, brown sand, which, in its turn, further up, is again overlaid by clay. Six or eight miles below Round Lake, where the cliffs are upwards of a hundred feet high, the middle portion consists of sand, while at the base and summit nothing is seen but clay.

Otter River.

The Otter River drains by far the larger portion of the area to the south-east of this part of Lake Temiscaming. The main stream rises about six miles south-east of Lac aux Feves, where it occupies the same depression as Chemagan and Hay bays of Lake Keepawa. Its channel is very tortuous, and in its lower portion has an average width of about 100 feet, with a depth of ten feet, while its rate of discharge was measured by Mr. Guerin as 229 cubic feet per second, or less than one half that of the Blanche, and its velocity twenty-six feet per second. It is navigable by canoe without interruption for a distance of about ten miles from the mouth, and is frequently used by the settlers in going to and returning from North Temiscaming. About six miles from the mouth, the Cameron Branch enters, and, with a general course of nearly east-and-west, has its head-waters in a small lake only a mile west of Lac des Quinze. This tributary also serves to empty two considerable lakes, known as Long and Sasaganaga, the former about three miles in length, but with an average breadth of scarcely a quarter of a mile, while the latter is two and a-half miles long, with a somewhat uneven shore-line and containing several islands, has an approximate breadth of a little over half a mile. The south branch, or Duford River, drains the larger portion of the township of Duhamel, rising in a small marshy lake about the centre of the township. This stream is rather crooked, even in its larger bends, while it meanders in a very tortuous manner through clay flats.

Its discharge.

Cameron Branch.

South branch.

Geological Description.

Bouldery terrace at Mattawa.

The village of Mattawa is built upon a bouldery terrace of morainic origin, which, subsequent to its deposition, has been modified to a considerable extent by the scouring action of water. This boulder-covered field or plateau has a somewhat uneven contour, but in general

*Report of Progress, Geol. Surv. Can., 1872-73, p. 134.

it may be said to rise from thirty to seventy feet above the river. It is only one of many similar occurrences to be found in the neighbourhood of the Ottawa River, all of which seem to owe their accumulation primarily to deposition from a melting detritus-laden glacier. This bouldery terrace begins nearly a mile up the Mattawa River and extends a little over half a mile down the southern bank of the Ottawa. In the angles formed by the junction of the two streams, it has its maximum development, producing a bar consisting almost wholly of boulders and coarse gravel, which stretches nearly across the river, leaving a deep though narrow channel near the Quebec shore. The boulders about Mattawa vary in size from a few inches to as many feet in diameter, while many of them measure from ten to fifteen feet across. By far the larger number of these erratics consist of very evenly folioted gneiss, and have not been carried far from their original positions. Some are of red and gray granite, while a few are of greenish gabbro or diabase. Recent cuttings show that the bouldery layer overlies silts and other fine deposits. A well defined old river-channel occurs, running through the rear portion of the village between the main street and the railway station, which has evidently been followed by the Mattawa or its antecedent stream. It leaves the Mattawa about a mile above the mouth, and reaches the Ottawa at the foot of the rapid, nearly three-quarters of a mile below.

Character of boulders.

Terrace.

On the north side of the river, a steeply scarped though somewhat narrow terrace rises to a height of nearly eighty feet above the level of the river. Near the junction with the Ottawa this terrace is composed of well-rounded fragments or small boulders with coarse gravel and sand, this material being in a much finer state of division than that on the south side.

Mattawa Mountain.

Opposite the village of Mattawa, on the north side of the Ottawa, is "Mattawa Mountain," about 600 feet high. It is composed of a grayish granite-gneiss, consisting of the usual alternation of lighter and darker bands, causing a distinctly marked foliation. The strike of this foliation corresponds closely with the trend of the hill, being nearly east-and-west, while the dip is about 20° to the south. In places it contains an abundance of rather small garnets, especially numerous in the darker or more basic portions of the rock.

Pegmatite dykes.

At many points this gneiss is cut by dykes of pegmatite, varying irregularly in breadth from a few inches to several feet. These pegmatites are composed usually of a flesh-coloured orthoclase or microcline and quartz. Occasionally a white plagioclase, probably oligoclase, was noticed in the same dyke with the orthoclase, while the ferro-magnesian constituent is sparingly represented, if at all, and is usually biotite. The quartz is as a rule segregated in the centre of each dyke, leaving an almost pure felspathic margin of varying thickness. Many of these dykes cut the foliation at considerable angles, running from S. 40° W. to S. 55° W., while others, especially the smaller ones, conform very closely to the foliation.

It is quite apparent, from the many conflicting local dips and strikes observed in the area to the south of the Ottawa River, and extending for a few miles east of Mattawa, that the gneissic rocks rise into a series of small domes, each presenting quaquaversal dips; while, on the other hand, the complete examination of this small area has also shown that the grander structural features of these rocks exhibit a rather constant dip at low angles, varying in direction from south to S. 10° W. These gneissic rocks are well foliated and of a dark-gray colour where the bisilicate material is present in relatively greater quantity, while a prevailing reddish tinge is usual where felspar present increases. Some bands exhibit the "augen" structure in great perfection. Gneisses forming small domes.

About a mile east of Mattawa, the main line of the Canadian Pacific Railway has cut through the axis of one of the most perfect of these dome-shaped bulges. The gneiss occurs in alternating light- and dark coloured bands which exhibit very sharp lines of demarcation one from the other. The main axis of this dome runs in a direction S. 80° E the dips on the north side of the railway track thus turning from N 80° W. all around to S. 80° E.; while on the south side of the track dips exactly the opposite of these may be noticed.

The gneisses contain a large percentage of pyrite, and all the joints and fissures are plentifully coated with brown hydrous oxide of iron due to the decomposition of this mineral. The rocks crumble and fall to pieces when exposed to the action of the atmosphere for any length of time, giving rise to a coarse brownish sand that constitutes much of the soil of the region surrounding Mattawa. Character of gneiss.

About a mile and a-quarter east of Mattawa, the gneiss has a dark reddish-gray colour, the reddish tinge being due to the presence of felspar, which is in reality much more abundant in certain bands than in others. On the surface the gneiss presents a smooth hard crust, that is evidently merely the result of weathering, while beneath this thin coating the rock has undergone somewhat advanced decomposition, being yellowish in colour and comparatively soft and friable. This outer induration is very frequently characteristic of the exposed surfaces of both gneisses and the Huronian sandstone and greywackés, and, as has been Superficial induration.

shown by Irving and Van Hise, is caused by the secondary enlargement of the quartz and felspar individuals, the interstitial material constituting interlocking areas which are optically continuous with the original grains.

Rocks between Mattawa and Calvin.

To the west of Mattawa, the railway follows up the valley of a creek that empties into two small lakes, the larger of which is known as Earls Lake. The shores of both these lakes are low and grassy, with only one rock exposure at the western end of Earls Lake. Between Mattawa and Calvin stations the rock is usually well foliated granite-gneiss, although in one or two places it is very massive, and the foliation is either absent or quite indistinct. Some of the bands differ in colour from dark-gray to almost black where the biotite is exceptionally abundant; others are light-gray, while still others are of shades of flesh-red or pink where the felspar is plentiful and is of that colour. The component bands are frequently so irregular in their development and in places so contorted, while the region as a whole has undergone such uneven truncation, that it is often exceedingly difficult to pronounce with any degree of certainty as to the direction of either the dip or the strike. In general, though, these rocks gradually bend round from S. 45° W. a little west of Mattawa, to S. 80° W. in the vicinity of Calvin, with a common dip at a high angle to the south. One of the pegmatite dykes, noticed about two miles west of Mattawa, is composed of a very large quantity of flesh-red felspar in coarse cleavable masses, some quartz and a considerable amount of dark-coloured mica, in large crystals and plates, doubtless a partially bleached biotite. All of the rocks are well rounded and glaciated, and although the striæ are not very plainly marked, some indistinct ones have a south-west direction, and are thus referrable to the period of general glaciation.

Strike of gneiss north-west of Mattawa.

In the angle formed by the junction of the Mattawa and Ottawa rivers, and to the north and east of these streams, the foliation of the gneiss shows a curious fan-like arrangement, the convergent lines pointing towards the Ottawa, where the gneiss shows a rapid change in strike from nearly east-and-west at the southern end of the rock exposure to N. 25° W. at the northern end. This structure is, however, only a local feature, and is confined to a small area. To the west, this fan-like formation broadens, the bands near the southern end curving round rather sharply to the south-west to meet those exposed on the shores of Boom Lake and in the vicinity of the Plain Chant Rapids on the Mattawa, where the gneiss strikes from S. 30° W. to S. 60° W. with a south-easterly dip $<$ 40° to 45°. To the north, as the Ottawa River is ascended, on the west shore the strike of the gneiss

Strike at Cave Rapids.

CUTTING IN GNEISSIC ROCKS, ONE MILE EAST OF MATTAWA, ON MAIN LINE OF C.P.R.

Showing the dome-like structure frequently noticed in highly differentiated gneisses.

changes first to the west and then to N. 75° W., which latter seems to be the general direction of the foliation in the vicinity of the Cave Rapids. At the bluff on the east shore, the rock is composed of alternating bands of light- and dark-gray micaceous gneiss, evidently of the ordinary granitite variety, and shows a strike of N. 55° E. and a dip to the south $<$ 10°-15°. Above this again the foliation exhibits a change in direction, and about three-quarters of a mile below the Cave Rapids a strike of S. 75° E. was noted, with a dip southward $<$ 20°. A little above the rapids, the evenly foliated gray gneiss trends in a north-easterly direction, dipping to the south-east $<$ 30°. Between the Cave and Les Erables Rapids, the granitite-gneiss, which in the more basic bands seems to contain some hornblende in addition to the biotite, varies in strike from S. 70° W. to N. 70° W. with a southerly inclination.

At Les Erables Rapids.

Les Erables Rapids are caused by the outcrop of ledges and islets of gneiss, which obstruct an already much contracted channel. The strike is N. 70° W., while the dip is northwards at an angle usually considerably less than 10°. A little above these rapids the foliation has an almost east-and-west direction, while near the mouth of Snake Creek the strike is N. 80° E., and the dip S. $<$ 70°. From the head of Les Erables Rapids to about half a mile beyond the mouth of Snake Creek, the exposures, which were very closely examined, show a gneiss composed of alternating bands of light- and dark-gray colour. The bisilicate present, which, from its preponderance, gives the dark colour to certain bands, is biotite, and the rock is thus a granitite-gneiss composed essentially of felspar (chiefly orthoclase), quartz and biotite. Besides these constituents, there are others, which in places are so abundant as to characterize the rock. The principal and most interesting of these is cyanite, although individuals of an almandine-garnet are usually numerous, especially in the more basic portions; while graphite was noticed finely, though rather thickly distributed through the rock. Cyanite of a prevailing blue colour is frequently so plentiful as to characterize large exposures of this gneiss. It occurs in rectangular or flattened prisms, which are very long and blade-like in their habit, presenting round, jagged, or irregular terminations.

Gneisses containing dyanite.

Rocks near the Mountain Rapids.

About a mile below The Mountain Rapids, the high hills on the east shore are formed of alternating bands of light- and dark-gray garnetiferous granitite-gneiss, striking S. 55° W., and dipping south-easterly $<$ 45° to 60°.

At the foot of the Mountain Rapid, the gneiss is more massive in structure, although still preserving a distinct foliation that runs nearly east-and-west, while the dip is to the south $<$ 35° to 40°. In places it is filled with small crystalline or irregular fragments of garnet, while the rock in general has a distinct reddish colour. The Mountain Rapid runs for the most part in the strike of the rock, which is a dark-gray, well foliated gneiss. The ridges and islets are composed of this gneiss, presenting a strike varying from S. 50° E. to S. 55° E., with a dip to the north-east < 20° to 30°.

Above the Rapids.

About a mile above the Mountain Rapid, on the west side, the dark-gray, micaceous or granitite-gneiss strikes S. 70° W., with a dip to the south. About one and a-half miles above this point, a gray gneiss was noted with a decided foliation, exhibiting a series of beautiful curvings and twistings, while the general strike is N. 60° E., with a dip to the south-east < 65° to 70°. About four miles above the Mountain Rapid, a massive, fine-grained, red gneiss was noticed, associated with some more evenly foliated, gray gneiss; the whole dipping south < 40°-80°. In the vicinity of the narrows of Seven League Lake, and for some distance beyond, the gneiss is in many places much contorted, and usually of a dark-gray colour, owing to the prevalence of the more basic bands. In many places the rock runs in long curves, presenting a gentle undulating dip, which often approaches horizontality, while at other points not far removed the bands are almost on edge. Beyond the narrows on Seven League Lake, the gneiss, which has a gray colour and is well foliated, strikes about S. 65° E., with a southerly dip at a low angle, generally from 20° to 30°. Opposite La Tuque, on the east shore and below the mouth of Obashing Creek, the lighter coloured bands, which are reddish, alternate with those of a dark-gray. These constitute a granitite-gneiss, which generally dips S. 25° W., < 10° to 20°, although in some places it seems perfectly horizontal, and in others it is much contorted.

At narrows of Seven League Lake.

On northern part of lake.

At the foot of the Long Sault, the reddish granitite-gneiss dips S. 20° W., < 25°. In many places along the shores of the northern part of Seven League Lake, the darker and more basic bands of gneiss contain epidote in very considerable quantities, indeed sometimes so abundant is this mineral as to give a yellowish tint to the band in which it is contained.

Rocks between Long Sault and Lake Keepawa.

The country between the Long Sault Rapids and Lake Keepawa, is composed of high, rocky ridges of flesh-red and dark-gray gneiss, the former prevailing, while the alternation of both produces a marked foliation in the whole mass. The darker bands are made up mostly of the coloured constituents, while the lighter ones show a relatively greater quantity of quartz and felspar. The general strike varies from S. 50° E. to S. 60° E., while the dip is under 30°. A thin section of what was regarded as a typical specimen of this gneiss, showed it to be a quartz-mica-diorite-gneiss, although it is probable that other and more acidic portions would show the ordinary granitite-gneiss, as well as the hornblende-granitite-gneiss, to be present. The rock, as examined under the microscope, showed the chief mineral constituents to be plagioclase, quartz, some unstriated felspar (probably orthoclase) and a little microline, hornblende, biotite and epidote, with smaller quantities of titanite, pyrite, zircon, allanite, apatite and hæmatite.

On Obashing Lake.

On the Big Obashing Lake, the gneiss is usually well foliated, often of a light-gray colour, although some portions present reddish-coloured bands where the felspar contains much iron oxide, and the general strike in the vicinity of the narrows varies from S. 66° E. to S. 75° E. with a dip to the south < 15° to 30°. At the east end of the little island in the bay out of which the road goes south to the small lake at the head-waters of Snake Creek, the gneiss is composed of alternating reddish and dark-grey bands, in places somewhat contorted, and shows a general strike of S. 85° E. with a dip to the south < 70° to 80°. Near the east end of Obashing Lake, the dark-gray well foliated gneiss strikes S. 84° E., and is either quite vertical or dips at a very high angle to the south.

Near the outlet of Little Obashing Lake, the gneiss, which is distinctly foliated and has a reddish colour, strikes east-and-west, dipping south at an angle of about 35°. The smaller lakes to the south-west of Little Obashing Lake, generally present high shores which are well wooded and green to the water's edge, so that there are only limited opportunities afforded for ascertaining the trend of the bordering gneiss. On a small island in Thompson or McConnell Lake, however, gray gneiss was noticed dipping S. 20° W. at a low angle.

Rock from Long Sault to Opimika Narrows.

Near the head of the Long Sault, on the west shore of the Ottawa, the gneiss is composed of alternating light and dark bands. Many of the lighter bands have a flesh-red colour where the felspar is abundant, while others are grayish or nearly white. The dip is S. 30° W. < 20°.

There are comparatively few exposures of rock between the head of the Lang Sault and the Opimika Narrows, and the strike at some of these is hard to ascertain with any degree of certainty. The general strike seems, however, to be S. 55° E., which is apparently maintained as far as Schooner or Ship Island. On the east shore, opposite this island, the gneiss, which is exceedingly well foliated in alternating bands of light-gray flesh-red and dark-gray colours, dips S. 10° W, < 30°.

To the south of the Opimika Narrows, on the west side, and nearly opposite Lumsden's depot (Opimicong P. O.) is a gray, rather fine-grained, evenly foliated micaceous rock, showing lenticular areas of quartz and felspar which are comparatively free from coloured constituents. The microscope shows the rock to be a hornblende-granitite-gneiss composed chiefly of quartz, orthoclase, plagioclase, microcline, biotite and hornblende, whith smaller quantities of ilmenite associated with leucoxene, sphene, apatite, calcite, zircon and epidote. The dip of this gneiss is S.W. $<$ 45°.

Curving strike of foliation.

This exposure marks the southern end of a great curve in the gneissic rocks, the Opimika Narrows conforming closely with the strike of the rocks in their bend. At the southern end, the strike is north-west, about half-way through it has changed to S. 75° W., at the north end of the Narrows the strike is N. 15° W., while still further north on the same side it bends around to N. 30° W., and near the mouth of Ottertail Creek the rock strikes N. 35° E.

The gneiss, in this interval, is of the usual gray micaceous variety, occurring in alternating light and dark bands, while the dip is to the west or north-west at high angles, usually about 65°. A thin section, cut from a specimen obtained at the exposure immediately below the mouth of Opimika Creek, showed the rock to be a granitite-gneiss, composed chiefly of quartz, orthoclase, plagioclase and microcline, with biotite, epidote and sphene as its principal coloured constituents.

Region south-west of Opimika Narrows.

In the region to the south-west of the Opimika Narrows, the country is well wooded, and the few rocky outcrops encountered have a general south-westerly strike. Near the small bridge on the old McLaren lumber road, crossing Opimika Creek less than a mile from the lake-shore, the gneissic rocks are very evenly and distinctly foliated, showing interlaminations of reddish light-gray and dark-gray material, the whole having a strike of nearly north-and-south and dipping west $<$ 20°. Two miles south-west of the lake, other small outcrops of a light-gray granitite-gneiss occur, dipping S. 50° W. $<$ 35°. Near the end of McLaren road, the rock is concealed for the most part by sand, but here and there hummocks of gneiss occur. One of these, situated about three-quarters of a mile from the end of the road is composed of gray well foliated gneiss dipping S. 80° W. $<$ 20°.

Region north-west of Opimika Narrows.

To the north-west of the Opimika Narrows are situated Long and White lakes, which empty into Lake Temiscaming a short distance north-west of Lumsden's depot. These lakes are noteworthy as affording an opportunity of tracing in some detail the general outline of an immense curve in the strike, that, starting at the south end of the Opimika Narrows with a direction N. 40° W., circles around to S. 65° E. at the Beauvais Narrows on Lake Keepawa. On Long Lake, the gneiss is composed of successive bands of reddish-gray, gray and flesh-red colours, which vary in strike from N. 20° W. to N. 7° W., while the attitude of the layers changes from nearly horizontal in the south-western part of the lake to an inclination to the west of 35° in the north-eastern part. On White Lake, the rocks curve around gradually to N. 53° E., and on the north shore the gneiss has a strike of only a few degrees south of west. These rocks are light-red, reddish-gray, light-gray to dark-gray gneisses, the layers running in low, broad undulations with a prevailing southerly dip at angles varying from 5° to 10°.

On White Lake.

On the north side of White Lake, there is a reddish contorted gneiss very plainly foliated, a ferromagnesian constituent being present in long slender dark-greenish bands, while in the wider and more felspathic portions such coloured constituents are almost entirely absent.

On portage to White Beaver Lake.

To the north-east of McMartin Point, on the portage going to White Beaver Lake, the gneiss is exceedingly well foliated, running in long generally straight and somewhat continuous bands of alternating light- and dark-gray colour and varying in strike from N. 40° S. to N. 50° E.: with a prevailing north-westerly dip at high angles generally about 75°. Exposures on the south shore of White Beaver Lake exhibit a light reddish-gray gneiss in successive bands of lighter and darker colours, the whole showing a changeable strike from N. 60° E. to N. 68° E., while the folia are nearly if not quite vertical.

Of east shore above McMartin Point.

Between McMartin Point and Latour's mills, the east shore of Lake Temiscaming is very high and precipitous and for considerable stretches presents perpendicular rocky cliffs. For two miles above McMartin Point, the gneiss is comparatively massive and chiefly of the red variety, although gray bands may be noticed marking the foliation. This rock has, in general, a dip N. 65° W. $<$ 35° to 80°. The combined action of the weather and the waves of the lake have served in many places to remove an appreciable portion of the softer and more micaceous bands, leaving the red felspathic parts standing out in rather prominent relief, smoothed and planed as a result of glacial action. The surface now exposed exhibits, in great perfection, even the smallest bendings and foldings which these rocks have undergone. In the last half mile of the distance already mentioned, the gneissic rocks seem to strike approximately with the trend of the shore-line, exhibiting beautiful examples of contortion, while in other places the rock lies in a series of low undulating folds. Above this, for a little over four miles, and extending a short distance beyond Latour's mills, are almost continuous exposures of micaceous or granitite-gneiss, which is so evenly laminated that slabs could readily be obtained of almost any dimensions for flagstones. The strike is very regular, generally about N. 15° E., and the dip easterly $<$ 50° to 80°. The alternating bands composing the gneiss are usually reddish, grayish and dark-gray in colour.

Of west shore near McMartin Point.

On the western shore, for a short distance both above and below McMartin Point, the rocks are somewhat similar in character, the strike varying from S. 35° W. to S. 90° W., while the inclination, which is towards the north-west, changes from an angle of 65° to 35°.

About a mile above McMartin Point, on the west shore, the gneiss is much contorted, and in one place presents a low, dome-shaped anticlinal arch, the banding of the gneiss dipping either to the north-west or south-west at low angles. Nearly two miles above McMartin Point, or ten miles south of the mouth of the Keepawa, the gneiss is made up of alternate layers in which a relatively greater amount of felspar and quartz or biotite and hornblende are respectively present. The darker bands have yielded somewhat extensively and unevenly to atmospheric decay, the felspathic layers standing out in rib-like forms. The strike is chiefly to the south-east, while the bands have either an almost vertical attitude or dip at high angle, never less than 70°, in a south-easterly direction. Microscopical examination of a specimen representing the more basic portion of the rock, shows it to be a quartz-mica-diorite-gneiss, composed essentially of plagioclase, orthoclase, quartz, hornblende, biotite and epidote, with sphene, apatite and zircon as accessory constituents.

Rocks opposite Latour's mills.

Opposite Latour's mills, and for a short distance both north and south, the gneiss is well laminated, exhibiting precisely similar features to that on the opposite side of the lake. The felspathic bands, which are usually flesh-red, are rather fine-grained and contain little quartz or mica, while the darker bands show a superabundance of biotite and other coloured constituents.

Inclusions in gneiss.

In several places, associated with this gneiss and evidently caught up in it, are irregular masses of a dark-green, almost uralitic diabase. with somewhat large and glistening scales of dark-brown mica. The surface of this rock weathers very unevenly, presenting a very rough and pitted character. This roughness is increased by a series of intricate, reticulating dykes of a fine-grained aplite or granite that stand out in strong relief. Under the microscope, the rock is seen to be an altered diabase, the hornblende showing undoubted evidence of having been derived from pyroxene, while traces of a rude ophitic structure can still be detected. The other minerals present are biotite, plagioclase, garnet and iron ore.*

Between Latour's mills and the western end of the old Indian portage-route to Lake Keepawa, the gneiss is not so regular as that further south, and in some places runs parallel with the shore-line, while at others it forms considerable angles with this direction, making at least one great bend, which is shown on the accompanying map. Rocks north of Latour's mills.

The rocks are either vertical or dip at high angles to the east and south-east. A little south of the Indian portage, there are some dark-green, almost black, glistening bands of amphibolite, which occur for the most part interfoliated with the prevailing gneiss. These present many of the characteristics of parallel or interfoliated dykes, and some portions of them cut across the foliation, but their true relations were not studied in detail, so that it cannot be stated with certainty whether they are of later origin than the gneiss with which they are associated. The microscopic examination of two thin sections shows that, although it must be referred to as quartz-mica-diorite-gneiss, it differs in many particulars from the basic bands of the ordinary gneiss to which this name has also been applied. It has very evidently been derived from the shearing of a basic eruptive rock, resulting in its more or less complete re-crystallization, and several places were noticed throughout the region where a similar rock could be traced directly and continuously into the ordinary massive phase, which for some reason had escaped such complete deformation. One of the localities where this can perhaps be seen to the best advantage, is on the shores of one of the smaller bays running to the north-west, and forming part of Leonard Inlet, on the west coast of Shabosagi or Wicksteed Lake. This amphibolite, or quartz-mica-diorite-gneiss, is composed of quartz, plagioclase, hornblende, with an iron ore (probably titaniferous) and epidote, garnet, apatite and zircon. Associated also with the gneiss near this point is some of the uralitic diabase already described as occurring on the west shore of the lake. Amphibolites. Produced by shearing.

From the Indian portage northward to within about two miles of the mouth of the Montreal River, the rocks present the usual alternation of reddish, gray, and almost black bands. The strike of the foliation is somewhat irregular or divergent, but the general directions are indicated on the accompanying map. East shore, north to Montreal River.

Martel Point, as well as the shores of the small bay to the south, and some small rocky islets lying close to the eastern shore of the lake in this vicinity, are composed of a dark-green, almost black diorite.

*Section No. 58.

West shore.

From Buffalo Rock northwards along the west shore, the strike of the gneiss does not show any wide variation, the general direction being from S. 45° W. to S. 65° W. with a dip to the south-east <40° to 80°. The general colours are shades of light- and dark-gray, with some reddish bands where the felspar has been stained by iron. A specimen obtained from an exposure nearly opposite the mouth of the Keepawa, shows a fine-grained, gray, evenly foliated, micaceous rock, slightly discoloured throughout by iron oxide. The microscope shows the rock to be a granitite-gneiss, consisting chiefly of orthoclase, quartz, biotite and epidote and bearing a close resemblance to the gneiss exposed near the north end of the Opimika Narrows, although somewhat finer in texture.

Contact of Laurentian and Huronian.

The contact between these gneissic rocks, mapped as Laurentian, and the Huronian rocks, is exposed on the west shore of the lake about two and a quarter miles south of the mouth of the Montreal River. Immediately south of the small creek which enters the lake from the west four and a half miles south of the Montreal River, the gneiss has a strike of S. 60° W. with a dip S. 30° E. <85°, while in the bed of the creek itself the rock is apparently of a coarse dark micaceous variety, decomposed almost wholly to a chlorite-schist associated with some steatite or soapstone. For nearly a mile north of this, the shore is composed of a flesh-red gneissic granite, striking from N. 60° W. to N. 70° W. and dipping to the south-west at high angles. The point about a mile to the south of the contact is occupied by a massive dark mica-diorite or uralitic diabase, intersected in various directions by dykes of red gneissic material. Near the junction the Laurentian is represented by a light-reddish or reddish-gray gneissic granite, with somewhat indistinct foliation but no lamination. The rock is massive, rather coarse-grained, containing a comparatively small proportion of bisilicate material. Under the microscope it is seen to be a granitite-gneiss, the felspar having undergone somewhat advanced saussuritization, while the biotite originally present has been wholly converted into chlorite.

Breccia-conglomerate at the contact.

The rock in contact with this gneissic granite on the west shore representing the Huronian, is the typical and widespread breccia-conglomerate described by Sir William Logan as "slate conglomerate" or "chloritic slate conglomerate".

Contained fragments.

This rock contains numerous angular as well as rounded fragments, among which those of a somewhat coarse flesh-red granite are the most abundantly represented. These granite pebbles are composed chiefly of flesh-red orthoclase, with a smaller quantity of grayish translucent quartz and relatively little biotite, which has evidently undergone very

THE NOTCH OR GORGE, NEAR MOUTH OF MONTREAL RIVER.

Huronian greywacké-slates, much jointed and broken.

advanced alteration to chlorite. Occasional specimens of a dark-green rock which seems to be an extremely fine-grained and altered diabase, were noticed, while irregular and angular fragments of simple minerals, chiefly quartz and felspar, are rather abundant. This coarse fragmental material is held in a dark-green slaty matrix, in which chlorite and epidote are the most abundant constituents. Both the larger fragments and matrix have been subjected to intense and long continued pressure. The coarser fragments are squeezed out in a direction at right angles to the line of junction, while the softer and more yielding matrix curves around these inclusions.

Actual line of junction.

The granite and conglomerate are very closely and firmly cemented together along their line of junction, and it would be quite easy, were it not for the broken and jointed character of both rocks, to secure pieces exhibiting portions of each in the same band specimen. The line of contact in the immediate vicinity of the lake runs in a general direction of S. 75° W., but this line is not perfectly straight, as the granite has a somewhat sinuous edge which is followed very faithfully by similar irregularities in the schistose structure of the breccia-conglomerate. It is quite evident from an inspection of the coarser fragments that they have not been derived from the disintegration of the gneissic rocks with which these clastics come in contact, for the minerals composing them are much coarser in their method of crystallization and of a deeper red colour, resembling closely in these particulars the granite exposed on both shores of the lake to the north of the Old Fort Narrows. Besides, the rock in immediate contact with these Laurentian gneisses often contains far fewer fragments of such materials than exposures of similar rock farther removed from the line of junction.

Character of Huronian near Montreal River.

The Huronian to the south of Montreal River, on the west shore of the lake, is as a rule represented by a fine-grained felspathic sandstone, generally of a pale greenish-gray colour. Microscopic examination of a specimen obtained about a mile and three-quarters south of the mouth of the river, shows this rock to be made up of angular, sub-angular and occasionally of rounded fragments of orthoclase, quartz, plagioclase and microcline, cemented together by similar material in a finer state of division, with some chlorite, epidote and serecite often filling in the smaller interstices. In many places this rock is very hard and flint-like in character, breaking readily under the hammer with a splintery or conchoidal fracture. It occurs in somewhat thin beds, often shaly, dipping S. 83° W. $<20°$ while a set of cleavage planes which have been developed as a result of pressure dip S. 20° E. $<70°$. At the point just north of the contact, the rock is a greenish-gray compact slaty greywacké, which has evidently been subjected to great pressure and alteration, for a distinct foliation or schistose structure has been developed, the various bands of the rock being squeezed out into lens or pod-shaped areas, while pronounced curves in the direction of the schistosity may be observed, due to the unequal resistance deformation offered different bands and portions of the rock. At the immediate line of contact the parallel structure of both Laurentian and Huronian comform with one another, these being produced as a result of mutual reaction, the resistance offered by the neighbouring clastic primarily determining the direc tion of foliation in the granite, while the forces of upheaval in the gneiss have served to compress very materially the neighbouring clastic rocks. The Huronian strata which are here present, form a curiously lengthened wedge-shaped strip between the Laurentian granite and the laccolitic or overflow mass of diabase which constitutes the summit of the "King of the Beaver."

East shore, north of Martel Point.

On the east shore of the lake, from Martel Point northward, the Laurentian is represented almost altogether by a pale flesh-red granite, showing little or no bisilicate material, the principal coloured constituent being epidote, which is somewhat abundant. The contact between this rock and the breccia-conglomerate of the Huronian, is, on the east side of the lake, about three miles north of the Montreal River. The actual contact is concealed, but outcrops of both rocks occur within a space of less than one hundred yards and from these it would seem that the line intersects the shore at a point immediately south of a small creek which empties into the lake in this vicinity. Inland, the line is effectually hidden by overlying drift material, but its general direction seems to be very approximately N. 55° E.

The granite near the contact contains a large irregular mass of a coarse dark-green diorite. An area of finer crystalline chlorite-schist runs at right angles to the line of junction, and may represent either a small basic dyke which has been subjected to pressure, or an extremely altered fragment of the Huronian greywacké which has been caught up in the granite.

Character of breccia-conglomerate.

In the breccia-conglomerate the matrix is often present in very subordinate quantity, The most abundant fragments are of the usual biotite-granite type, while others of a pale grayish granitic rock, are seen in thin sections under the microscope to consist of phenocrysts of plagioclase or orthoclase imbedded in a fine-grained quartz-felspar groundmass. Besides these, there are some fragments composed of a fine-grained altered diabase and others of a greenish-gray slaty rock (resembling in a most marked manner the compact variety of the greywacké of the Huronian) and some gray quartz.

The material filling the interspaces is seen under the microscope to consist of a confused aggregate of scales and grains of chlorite and epidote, with abundantly disseminated particles of iron ore and fine granules of sphene and epidote. At first sight this conglomerate, occurring as it does in very massive beds, with no pronounced parallelism in the arrangement of the larger fragments, seems devoid of any definite structural features, but a closer inspection shows the strike to be about N. 50° E. while the dip is to the south-east $<10°$. As here exposed it forms a hill about four hundred feet in height, presenting a very sharp and abrupt northern face, while to the south it slopes more gradually down towards the line of demarcation between the two formations. To the north and west, this rock is succeeded by a dark greenish-gray, compact, slaty rock which seems to underlie the breccia-conglomerate, although in other sections the conglomerate occurs at the very base of the Huronian. The exposures at this place, however, are not in immediate contact, so that the relations of the two could not be ascertained with certainty. Stratification.

On the small island in Lavallee Bay, the rock is a fine-grained, greenish-gray greywacké, much squeezed and jointed, breaking with a conchoidal and somewhat splintery fracture. The small island near the east shore about a mile south-east of Roche McLean is also formed of a similar greenish-gray compact felspathic sandstone rather massive in structure. Rocks on islands.

The western shore of Lake Temiscaming, from the Montreal River to Roche McLean, is occupied by the massive, bedded, breccia-conglomerate which dips in a westerly direction at an angle of 15° This rock has already been described. A specimen obtained from an exposure about two miles north of the Montreal River, however, showed the matrix to be relatively more abundant than usual. The diabasic pebbles are also more plentiful than those of red granite, while fragments of simple minerals predominate greatly over those of composite rocks. The quartz and felspar fragments are sharply angular, while the composite individuals are as a rule somewhat rounded. West shore Montreal River to Roche McLean.

In the conglomerate near Roche McLean, the pebbles are more rounded and much more sparsely disseminated through the matrix. Pieces of an extremely altered diabase were noticed and also some of a fine-grained greatly crushed quartz, filled with small scales of serecite and chlorite. The reddish pebbles are of the prevailing type of biotite-granite or granitite. Roche McLean itself is a large rounded and glaciated hummock of this breccia-conglomerate, separated from the west shore by a narrow interval at high water.

West shore, north of Roche McLean.

To the north of Roche McLean, the western shore for a distance of a little over a quarter of a mile, is occupied by a series of dark-gray slaty rocks, the only structural feature discernible being the planes of cleavage, which dip northward at a high angle. This comes in contact with, and is somewhat altered by, a small intrusion of diabase which is doubtless an extension of the large mass which comes out on the eastern shore at Quinn Point. To the north of this diabase, the massive breccia-conglomerate again outcrops, and is penetrated by a mass or dyke of similar diabase, but with this slight interruption continues northward along the shore almost as far as Island Point.

Island Point

This point is so named because of the existence at high-water of a narrow and shallow channel separating it from the western shore. It is composed of a much squeezed, contorted and altered slaty greywacké, containing a considerable quantity of epidote. It is pierced throughout by small and intricate granitic intrusion which have evidently assisted materially in hardening and otherwise changing. To the north this rock is again succeeded by a conglomerate, containing the usual abundance of granitic fragments embedded in a dark-green diabasic or dioritic paste, resembling a diabase-tuff. About a quarter of a mile north of Island Point, this rock comes in contact with a fine-grained hornblende-granite that forms the shores of the bay to the south of Pointe a la Barbe, extending inland in a north-westerly direction and possibly connected with the mass of granite exposed on the western shore of the lake above the old Fort Narrows, although it is very different in appearance from this.

Spotted granite.

In many places, this granite shows dark patches, generally oval or rounded in outline, varying in diameter from a few inches to a foot or more. These patches are caused by the segregation of the coloured constituents and the more or less complete exclusion of the felspar and quartz. They constitute what are familiarly known as the "dark spots" (ausscheidungen) so commonly seen in granites, and evidently represent the first-formed nuclei in a slow-cooling magma.

Quinn Point

Quinn Point, is the name usually applied to a series of rugged hills that form the shoreward extension of a pronounced range that extends with little interruption for some miles to the north-east. The rock composing these hills is a dark greenish-gray uralitic diabase, in which the ophitic structure is generally apparent to the eye. The rock varies in texture, the coarse phases assuming more of the holocrystalline or granitoid structure, characteristic of gabbro. Jointed structure is very perfectly developed, one set of planes dipping westward $< 80°$ while another series dips eastward $< 12°$. The rock is composed chiefly of plagioclase, which frequently contains much disseminated iron oxide, giving it a red hue, and hornblende, which has evidently resulted from the alteration of augite. A small quantity of some carbonate (probably dolomite) a little interstitial quartz and titanic iron ore were also noticed.

Gull Rock Islands.

The Gull Rock Islands are situated about half a mile north of Quinn Point. There are two of them, presenting low rounded and well glaciated surfaces, but little raised above the high-water level of the lake and almost destitute of vegetation. The rock composing them is the breccia-conglomerate, containing very numerous and often well rounded pebbles and boulders, chiefly of red and reddish-gray granite, with some of a compact dark-green altered diabase and a few of a fine-grained greatly crushed quartzite. The matrix consists of the same sort of material in a finer state, with greenish chlorite filling in the smaller interspaces.

Moose Rock.

Moose Rock is the name applied to a huge boulder of rounded outline, perched upon a shoal. It is almost thirty feet in diameter and must have been detached from the cliffs of similar rock on the east shore, over a mile to the northward of its present site, it has been moved during the glacial period.

Breccia of Point a la Barbe.

The northern end of Point à la Barbe, on the west shore, about two miles south of the Old Fort Narrows, is formed by an island which, at high-water, is divided into two almost equal parts, connected by a slender rocky peninsula. The rock composing it resembles the finer-grained, hardened and altered matrix of the breccia-conglomerate. On the opposite shore a steep rocky point juts out into the lake, forming a narrows. The breccia-conglomerate is here exposed for a considerable distance along the shore either way, reaching to within about a quarter of a mile of the mouth of the Little River. The shore-line at this point rises steeply into a hill nearly four hundred feet in height, forming the shoreward extension of a conspicuous ridge that runs for several miles to the north-east, and marks the southern limit of the Little River valley. The rock has a strike of about N. 60° E., and a dip at low angle, less that 5°, to the north-west. The breccia-conglomerate here passes upward, by a gradual diminution of the larger fragments, into a compact, fine-grained arkose sandstone or greywacké, that is exposed along the shore toward the mouth of the Little River. Under the microscope, this rock is seen to be made up of partly rounded fragments of quartz, orthoclase, microcline and oligoclase, embedded in a matrix proportionately less in quantity and composed chiefly of chlorite and sericite. The fragments are nearly equal in size and show

Microscopic character.

no pronounced rounding. The greenish colour is owing mainly to the large amount of chlorite present in the matrix.

Overlying beds.

To the north, and in ascending order, this rock is succeeded by a somewhat coarse-grained sandstone or grit, which forms the point immediately north of the mouth of the Little River. It also extends across the lake, occupying a corresponding promontory on the west side, known as Blueberry Point. On both sides of the lake the rock occurs in thick massive beds, the stratification being shown only by the occurrence of conglomeritic bands disposed in a somewhat constant direction. The rock is much jointed and broken, the fragments having a rough rhombohedral outline. To the north, it is concealed in great part by the deep and extensive sand and gravel deposits that form the narrows opposite the Old Fort, but occasional outcrops may nevertheless be noticed. The rock extends along the east shore of the lake, nearly three-quarters of a mile north-east of the Narrows, where it reposes directly on a massive red biotite-granite, although the actual junction is concealed. To the south of the narrows, the rock occurs either in horizontal beds or dipping at a low angle to the north-west, but north of the narrows it seems to dip S. 35° E. $< 20°$

Rocks near Old Fort.

A specimen obtained from a point composed of this rock about half a mile east of the Old Fort, is a pale yellowish-green coarse-grained quartzite or grit. The thin section under the microscope shows it to be composed of quartz and felspar embedded in a groundmass made up of pale yellowish-green sericite, for the most part present in exceedingly minute scales.

Granite area north of Old Fort.

The granite which replaces the quartzite to the north-east of the narrows, is exposed on both sides of the lake. It forms the western shore as far as Paradis Bay, a distance of about four miles, and extends from half a mile to a mile inland. On the east side it composes Wine Point and the southern shore of Kelly (Priests) Bay, extending for a short distance west of the steamboat wharf to the point already mentioned, about three-quarters of a mile north-east of the Old Fort Narrows. In all, these granite exposures cover roughly an area of six miles. Microscopically, the granite is rather coarse in texture and of a deep flesh-red colour, owing to the marked predominance of the felspathic constituents, all of which have been abundantly stained by iron.

Character of granite.

Several small areas were noticed which have assumed a greenish colour owing to the epidotization and sericitization of a portion of the felspar; but such decomposed portions are proportionally insignificant, and the whole mass of the rock is extremely uniform, not only in colour but in the relative abundance and mode of development of its mineral constituents. The quartz occurs for the most part in somewhat rounded though irregular isolated areas, giving to the rock a conglomeritic or porphyritic appearance, a fact noted by Sir William Logan on the manuscript map embracing his survey of this lake made in 1845. Indeed, the rock at first glance presents a marked resemblance to some of the brick-red quartz-porphyrites of Lake Superior. The ferromagnesian constituent is present in very small quantity and is now almost wholly converted to chlorite, the deep green colour of this mineral being probably the reason that the rock has hitherto been described as a hornblende-granite.

Former views concerning this granite.

On previous geological maps covering this area, this granite received the colouration usually applied to an acid eruptive, and as nothing was stated to the contrary, it was very naturally inferred that, as such, it was of later age than the Huronian clastics with which it is associated. Sir William Logan in his early report does not give any details of its relations with the neighbouring stratified rocks, but only speaks of it as "interrupting" the sandstones on Lake Temiscaming. During the progress of the present survey, a detailed examination was made of the line of junction between this granite and the quartzite-grit. The best locality for investigating the various contact phenomena, is situated in the small bay immediately west of the steam-boat wharf at Baie des Pères. In addition to the observations made on the ground, a large suite of specimens was obtained illustrative of the line of junction, for microscopic examination.

Clastic rocks derived from it.

The facts obtained indicate the derivation of this quartzite-grit or arkose from the disintegration, *in situ*, of the granite, and is believed to be an almost unique example of the recognition of a portion of the original granitic floor upon which the Huronian sediments were deposited and from which they were derived.

Line of junction.

In the vicinity of the line of junction between the two rocks, the arkose or quartzite may be seen dipping away from the mass of the granite at a very low angle. The massive and jointed character of the beds of the arkose, render it impossible to ascertain exactly all the minute details of the structural relations, but it is clear that the quartzite originally transgressed upon the surface of the granite almost horizontally. The granite has been unequally eroded and truncated, so that the present line of contact between the two rocks is undulating and irregular.

Passage beds.

From a distance, the line appears to be sharp and abrupt, the greenish colour of the quartzite showing up very clearly and distinctly in contrast to the red colour of the granite. A closer inspection, however, showed that there is a gradual passage upward and outward from the main granite mass to the overlying arkose. Macroscopically this passage consists in a gradual loss of the red colouration of the unaltered granite and the progressive appearance in its arkose of a yellowish-green hue, although along the immediate contact there is no visible change in the position of the constituent minerals.

Character of unaltered granite.

Thin sections of the least altered portions of the granite exhibit a normal holocrystalline hypidiomorphic structure, with a tendency to idiomorphic development on the part of the plagioclase. The rock is a rather typical biotite-granite.

The quartz is somewhat cracked and the felspar and biotite are more or less altered, but the rock, as a whole, is fairly fresh, and neither dynamic nor chemical forces have acted on it to such an extent as to render its true character and origin doubtful.

The junctions between the grains of the various minerals are sharp with no interstitial granulated material. The quartz is the ordinary granitic variety and is filled with minute inclusions, frequently arranged in irregular interlacing bands. Many of these, when highly magnified, prove to be cavities filled with fluids and often containing movable bubbles. The larger quartz grains, under polarized light, are seen to be made up of an aggregate of smaller grains with differing orientation, and the quartz has a distinct but not excessive undulatory extinction. The predominent felspar is generally microcline, which can be seen in all its varions stages of development from grains exhibiting only an indistinct moiré structure (Plate V., fig. 2) to those in which the cross hatching is perfectly developed (Plate V., fig 2.) The former, however, are the more abundant. It is turbid and much stained with iron oxide.

Microcline felspar.

Plagioclase.

Plagioclase is as a rule quite abundant, and as already remarked, exhibits a tendency to idiomorphic development. It is frequently embedded or intergrown with the orthoclase and microcline. The individual sections are broad and tabular, parallel to M., and show in great perfection the fine striation due to multiple twining. Their outlines are more or less rounded. Carlsbad twins appear to be rare, but were occasionally observed. Zonal structure was noticed in only a very few instances and then was not at all pronounced. Like the orthoclase and microcline, this felspar is turbid, in consequence of incipient alteration, and little scales of sericite are scattered through it. Inclusions of biotite are not infrequent. Bending of the twin lamellæ is rare, and exists only in a very slight degree. The mean of several determinations gave about +10° as the extinction-angle measured on M., between adjacent lamellæ, showing the felspar to belong probably to the acidic end of the oligoclase series. As usual, where alteration is commencing, it shows itself in the centre of the crystals.

Biotite was the only ferro-magnesian constituent noted in the section. It forms irregular plates and flakes which are considerably altered to chlorite. The original brown colour of the material has been changed to a light-green, but without entirely obliterating the optical characters of the biotite. Inclusions of ilmenite with leucoxene, are common. The mineral is not very abundant in this particular section. Biotite.

Ilmenite is the iron ore present in the rock, always accompanied by its alteration-product leucoxene, and in some instances immediately associated with zircon and apatite crystals. Occasionally it may be observed replacing titanite, skeleton forms of the latter mineral, with sharply defined acute rhombic outlines, being filled with a mixture of carbonates, ilmenite, etc. Ilmenite.

Chlorite is present in the rock as the final stage of alteration of the biotite. Other constituent minerals.

A few irregular grains and crystals of zircon with well-defined zonal structure were noted, and exhibited the usual optical characters of the species.

Apatite is also present, but is not very abundant, occurring in small crystals and irregular grains.

Sericite, or an allied hydrous mica, is present in minute scales and flakes scattered through the felspar, as the result of their alteration. Red oxides of iron are abundant.

At the other extreme, the derived arkose or quartzite-grit show distinctly rounded and water-worn fragments, chiefly of grayish translucent quartz, varying in size from those only microscopically observable, to others which are sometimes an inch in diameter and are arranged in layers which have evidently resulted from a sorting of the material by water action. These fragments are embedded in a groundmass or cement varying greatly in proportionate quantity and composed of a confused mass of minute sericite scales, being the argillaceous product of the decomposing felspar. Derived materials of the arkose.

Progress of degradation of granite.

The series of thin sections studied represent the various stages in the process of the degradation of the granite, in consequence of which the overlying arkose has been produced. The first step shows the development of microcline at the expense of the orthoclase, accompanied by an incipient sericitization of the felspars, which is noticeable, to a considerable extent, even in the least altered specimens. This is accompanied by marked alteration of the biotite to chlorite, the development of a distinct undulous extinction in the quartz, and a cracking of some of the individual grains. A further stage is reached when the quartz is accompanied by the occurrence of mosaic-like areas between the larger grains, while these latter show very pronounced strain-shadows. The plagioclase likewise shows more frequent evidence of presure in its twinning, the lamellæ often in these cases ending abruptly against cracks traversing the crystal. Bending of the lamellæ is more frequent, while the alteration of biotite to chlorite is more complete, and is frequently accompanied by the deposition of iron ore between the flakes.

Second stage

Third stage.

This is closely followed, marking what may be called the third step in the transition, by an appreciable advance in the alteration of the felspar, especially of the plagioclase, which becomes traversed by a series of cracks filled with sericite, the alteration extending outward into the main mass of the individual grains; but there is still no evidence of motion or shoving apart of the fragments.

Fourth stage.

A fourth, and somewhat sudden advance, appears when the alteration of the felspars has proceeded to an extreme degree, while certain fragments have been shoved apart. Each individual grain still occupies the same relative position with regard to the other mineral constituents, but in places portions of quartz and felspar, especially the former, can be noticed to have changed their position along certain cracks traversing the grains, the portions, however, being never widely separated. The plagioclase has been almost completely saussuritized, leaving the unaltered quartz grains in almost the original position occupied by them. The microcline and orthoclase, though badly decomposed, have not undergone such complete alteration as the plagioclase. The fifth stage is reached when both orthoclase and microcline have undergone somewhat complete decomposition, some of the individuals being now represented by an intricate mass of their alteration-products. This is accompanied by markedly uneven extinction in the quartz grains, as well as by a cracking and separation of quartz and felspar-crystals, which is more evident in the former.

Fifth stage

Sixth stage.

The sixth and final stage in the process, shows, that the felspars have almost entirely disappeared, although occasionally irregular cores o

FIG. 1.

FIG. 2.

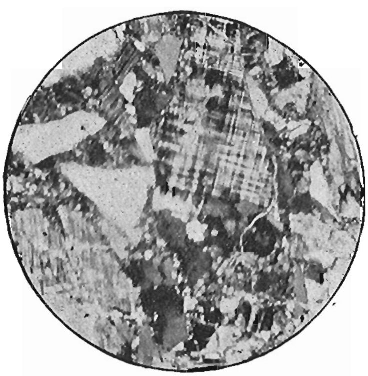


FIG. 3.

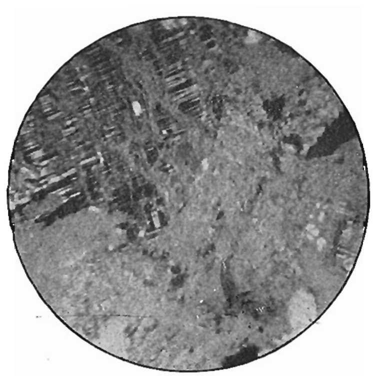


FIG. 4.

FIG. 1.—Biotite-granite or granitite, near Cedar Point, east side Lake Temiscaming—orthoclase, quartz, plagioclase and chloritized biotite. × 52.

FIG. 2.—Effects of pressure, granulation, and the formation of microcline in arkose, near Baie des Pères, Lake Temiscaming. × 52.

FIG. 3.—Formation of microcline and moving apart of minerals, of arkose resulting from degradation of granitite, near Baie des Pères, Lake Temiscaming. × 52.

FIG. 4.—Decomposition of felspar (microcline) *in situ*, forming arkose, near Baie des Pères, Lake Temiscaming. × 52.

the unaltered mineral remain. The groundmass is now seen to consist of a fine-grained sericitic material, in which are embedded sharply angular or sub-angular fragments with very pronounced undulous extinction. The whole appearance of the rock, both in the hand specimen and under the microscope, is that of a typical clastic (arkose). There is every evidence, however, that much of the material has not undergone any very wide separation, while the quartz fragments still preserve a tolerably sharp outline, showing no pronounced water-action.

Mechanically assorted material.

The suite of specimens obtained, exhibits a still further stage, representing the whole process leading to a final assortment and re-arrangement of the degraded material by water into bands of differing coarseness, and resulting ultimately in the formation of somewhat typical grits and conglomerates. The change has evidently been first mainly a chemical one, primarily attacking the biotite, then the plagioclase, microcline and orthoclase and leaving the quartz alone comparatively unchanged. The rock thus softened and loosened by decomposition, has offered a less effectual resistance to the process of disintegration, the process ending finally in the complete breaking down of the surface of the granite mass and the formation of the overlying arkose.

Greenish quartzite.

The latter rock forms the western shore of the lake between Paradis and Martineau bays, opposite Bryson Island, where it constitutes perpendicular cliffs that rise from 150 to 200 feet, while the hills immediately behind, continue with a more gradual upward slope representing a considerable additional elevation. The rock occurs in almost horizontal beds, striking with the lake, the structure seemingly representing a very shallow and narrow syncline; the beds near the southern part of the exposure in the vicinity of Paradis Bay dipping west, while those near Martineau Bay dip east or toward the lake. Almost the entire eastern shore of the lake, as well as Chief, Drunken and Bryson islands are composed of this greenish quartzite or arkose, excepting only some small patches and strips of Silurian limestone, elsewhere described.

Its character

This greenish quartzite is remarkably homogeneous, generally presenting the characters of a coarse quartzose sandstone or grit, but occasionally, as on Drunken Island, becoming finer-grained. It is very hard, resisting well the general influences of weather, and occurs in thick and much jointed beds, generally of a pale yellowish-green colour, weathering in some cases to a light-brown to a depth of about an eighth of an inch. It sometimes has a brownish-green colour, in which case the exposed surfaces gradually assume a yellowish-green colour, and in occasional exposures it has a light-grayish tint with irregularly disposed spots or areas of a greenish colour.

Relations of green quartzites.

In the vicinity of the narrows between the eastern shore and Bryson Island, the rock dips N. 22° W. < 3°, and for the most part runs in low broad undulations. At a point on the east shore about one mile and a quarter south of Wright's mine, this rock is seen directly superimposed upon the hummocky surface of a very massive breccia-conglomerate. The latter holds the usual pebbles of eruptive material, chiefly granite and diabase, and the chloritic matrix is very subordinate in quantity. The exposure presents a well rounded and glaciated outline sloping at an angle of nearly 60° to the north. At the summit, about forty feet above the water, the greenish quartzite seems to rest directly upon the conglomerate, presenting none af the usual transitional slaty or greywacké beds. The beds of quartzite seem to run in a somewhat undulating though approximately horizontal manner, apparently conforming with the line of outcrop of the conglomerate.

Section near Wright's mine.

About three-quarters of a mile north of Wright's mine, on the same shore, there is a very interesting section. Showing the usual breccia-conglomerate at the base, very massive, and giving little or no structural detail. In ascending, however, it passes into a breccia, somewhat similar in colour and composition, but in which the lines of stratification can be readily distinguished. This is in turn succeeded by a fine-grained, brownish, well banded greywacké-slate, some portions of which cleave readily parallel to the bedding. This contains some smaller intercalated bands of the breccia, in which diabase and quartz fragments prevail. This is in turn overlain by another bed of conglomerate that passes upward into the yellowish-green quartzite-grit. The dip of these strata is to the north-west, at an angle of 10°, and the whole thickness of the section exposed is about 50 feet. The point immediately south and west of Wright's mine is likewise composed of the breccia-conglomerate, filled with pebbles of eruptive material, and the lode itself is situated in a similar though finer rock. In many instances the chloritic matrix is seen to wrap or flow around the enclosed fragments.

West shore, north of Martineau Bay.

From Martineau Bay northward, for about two and a half miles, the western shore is composed of a dark-greenish or greenish-gray, medium textured diabase. For nearly the whole of this distance this rock rises into cliffs, sometimes 200 feet high. The mass of the rock is much jointed and broken, and some of the jointage planes traverse it for considerable distances, thus simulating the basaltic structure so frequently assumed by similar basic eruptive masses. Under the microscope this rock is seen to possess a typical diabasic or ophitic structure, the interlacing idiomorphic laths of plagioclase penetrating the allotriomorphic individuals of augite. The plagioclase has been rendered more or less turbid by the development of the usual saussurtic products of decomposition, but many individuals still retain their clear and limpid character. The augite has, however, been altered to hornblende, the alteration being first to the fibrous form (the more abundantly represented), and then into the compact green trichroic variety, which is occasionally present. In some cases decomposition has proceeded so far that chlorite has resulted. A small quantity of unstriated felspar in broad, irregular areas, that may be orthoclase, was noticed, while a considerable quantity of quartz fills in the interspaces. Occasional flakes and scales of brown biotite are likewise present, at times altered to chlorite. The ilmenite is almost entirely altered to leucoxene, although undecomposed portions remain. This diabase constitutes the vertical cliffs known as the Manitou or Devils Rock, forming the shoreward extension of a huge mass that occupies the intervening area between Lake Temiscaming and the Montreal River, and which, extending across this river, forms a considerable strip on its south-west side. It also composes the area to the north-west, extending to the shores of Portage Bay, on Bay Lake, and beyond.

Microscopic structure of diabase.

Extent of diabase mass.

To the north of this diabase, on Lake Temiscaming, the characteristic breccia-conglomerate again comes in. The finer portions of the matrix are composed of a much hardened chlorite-slate or greywacké, while coarse-grained varieties resemble in appearance a diabase-tuff. The pebbles are usually abundant, and some of these resemble the diabase with which this rock is associated. Other pebbles are of quartz, and some are of a dark-gray compact felsite or greywacké, while a few consist of a pale-yellowish, fine-grained hälleflinta-like rock. Near a clearing on the west shore, a little south of Percy Island, the rock exhibits a similar fine-grained chloritic groundmass, containing very numerous small fragments, chiefly of felspar, while the rock itself as a whole greatly resembles a chloritized tuff or trap ash.

Further exposures of breccia-conglomerate.

This is succeeded to the north (and doubtless in ascending order) by a fine greenish compact slaty greywacké, exposed in the vicinity of Farr Creek, that continues beyond Lawlor's farm. For about two miles in the vicinity of Haileybury, the western shore is occupied by Silurian strata. About two miles north of Haileybury, the basal bed of the Silurian consisting of a coarse grit or conglomerate, rests unconformably on the mammillated surface of the compact green slate of the Huronian.

Slaty greywacké.

Rocks of Wabis Bay.

This slaty rock, near the junction between the two formations, is very much hardened and presents alternating bands of greenish and brownish colours, so frequently characteristic of the middle member of the Huronian of the district, and these bands have a general direction of S. 70° W. The shore-line where the rock outcrops, is more irregular than that to the north or south, with two small off-lying islets. About a mile north of the contact, the slate passes into the breccia-conglomerate, containing many pebbles and boulders of grayish slate, compact quartzose and hälleflinta-like rocks, and pebbles of diabase of varying degrees of texture. The matrix in which these fragments are embedded is, as usual, dark-green in colour, while the whole mass of the rock presents little or no evidence of stratification. In general, however, it may be stated, with some degree of confidence, that the structure exhibited on the shore from the contact to the south as far as the diabase mass, is that of a shallow syncline, the breccia-conglomerate forming the basal beds with the slates superimposed without break.

Pyritous conglomerate.

Where the fragments are abundant in the conglomerate, there is frequently present a considerable amount of pyrite, which in some cases acts as a sort of cement, inclosing these fragments. The oxidation of this pyrite and its subsequent removal, has left a series of rusty cavities that are rather characteristic of these outcrops.

Exposure on Sutton Bay.

The last exposure that may be mentioned here, is one of the breccia-conglomerate which occurs on the north-east shore of Sutton Bay, forming hills that are rather conspicuous and rise from a somewhat extensive marshy flat. The rock presents the usual dark-green chlorite groundmass. This matrix encloses larger pebbles of red and gray granite, green diabase of several varieties and degrees of coarseness, and some fine-grained compact greywacké-slate, with a few of gray quartz. The larger fragments, especially those of granite, possess more or less rounded outline, while most of the smaller fragments, and especially those representing basic eruptive material, are decidedly sharp and angular. The rock is massive and for the most part structureless, but planes that possibly represent the original bedding dip N. W. $< 25°$.

River and Lac des Quinze.

River des Quinze.

The River des Quinze, doubtless received its name from the fact that fifteen portages have to be made between Lake Temiscaming and Lac des Quinze, but this number may be diminished under some circumstances. Although the stream presents considerable stretches of deep water with little or no current, it is, as a whole, wild and turbulent.

The river has a general east-and-west direction, and in a straight line is about thirteen miles long, although this distance is increased to eighteen miles by means of flexures. It enters the north-eastern corner of Lake Temiscaming in a shallow indentation known as Paulson Bay. With the Blanche, which reaches the lake a little over a mile further west, it forms a delta with low marshy islands, and only two channels can be utilized for purposes of navigation. The more easterly of these two channels is seldom used, on account of its being extremely shallow, while the western or main channel is of good depth. About half a mile from the lake, a rather narrow and crooked, though deep and navigable channel joins the Quinze, with the main portion of the Blanche. This is known as the Chenal du Diable, and during freshets the waters of the Blanche follow this channel to the lake, but during the summer months the current in this channel is reversed, and a considerable portion of the waters of the Quinze reach the lake by this somewhat circuitous route.

Confluence with the Blanche.

The River des Quinze is generally a little over a mile wide. The banks, especially on the north-west side, are low and liable to inundation. The south-east bank is somewhat higher at Miller Point, with a hill of gravel and boulders.

Width and character.

In ascending the river, the first rock-exposure is on some small islets nearly opposite the North Temiscaming P. O. (McBride's). The rock is the breccia-conglomerate of the Huronian, the matrix being a very compact, fine-grained material of dark green colour, through which are disseminated occasional pebbles as well as angular fragments of a grayish granitic rock. There is little or no evidence of stratification. The further ascent of the river exhibits a corresponding rise in the geological scale. The first three rapids come very close together, and are not more than a mile in all. The first and second rapids each show a descent of about twelve feet. The third has a fall of about sixty feet, and is one of the worst on the river. The rock exposed at the several portages, is a dark-gray micaceous slate, the cleavage or foliation planes, which are the only distinct structure exhibited, showing abundant small black scales of biotite.

Ascending rock-series on the river.

Rapids.

There are many lighter coloured streaks running through the rock, more or less parallel with one another, which seem to be composed mainly of felspar and quartz. These occur in irregular curving and often branching and lenticular areas giving a decided foliation to the rock. They do not appear to represent coarser and more quartzose bands of the darker coloured slates with which they are associated, but are more or less veinlike in structure and secondary in their origin.

Rocks exposed.

The strike and dip could not be ascertained with any degree of certainty, but the rock, from its lithological character and apparent stratigraphical position, represents the lower portion of the slate, or middle member of the Huronian, overlying the breccia-conglomerate noticed as occurring near the mouth of the river.

Fourth rapid. Above this third portage, there is an interval of three miles of deep unobstructed navigation, to the fourth rapid, immediately above the mouth of Tiger Creek, an important tributary coming in from the north side. The river is here divided into several channels by rocky islands, the largest of which, Burnt Island, is nearly one and a half miles in length. The main channel which runs to the north of this, is one long succession of heavy rapids with a total fall of about eighty feet. The portage-route, about two miles long, follows the north bank.

Slate and diabase. On this portage, the rocks met with are dark greenish-gray slate, much cleaved and jointed and probably dipping to the south-east. In places they show considerable alteration and development of sericite, the alteration being greatest near the eastern end of the portage. These slates continue to the upper end of the island, where they are interrupted by a mass of uraltic diabase and amphibolite, about three and a half miles in breath, which extends southward, and is probably continuous with similar rocks exposed in the north-east corner of the township of Duhamel and the eastern portion of the township of Guigues. This rock is often massive, but not without traces of foliation and towards the eastern limit it passes into a distinct grayish-green amphibolite, in which considerable mica has been developed. Under the microscope, it is found to be composed chiefly of plagioclase and hornblende, and thus to be classed with the diorites, but it evidently was originally a diabase, as a well marked ophitic structure is still apparent. The augite, originally present, is almost wholly converted into hornblende, while during this process of uralitization, as is usual, a considerable quantity of epidote has been developed. It is a straw-yellow colour, exhibits strong pleochroism, and has often fairly good crystallographic outlines, although occurring mostly in irregular grains and patches, associated chiefly with the hornblende.

Alteration of the diabase. The process of uralitization is here very interesting. The augite alters first into a compact green trichroic hornblende. Where it has suffered most from dynamic action, a fibrous variety of hornblende (actinolite) has resulted, which has in turn decomposed into chlorite that still preserves much of the pleochroism of the hornblende. Between crossed nicols, the matted aggregates of scales of chlorite show collectively the deep-blue polarization-colour so often exhibited by it. Much of the plagioclase is remarkably fresh for such a decomposed rock, but a great deal of it shows a somewhat advanced saussuritization, the resulting epidote, zoisite and sericite being especially abundantly developed where the rock has been most squeezed. Ilmenite occurs in aggregates of small grains which are each surrounded by a rim of leucoxene. Quartz, although present, is not at all abundant. Where pressure has been greatest the rock passes into a typical hornblende-schist or amphibolite. The ophitic structure cannot be detected under the microscope, while pressure has caused the breaking up of the original bisilicate individuals, so that they are now represented by many small shreds and fragments, arranged with a more or less parallel alignment. A great deal of epidote has been developed, while the ilmenite originally present has been almost converted into a brownish sphene, now seen in irregular grains or aggregates of grains scattered through the rock. Associated with and apparently caught up in this eruptive are certain, small patches of sericitic and epidotic slates, while on one portage (the tenth from Lake Temiscaming) an interlamination of light- and dark-gray quartzite with red jasper and magnetic iron ore occurs, the whole running parallel with the foliation of the inclosed rock, N. 20° E., and dipping N. 70° W. $<$ 70°.

Seventh to thirteenth portage.

Above Burnt Island, the seventh portage, from the lake, is merely a lift over a rocky islet to avoid a small rapid in the river. A short distance further up, the next or eighth portage is reached. This is but a short carry across to a small lake, to the north-east of the river and a short paddle across this brings us to the outlet at its east end. Another short portage along the bed of this outlet comes out again to the main stream. Above this is a sharp turn in the river, its direction changing abruptly to a south-easterly bearing. The canoe-route again leaves the main stream below this elbow, a very rough portage on the south-east side, leading to a narrow lake about half a mile in length. The next portage, divided into two carrys by an intervening pond, counts as the eleventh and twelfth, leading back to the main river. The route thus follows a narrow valley running parallel to the river, avoiding a very rapid stretch of river, with a total fall of about fifty feet. The direction of the river here coincides with the foliation of the hornblende-schists. The thirteenth portage is on the east side of the stream, and is sometimes called Cypress Portage. It is over half a mile in length, and is occasioned by a rapid with a fall of over twenty feet.

Diabase at Cypress portage.

Toward the head of Cypress portage, the uralitic diabase, largely changed into a rather typical hornblende-schist, is penetrated by small stringers composed chiefly of flesh-red felspar and gray quartz, with occasional small fragments of hornblende. The connection of these small apophyses of granitic material with the larger parent mass of hornblende-granite-gneiss exposed further east, was clearly established, and these lenticular patches of quartzo-felspathic material become more abundant as the vicinity of the granite-gneiss is approached. The rock contains considerable secondary biotite, developed chiefly along the planes of shearing, and this, in conjunction with lighter felspathic bands produces a very distinctly foliated rock. The foliation dips westwards at a high angle, generally about 50°.

At Maples portage.

The same rock continues, with the interfoliation of lighter and darker bands, across the fourteenth or Maples portage, at the head of which the course of the river turns rather abruptly to an easterly direction while the width is increased to a quarter of a mile. The dividing line between the hornblende-schists-gneisses crosses this lake-like expansion obliquely. Although the actual contact is not exposed, the two rocks are seen within a very short distance of one another, both striking toward the north-west, while the dip of the foliation is to the south-west at an angle of about 50°. The junction between the two is evidently one of intrusion, the granite-gneiss piercing the amphibolite in the form of the small interfoliated pegmatite-like streaks and patches above described, and it appears that the irruption of the hornblende-granite-gneiss was the cause of the foliation and alteration of inceptive diabase, producing the hornblende-schist.

Contact with gneisses.

Character of gneiss.

The granite-gneiss just alluded to, is a reddish, very distinctly foliated rock, the foliation being determined by the more or less parallel disposition of the fragments and individuals of hornblende. The thin section shows the rock to be composed essentially of orthoclase, microcline, hornblende and quartz, with sphene, epidote, zircon and apatite as accessory or accidental constituents. Much of the orthoclase occurs as irregularly shaped individuals or phenocrysts embedded in a finer-grained mosaic composed of broken up fragments of felspar and quartz. These smaller fragments very often assume the microcline habit, which is evidently the result of pressure. The larger orthoclase individuals show considerable alteration, especially in their central portions, and although in some cases they exhibit tolerably sharp and perfect crystalline outlines, they are usually more or less jagged, owing to the breaking up of their borders to form part of the finer-grained mosaic. The hornblende is dark-green, trichroic, and occurs in irregular shreds and fragments having a marked parallelism. The sphene is deep brown in colour, and occurs in characteristic wedge-shaped crystals.

The epidote is evidently of secondary origin, and is present in irregular grains and masses of a deep straw-yellow colour and strong pleochroism. Zircon and apatite are in small acicular prismatic crystals. The reddish colour is imparted by the presence of iron-oxide, which fills the cleavage-cracks of the felspar as well as the minute fissures present in the rock itself.

Rocks near the lake.

This rock continues as far as Lac des Quinze, but near the lake it becomes coarser in texture and more highly porphyritic, the reddish crystals of orthoclase being frequently as much as half an inch in diameter. The foliation is rather obscure, but on the lake itself is more evident.

The fall overcome by the last or fifteenth portage before reaching the lake is about ten feet.

Lac des Quinze.

Lac des Quinze takes its name from the river. The general summer level of this lake, as determined by the mean of a large number of aneroid readings, is 848 feet above sea-level. The area of the lake is approximately forty square miles. A considerable portion of the northern part of the lake is, however, not represented on the accompanying map. There is a Hudson's Bay trading post on the lake, known as Long Point, while lumbermen now at work in the country near Lake Winnowaia or Expanse, a little to the east of the present map-sheet, have several farms or clearances, and depôts for supplies.

Form and outlines.

The main body of the lake extends to the south-east from the outlet for a distance of about eight miles, with an average width of a little over a mile. A second, generally about a mile wide, runs northward for a like distance from the outlet and then divides into two bays, which continue with the same general direction for about three miles further, the more westerly of the bays being the one followed in going to Lake Abitibi. About two miles to the east of the north arm, a second narrow inlet extends to the north for about three miles. From the south-eastern extremity of the main body of the lake, two arms branch off. The larger one runs to the north-east for about fifteen miles, gradually tapering to a point, where it receives the Upper Ottawa. The second arm runs to the southward for about five miles, and at its south-easterly corner reaches the western terminus of the road from Baie des Pères. A new road from Lake Temiscaming to Lac des Quinze, to the north of the River des Quinze, starts from the foot of the first rapids, but is not yet completed.

Surrounding rocks.

The several arms of the lake have all been eroded in a direction corresponding with that of the foliation of the gneissic rocks, and evidently represent the more schistose and least resisting belts of these rocks. The prevailing rocks are gray granitic and dioritic-gneisses, the latter containing usually a considerable proportion of biotite in addition to the hornblende, and with an increase in the abundance of the bisilicates, passing into an almost black, glistening amphibolite, in which the schistosity is always well marked. Quartz is present in considerable quantity, particularly in certain bands, and epidote was also noticed as a somewhat abundant constituent. At several points on the lake massive crystalline diorite was observed. The gneisses have a well marked foliated structure, the inclination of this foliation varying from 30° < 45 in a westerly or north-westerly direction.

LAKE KEEPAWA.

Lake Keepawa.

The name Keepawa or Kippewa means, freely translated, "a very narrow passage between steep rocks," and refers to the presence of a gorge in the northern part of the lake, now generally known as

Form and size.

The "Canal." The lake is very irregular in form and full of islands. In general the lake may be described as filling several valleys approximately parallel to that occupied by the southern portion of Lake Temiscaming. The general trend of these valleys, like that of Temiscaming, cuts across that of the foliation of the gneissic rocks, except in those portions to the south-east of Roche à Corbeau and the Beauvais Narrows, where the main direction of the lake corresponds rather closely with the foliation of the adjacent gneisses. The greatest length of the lake, from Chemagan Bay on the north, to the portage leading out of Jeanbeau Bay on the south, is almost thirty-two miles, on a line bearing S. 12° E. It may be said to be divided into two main portions occupying an approximately parallel position, each, however, branching off in bays and arms in various directions. These two larger portions are connected about the centre by a few comparatively narrow channels. The portion to the south-west, extending from the outlet at the north-west end of Sandy Portage Bay to Jeanbeau Bay, measures twenty-seven miles in a direction of S. 38° E.; while the large body of water to the north-east, reaching from the north-west end of Taggart Bay to the outlet of Hunter Lake, a distance of twenty-eight miles, has a general trend of S. 42° E. The area of Lake Keep-

Elevation.

awa, including the islands, is nearly 120 square miles. Its height above sea-level varies from 876 to 886 feet. The Keepawa River, its natural outlet, is a crooked and rapid stream which enters Lake Temiscaming a little over six miles below the Montreal River. The lumbermen have, however, built a dam across the Keepawa at the north-west end of Sandy Portage Bay, thus raising the water-level. The rocky obstructions between the south-western part of Lake Keepawa and the ponds at the head-waters of Gordon Creek having been removed, a large portion of the Keepawa waters now discharge by this artificial channel. In this way the "drive" for logs is much shortened and the water held back till required. Artificial outlet.

The greater part of the shore-line of the lake is somewhat high and rocky, the surface being often strewn with large boulders, chiefly of the underlying gneissic rocks. Surrounding country.

There is little level land, although clearances have been made and farms cultivated in connection with lumbering. Most of the white pine of first quality has been cut, but the shores are still beautifully wooded.

Of the very numerous islands, McKenzie and Karl islands are the largest, the former being a little over five miles in length and averaging about two miles in breadth, while the latter is scarcely half this size, measuring a little over two miles in length by about a mile and a-half in width. Islands.

The "Canal," already mentioned as giving its name to the lake, is a picturesque feature, being a narrow gorge about a quarter of a mile long with perpendicular walls of gneiss situated, about a mile north-west of Mackenzie Island, and it leads into a couple of small lakelets or expansions.

The rocks so abundantly exposed along the shores and islands of Lake Keepawa are remarkably uniform in composition and macroscopical characters. They are typical examples of "gneisses" being, as a rule, very distinctly and evenly foliated, and exhibiting darker and lighter-coloured bands of more or less basic character. The more acid bands are usually of grayish, reddish, gray or flesh-red colour; while the more basic bands are of varying shades of darker gray, becoming almost black in certain instances. The lighter-coloured phases are, perhaps, the most abundantly represented, and besides occurring as interfoliated bands associated with more basic material, these in themselves constitute the greater portion of somewhat important and extensive rock-masses. Under the microscope, they are seen to contain orthoclase as the prevailing felspathic constituent, and biotite as the principal and often the only ferromagnesian mineral. They must, therefore, be referred to as biotite-granite or granitite-gneiss. Besides these, microcline is usually abundant, together with some plagioclase (usually oligoclase). A large amount of quartz like- Gneiss of uniform character. Microscopic structure.

wise accompanies the felspar. The biotite is, as a rule, fresh and of a deep brown colour, occasionally showing alteration to chlorite. A little muscovite (most of which is of secondary origin), sometimes occurs, but not in sufficient quantity to characterize the rock. Besides these, smaller quantities of epidote, sphene, sericite, chlorite, apatite, zircon, magnetite, and sometimes allanite, are usually present.

The darker rocks.

Occasionally, somewhat darker and more basic portions are seen to contain a compact dark-green trichroic hornblende in addition to the biotite, the rock thus becoming a hornblende-granitite-gneiss. These portions are usually of a dark-gray colour, and show a very marked abundance of the coloured constituents.

The very dark-gray, almost black varieties, in which but little of the lighter-coloured minerals can be macroscopically detected, often show plagioclase as the prevailing felspar, while biotite is replaced by hornblende, the principal ferromagnesian mineral, although biotite is likewise almost invariably present. The constituent minerals are essentially the same as those present in the more acidic phases, differing only in their relative proportions.

The structural relations of these rocks show that they form integral and inseparable portions of one complex, produced by differentiation during the slow cooling of a magma of more or less heterogeneous composition.

Rocks near Kippawa post-office.

At the head of Gordon Creek, and in the vicinity of Kippawa post-office (formerly Norcliffe), the gneiss is very distinctly foliated, the strike being about S. 55° E., the dip S.W. $<$ 10° to 20°. The thick massive bands in the high bluff to the north of the railway terminus, representing the more acid portions of the rock, are granitic both in appearance and composition. Felspars, both reddish and grayish, are present as well as quartz, and a very sparing quantity of mica. The quartz, besides being present in grains and areas distributed throughout the rock, also occurs as veins and masses, evidently representing the most acid form of the prevailing pegmatite.

On the north-east shore of the largest island of the group, situated about a mile east of Kippawa post-office, are good exposures of light-gray and pinkish-gray quartzo-felspathic gneiss, alternating with darker bands which contain hornblende in addition to the more usual biotite. The strike is east-and-west, with dip to the south $<$ 35° to 45°. Along the shore the basic bands have been weathered out more easily than the acid ones.

On southern part of lake.

Further to the south-east, toward Jeanbeau Bay, the gneiss varies in strike from S. 50° E. to S. 60° E. with a dip to the north-east

< 20° to 30°. North of Gordon Creek, the foliation of the gneiss corresponds rather closely with the trend of the shore-line, dipping to the north-east at varying angles. At Greenorton Bay the schistose gneiss is very basic and contains hornblende in addition to the biotite. This rock also holds garnets and vein-like bands of smoky quartz. At the foot of Gibson Bay, the gneiss is of the common light-grayish granitite variety. On the south shore of Bryson Island, there are good exposures of a light-gray granitite-gneiss, the foliation being much contorted.

North of Beavais Narrows.

Beavais Narrows cuts the foliation of the gneiss at a considerable angle, the strike being S. 65° E. with dip to the north-east < 15° to 25°. On the south shore of Smith Bay, exposures of hornblende-granitite-gneiss show the constituent felspar much decomposed and a large part of the biotite altered to chlorite. At Fowler Point, a knoll rising about forty feet above the surface of the lake is composed of a fine-grained almost black quartz-mica-diorite. This rock contains irregular patches and stripes of a much more acidic gneiss, light flesh-red in colour, which seems to contain felspar, quartz, biotite and garnet, with occasionally some muscovite and epidote. Near Edward's depôt, on the north shore of Smith Bay, the granitite-gneiss is as a rule very acidic, containing only small quantities of biotite. At Somerville Point, the gneiss is a reddish granitite much weathered and showing what appeared to be a very local strike of N. 40° E. The south-west shore of the lake opposite Sunnyside post-office is composed of reddish granitite-gneiss, generally striking with the trend of the shore, but sometimes showing many local twistings. At Turtle Portage, the usual granitite-gneiss shows a beautiful curve in the foliation, the strike gradually turning from N. 80° E. to S. 60° E., with a prevailing southerly dip. At Hunter Lodge Narrows and on Hunter Lake the gneiss strikes about S. 60° E., dipping in a southerly direction.

At Somerville Point.

Gneiss of McLaren Bay.

Along the south shore of McLaren Bay, the gneiss is usually of a light-gray colour, rather fine-grained, micaceous and granitic in appearance, being tinged with iron-oxide. It usually shows a distinct though imperfect foliation on account of the comparative scarcity of bisilicate material. The strike is N. 82° E. and the dip to the south. Microscopically, this is a typical holo-crystalline granitic rock or granitite-gneiss, consisting essentially of orthoclase, quartz and biotite, with apatite-zircon, sphene, a very little magnetite, much microcline and some plagioclase, (oligoclase) small quantities of secondary muscovite and epidote are also present.

Exposures near McKenzie Island.

At the south end of an island immediately east of McKenzie Island, there are exposures of the ordinary flesh-red granitite-gneiss. On the north-west shore of McKenzie Island, the hornblende-granitite-gneiss seems to change in strike from N. 20° E. to N. 50° E., thus conforming with the trend of the shore-line, while the dip is to the south-east at varying angles generally about 60°. At one point a vein of quartz (pegmatite) varying in width from six inches to two feet cuts the gneiss, of which it contains fragments. The gneiss here is well foliated and often locally twisted. The gneiss composing the cliffs on either side of the "Canal," contains a considerable quantity of quartz and is much weathered and stained. It has a strike of N. 65° E. with southerly dip $< 80°$. At the south end of Campbell Bay, the strike of the gneiss is north 62° east. A thin section of a specimen obtained from the western shore, about two miles south of the entrance, representing the most basic bands, showed the rock to be a quartz-mica-diorite-gneiss. The rock is nearly black, very evenly and distinctly foliated and exhibits glistening cleavage-surfaces along the planes of foliation. Exceptional bands are of light pinkish-gray colour, felspar being the predominant constituent. Microscopically, this rock is composed of plagioclase, orthoclase, microcline, quartz, hornblende and biotite, with epidote, sphene, apatite, zircon and some pyrite, more or less altered to limonite.

Gneiss at Campbell Bay.

On Karl Island.

On the west shore of Karl Island, as well as on the island lying to the south-west, the gneiss shows the usual variation from grayish to reddish, with interfoliated darker bands in which the biotite is more abundant. The strikes vary from N. 64° E. to N. 67° E., with dip to the south $< 60°$ to 70°.

Porphyritic diorite.

At one place on the north shore of the lake, half a mile north of the north-east point of Karl Island, a very massive and coarsely crystalline porphyritic diorite, is associated with the ordinary grayish granitite-gneiss. This rock is of a dark-green colour when fresh, but near the surface is decomposed for a depth of nearly two inches, the decomposed layer being much lighter in colour. Large phenocrysts of deep-green hornblende, some of which are an inch or more across and most of which possess tolerably well defined crystalline outlines, are developed in a coarse-grained groundmass composed almost wholly of allotriomorphic individuals of dark-green trichroic hornblende, the small and irregular interspaces being filled with felspar and quartz. Much of the hornblende includes dark schillerization products. The decomposed layer near the surface shows the somewhat abundant development of epidote at the expense of the hornblende, giving the prevailing yellowish-green colour to this portion of the rock. The whole exposure measures about fifteen yards long by twenty-five yards wide and is surrounded by the grayish granitite-gneiss, while several dykes of pegmatite varying from a quarter of an inch to six inches in width cut the diorite.

Hay Bay.

In the northern portions of Hay Bay, the prevailing rock is the ordinary granitite-gneiss, the strike of which varies from N. 60° E. to N. 70° E.

Rocks on Sandy Portage Bay.

The rock exposed on the shores and islands of the bay running towards the outlet, the north-western portion of which is generally known as Sandy Portage Bay, is the usual reddish and grayish biotite-granite-gneiss or granitite-gneiss. The strike varies in general from N. 50° E. to N. 60° E., while the dip is to the north-west at high angles, generally varying from 65° to 85°. Near the outlet, the strike turns more to the north, the foliation in this vicinity running about N. 40° E., while the bands are nearly if not quite vertical. At one or two points extremely basic portions of the gneiss were seen to be highly hornblendic, thus passing into quartz-mica-diorite.

MATTAWA RIVER.

Character of Mattawa River.

The term Mattawa was first applied to the confluence of this river with the Ottawa. The river has also been known as the Petite or Little River, while to the Indians it was formerly known as the Tessouacsipi. It is really a succession of large deep lakes united by comparatively narrow and shallow rocky stretches. The total distance from the Ottawa to the western end of Trout Lake, in a straight line, is about thirty-six miles, but following the river this is increased to forty miles. The direction is in general nearly east-and-west, following a continuation of the main valley occupied by the Ottawa below the confluence of the two streams. In ascending the Mattawa, rapid water is encountered almost at once, the stream flowing over a shallow bouldery bed. This, together with a small rapid, a little over a mile above at the outlet of Boom Lake, gives a fall in the river of about two feet.

Boom and Plein Chant lakes.

Boom Lake, the first expansion reached, is only about a mile and a quarter long, and not over a quarter of a mile at its greatest width. At the upper end of this lake, the river is contracted in two places to a width of less than a hundred feet and a fall of nearly twenty feet is occasioned by the Plein Chant Rapids. Plein Chant Lake at the head of these rapids, is five and a half miles in length. The widest portion is near the eastern end, where it is about thirty chains, but this gradually diminishes westward, till, near the upper end it is not more than three or four chains wide. In the widest portion a depth of over two hundred and eighty feet was found.

Rapids and Lac des Aiguilles.

Between this lake and Lac des Aiguilles, the next expansion, the distance is a little over two miles, and four rapids intervene, with alternating stretches of still water; the combined fall is eighteen feet. The three largest rapids are known in ascending order as Les Epines, La Rose and Des Roches or Des Aiguilles. The Amable du Fond River, the largest tributary of the Mattawa, enters from the south side a short distance above the second rapid. Lac des Aiguilles, which is a little over a mile long and a quarter of a mile wide, is separated from the next succeeding stretch of river, lying parallel to it on the north side, by a rocky bar known as Les Aiguilles Islands. The three narrow rocky channels formed by these two islands, even at high water, barely afford a passage to loaded canoes. The eastern one constitutes the main route, and a small rapid at this point shows a descent of a few inches. Above this is a long stretch of deep water that gradually diminishes in width. The river throughout this distance of two and a half miles is flanked on either side by almost perpendicular walls of gneissic granite.

Series of rapids to Pimisi Lake.

At the end of this stretch, the upward course of the river changes sharply to a southerly direction for about two miles, and presents a series of rapids with intervals of deep water, the total fall being fifty-five feet. The Chute des Paresseux, where the water falls thirty-four feet, is the first and largest of this series. Pimisi or Eel Lake (sometimes also called Penice Bay and Moon Lake) above these rapids, marks another change in the course of the stream, which from this place to the head of Talon Lake trends north-westerly. Between Pimisi Lake and Talon Chûte, the river flows for three-quarters of a mile through a narrow rocky cañon inclosed between perpendicular walls of granite. Talon Chûte is the greatest single fall on the whole river, the water descending forty-three feet over a rocky ledge composed of massive flesh-red gneissoid granite. The main channel is on the north side, but in addition, there is another though much smaller parallel passage. The downward extension of this passage is continued in a deep gorge which connects with the main channel a short distance below the falls, the whole apparently representing the erosion of a band of crystalline limestone that here occurs. About half a mile below Talon Chûte, a small rapid occurs with a descent of less than a foot, and a short distance above it is Talon Lake. To the left, on entering the lake, a large bay runs westward for about three miles, Kabiskaw Bay at the western extremity of which an important tributary (Kabiskaw Creek)

Talon Chûte.

enters, forming the outlet of Nasbonsing Lake, a large and irregular sheet of water situated in the southern part of the township of Ferris.

Talon Lake lies north-west and south-east, is about seven miles long and has in general a breath of almost three-quarters of a mile. The shores are generally bold and rocky, although occasional small sandy flats occur. The general depth may be said to vary from fifty to one hundred feet, but in occasional spots a depth of two hundred feet and over was met with. Talon Lake.

The connecting stream between Talon and Turtle or Lower Trout Lake, the next expansion in the river, is about four miles. The stream leaves Turtle Lake about a mile from the eastern extremity. It is shallow, rocky and rapid with some small intervening ponds of deeper water. Turtle Lake lies nearly east-and-west and is about four and a half miles in length and not more than half a mile in width. Thence an ascent of barely a foot occurs, in a short channel, to Trout Lake, at the summit. This is eight and a half miles in length with a greatest breadth, near the upper end, of about two miles. It is often over 200 feet deep, and the shores are rough and rocky. To the north of the lake, a range of hills from three to four hundred feet high extends with almost unbroken continuity to the mouth of the Mattawa River and thence northward and north-westward up the valley of the Ottawa. Talon to Turtle Lake. Trout Lake.

The extreme west end of Trout Lake is only about three miles distant from Lake Nipissing, and the neck of land separating the two lakes is in general very level. The canoe-route usually followed to Lake Nipissing, leaves Trout Lake in a bay running to the south near its western end. The first portage runs over a ridge of sand. The Rivière de la Vase is then utilized all the way to Lake Nipissing, a distance of a little over six and a half miles. This small stream runs through low and often marshy ground most of the way, entering Lake Nipissing about six miles south-east of North Bay. Route thence to Lake Nipissing.

The land in the immediate neighbourhood of the Mattawa River is generally rocky, barren and unfit for agriculture. A short distance from this river, however, in the townships of Papineau, Calvin, Banfield and Ferris, considerable areas have been cleared, and good progress has already been made in the settlement of these townships. Character of land.

The rocks exposed along the Mattawa are for the most part massive reddish granitite-gneisses, the strike of the folation running in a series of widely undulating curves in a general east-and-west direction with a prevailing southerly dip $<$ 35° to 65°. Crystalline limestone is very sparingly present in association with these gneissic rocks, and Rocks seen along the Mattawa. Limestones.

wherever noticed the evidence seemed to show that it has been caught up in the gneiss during the irruption of the latter. On the south shore of Talon Lake, as well as in the southern channel at the falls, at the outlet of this lake, the crystalline limestone was found in association with a very massive indistinctly foliated granitite-gneiss, the intrusion and later age of the latter being apparently clear. Near the western end of Nasbonsing Lake, the rock is a light-reddish granitite-gneiss composed chiefly of felspar, with a small proportion of grayish quartz and a little black mica occurring in isolated areas of aggregated scales, together with numerous small garnets. The strike is to the north-west with a dip to the south-west, generally at a high angle. Near the eastern end of the lake, the gneissic rocks present are more highly differentiated and occur in irregular curving bands which have a general strike curving gradually around from east to north-east.

Gneiss of Trout Lake.

On Trout Lake, the granitite-gneiss occurs in reddish and dark-coloured bands which have a prevailing direction of nearly east-and-west, gradually bending round to the north-west in the western part of the lake, while the dip is to the south $< 45°$ to $65°$.

Lake Nipissing.

Size and form of Lake Nipissing.

This important lake has an area of 345 square miles, and is wholly surrounded by Laurentian rocks. Its main length is east-and-west, and its greatest length, from the shore at East Bay, near Callendar station to the western end of Bear Bay (west arm), is sixty miles; while the greatest width, from Beaucage Bay on the north to the mouth of the South River, is sixteen miles. The elevation above sea level, at different seasons, varies from 642·2 to 649·5 feet. The northern and eastern shores are in general low and for the most part present sweeping beaches of sand, separated by rounded points of rock. The water, for a considerable distance from the shore, is shallow. The west end of the lake has an irregular coast line with long arms and bays extending and rocky islands. A great number of these islands strew the more open water outside, running in long lines, more or less parallel in direction with the peninsulas or points which divide the bays from one another. The islands, generally small, are sometimes several miles in extent. The southern shores are bold and rocky and the water is deep even in their immediate vicinity. The whole of the eastern end of the lake is wide and exposed, containing only two small groups of islands known as the Manitou and Goose Islands.

Elevation.

Coasts and islands.

The western end of the lake consists of four principal bays or arms, separated from one another by rocky promontories, their continuation towards the deeper water in the central portion of the lake being marked by the occurrence of long lines of islands and reefs. The most northerly inlet, McLeod or Goulais Bay, has an almost direct north-and-south trend. It is about four miles in length by nearly two in breadth and lies immediately west of the marshy delta of Sturgeon River. The water in this bay is very shallow. A rather narrow and crooked channel, however, exists near the eastern shore, but is navigable only for very small steamers or tugs. Immediately south-west of this bay and separated from it by the rocky peninsula ending in Goulais Point, is another arm of the lake, divided to the west into two subsidiary bays, known as the North-West Bay and Middle West Bay respectively. North-West Bay is over four miles in length, with a width rarely exceeding a quarter of a mile, and having the general direction indicated by its name. Gradually tapering westwards, it receives a small stream that drains some marshy lakes situated in the north-western part of the township of Macpherson. Middle West Bay is much less important, being only about two miles in length, and at the west end receives a small tributary known as West River, that drains the southern part of the township of Macpherson.

Bays at western end of lake.

Of the indentation extending to the west, however, the largest is known as the West Arm or Bear Bay. The general trend of this extension is nearly east-and-west. An inspection of the accompanying map will convey a good idea of the close dependence of topographical outline on the strike of the foliation of the inclosing gneissic rocks. In many instances abrupt changes in direction are encountered, but these follow correspondingly sharp curves in the lines of foliation and cleavage. The width of the bay is very variable, alternately contracting into narrow straits only a few chains in width and opening again into wide expanses generally crowded with islands. In the eastern portion for a distance of nearly eight miles, the average width is nearly two miles. The bay gradually narrows towards the west end where it receives the waters of a small stream, draining several important expansions to the west.

West arm or Bear Bay.

Irregular form.

Several important streams enter Lake Nipissing. The largest is the Sturgeon River, draining about 3000 square miles of country to the north and west, and joining the lake in the midst of a large marsh on the north side. This low tract of land, forming a delta, has been produced by the gradual accumulation of detritus brought down by the stream.

Streams entering the lake.

Little Sturgeon.

The Little Sturgeon or Silver River, enters the Great North Bay with a swift and deep current, being navigable for canoes, without interruption, for a distance of a little over two miles from the lake, where the stream becomes very small and rapids occur. The general course is at first nearly north, and the upper course is nearly north-east, to its sources in the southern part of the township of Blyth. Duchesney and Chippawa creeks enter the lake in the vicinity of North Bay. The Rivière de la Vase or Little Mattawa, flows into the lake about five miles south-east of North Bay. Other important tributaries enter the lake from the south, but these are beyond the boundaries of the present map. The Veuve River is an important stream which enters the west side of McLeod Bay, draining a large tract of land, the sources extending westward almost to the Wahnapitae River.

Veuve River.

Manitou Islands.

Several important islands and groups of islands occur, lying out towards the middle of the wide eastern portion of the lake. The most important of these is the group named the Manitou Islands. These are five in number, situated five miles south-west of North Bay. The largest is known as the Great Manitou or Newman Island. It is an irregular triangle in form and about a mile across. McDonald Island, the next in size, is about half a mile in length from north to south but only a few chains in width. The other three islands are much smaller.

Goose Islands.

The Goose Islands lie toward the centre of the open part of the lake, about six miles west of the Manitou Islands, and about twelve miles west-south-west of North Bay. The largest island is known as the Great Goose, and is nearly a mile long with a trend of east-and-west. To the west and north-west of these there are about a dozen smaller ones, some of which are merely rounded hummocks of rock.

Country and rocks of west end of lake.

The general aspect of the western end of Lake Nipissing is rocky and desolate. In many cases the sparse soil overlying the rarely concealed hummocks of rocks, afford substance to a rather thin and scrubby growth of red pine, while the level spots are for the most part occupied by vast marshes, but some small tracts of level land occur along the banks of some of the tributaries, notably the one situated on the south side of Bear Bay near its entrance. The northern shores of the lake, however, border large areas of cultivable land. The rocks are generally well exposed, especially in the western and southern portions of the lake. They include the prevailing varieties of granitite-gneiss and hornblende-granitite-gneiss, the former being the prevailing type. These are cut by dykes and masses of pegmatite presenting the usual characteristics.

The Manitou Islands are composed of a rock which is remarkably uniform in composition and appearance, being a medium-textured reddish gneiss, that has evidently been subjected to intense dynamic action. It has a rather indistinct blotchey appearance, due to irregular bands of chloritic and epidotic material running through it, resulting from the alteration of the bisilicates. The microscope shows that the rock has everywhere been greatly granulated. Its chief constituents are quartz, orthoclose, plagioclase, hornblende and biotite, with epidote, chlorite, calcite, sericite, iron ore and apatite. It is thus a hornblende-granitite-gneiss which has suffered great alteration, the felspar being turbid and full of inclusions of sericite, calcite, etc., resulting from its decomposition. Numerous irregular patches of calcite are scattered through the section. Both felspar and quartz extinguish very unevenly. Hornblende is the most abundant ferromagnesian mineral present, but it has suffered such extreme alteration to chlorite and epidote as to mask its true characters. Biotite, largely altered to chlorite, occurs intergrown with the hornblende. The section is traversed by numerous cracks filled in with secondary quartz, epidote, iron oxides, etc.

Rocks of the Manitou Islands.

On several of the islands, this rock, which has evidently resulted from the crushing of a hornblende-granite, contains large patches of pinkish crystalline limestone; the latter, however, doubtless represents portions of the clastic Grenville series. The gneissic rocks are intersected by dark-greenish dykes of basic material previously described in that portion of the report treating of post-archæan eruptives. On several islands small outliers of the Birds Eye and Black River formations are exposed, as elsewhere noted.

Crystalline limestone.

Rock exposures are abundant on the Goose Islands, showing a medium-grained red granitic gneiss. The foliation is determined by the parallel arrangement of the little bands of biotite. The principal constituents are quartz, orthoclase, plagioclase, microcline and biotite, with small quantities of apatite, zircon, chlorite, epidote, sphene, calcite and secondary iron ore. It is one of the typical biotite-gneisses or granitite-gneisses of the region, evidently resulting from crushing and differentiation of a granitite. The felspars are exceedingly turbid, being filled with dust-like particles and contrasting sharply with the clear quartz grains. Orthoclase predominates, but plagioclase (albite) is very abundant. Most of the microcline grains observed exhibit a moiré-structure rather than the typical rectangular

Rocks of Goose Islands.

Constituents of the gneiss.

lattice structure. The biotite shows alteration to chlorite with development of secondary magnetite along the cleavage-planes. Apatite and zircon are both abundant in large well-formed crystals, as well as irregular grains. Numerous skeleton forms are scattered through the section, filled with calcite and a substance resembling leucoxene. Their outlines, sometimes rudely wedge-shaped, are defined by minute granules of a secondary iron ore, which also run along what were originally cleavage cracks. These in all probability represent titanite originally present in the rock which has undergone almost complete alteration with formation of calcite and ilmenite. Minute granules of epidote are present as the result of the alteration of the felspars. The rock does not present evidence of having been subjected to an intense degree of pressure, for although both quartz and felspar have wavy extinction, the quartz grains are only slightly cracked and not granulated to any extent.

Sturgeon River.

The Sturgeon River.

The Sturgeon River,* one of the largest in the country to the north-east of Lake Huron, possessing a drainage area of about three thousand square miles, takes its rise beyond the region covered by the accompanying map-sheets, and close to the sources of the most easterly branch of the Montreal River. From the source to its mouth on Lake Nipissing, the river measures about one hundred and forty miles in length, the general course being to the south-east. At a distance of a hundred and twenty-five miles from the mouth, the stream is divided into two branches inconsiderable in size. The more westerly of these has never been explored, but the branch which comes from the north-east drains an important chain of lakes forming the well-known canoe-route to Shusawagaming† (Smoothwater) Lake at the head of the eastern branch of the Montreal River. Three miles below the forks, the river expands to a quarter of a mile in width for a mile and a quarter, forming Paul Lake,‡ which is frequently though incorrectly described as the source of the Sturgeon. This lake is about 1258 feet above the sea. The Sturgeon debouches in an extensive marsh by two channels. The most direct or westerly one is almost completely filled with detritus, while the eastern branch is comparatively deep and navigable even for steamers. Once across the bars, the river offers

Its course.

Mouth of the river.

* This river is called "Champlain's River" on Delisle's map of New France, 1703.

† Sometimes also called "White Beaver Lake" from a mountain of that name which rises immediately to the west of the lake.

‡ The name is given in honour of "Big Paul," a sub-chief of the Temagami band of Chippewa Indians, who has made this lake his headquarters for many succeeding winter hunts.

uninterrupted navigation as far as the village of Sturgeon Falls, over four miles from the lake.

In ascending the stream the general direction is N. 35° E. for eleven miles in a straight line. This is to the mouth of a tributary coming from the east, known as Smoke River, that drains the southern portion of the townships of Grant and Charlton. In this distance navigation is interrupted by two falls and two rapids. The first of these, Sturgeon Falls, is opposite the village of the same name, at the intersection with the main line of the Canadian Pacific Railway. Sandy Falls is the name of the next, nearly six miles above the village, while the rapids, which occur a couple of miles beyond, generally require to be portaged in the ascent, although they can be run in descending. The portage to avoid this half-mile of broken water is on the west side of the stream.

Sturgeon Falls.

Near the mouth of the Smoke River, the Sturgeon takes a sudden bend, and has an upward direction in a straight line of N. 61° E. for 28 miles, as far as the "Elbow," in the township of Janes. Following all the sinuosities of the stream, however, this distance is increased to a little over thirty-six miles. The main tributaries in this interval are from the north, draining large lakes in this direction. The Temagami, which is a very turbulent and rapid stream, is the largest feeder of the Sturgeon, and is the principal outlet of the large lake of the same name. It enters the Sturgeon a little over twenty-three miles above the mouth of the Smoke River. The Tomiko (contraction for Otanacom-agosi or Canoe-making) River enters a little over five miles above Smoky Falls, deriving most of its water from several large lakes situated in the townships of Gladman and Hammell. The lower portion of the stream, from Tomiko Lake to the Sturgeon, is rarely if ever used for the purposes of canoeing. A long portage to avoid this rough stretch of river, runs northward from the Sturgeon, starting from a point nearly two miles above Smoky Falls. It affords an entrance to Cameron Lake and thence through Chebogomog Lake into Tomiko Lake. The upper portion of the river, however, is travelled to reach the numerous lakes situated near the head-waters of the several branches of the stream and thence to the region beyond. Pike River is another feeder, coming from a lake of the same name, situated near the centre of the township of Bastedo.

Course of the Sturgeon above Smoke River.

Temagami River.

Tomiko River.

Between the mouth of the Smoke River and the "Elbow", the Sturgeon is broken by one fall and five rapids, the latter all situated above the mouth of the Temagami River. The most important of these obstructions is the Smoky Falls, where the river descends over a solid

Smoke River to the Elbow.

barrier of gneiss for more than twenty feet. The portage runs over a small rocky island of gneiss which here divides the river into two channels.

Sturgeon River above the Elbow.

At the "Elbow," the trend of the river again changes abruptly to a direction of N. 14° W., which course is maintained as far the mouth of the Obabica River, a distance of twenty-two miles increased to thirty-four miles by the bends of the stream. Only a little over a third of this distance is included on the accompanying maps, as far as the mouth of the outlet from Wawiash-Kashing and Manito-Peepagee lakes. The largest tributary in this distance is the Maskinongé River, that reaches the main stream from the west about two and a half miles above the "Elbow" and drains a number of large lakes, shown on the Sudbury map-sheet (No. 130.)

Navigability of the river.

The Sturgeon River is in general readily navigable for canoes throughout the whole distance embraced in the present map-sheets, although the current is strong nearly the whole way. Between Smoky Falls and a point about three miles above the mouth of the Temagami branch (a distance of about twenty-five miles) there is no greater impediment to canoe navigation than the strength of the current. The river, except where contracted at the rapids and falls, varies in width from a little over two hundred and fifty feet near the mouth to about a hundred feet in the township of McNish near the north-west corner of the Lake Nipissing sheet. The depth varies from three to twenty feet, with an average of perhaps ten or twelve feet.

The flats along the river are liable to inundation during the high spring freshets and the actual rise in the water at the several points along the coarse of the stream, may be readily ascertained by a reference to the appended list of elevations.

Cultivable land.

The river for the most part pursues a somewhat tortuous course through a tolerably level flat of considerable extent, exhibiting numerous sections of a stiff grayish clay overlain by coarse yellowish sand, in the immediate valley of the Sturgeon. Below the Temagami River there are many areas of considerable extent which have been utilzed for settlement and the soil has in general proved productive. Between the mouths of the Tamagami and Maskinongé rivers, these flats are fewer and less extensive while the county immediately adjoining becomes for the greater part poor and rocky. Above the Maskinongé, very little land is available for farming, the country assuming a broken and mountainous character.

Rocks.

The rocks throughout this distance present the usual characteristics of the reddish and dark-grayish gneisses. The dip is towards the south or south-east at an angle of often considerably less than 45°. The exposures in the immediate vicinity are very few, and except in the neighbourhood of falls and rapids are small, consisting chiefly of rounded hummocks protruding from the overlying drift material.

The contact between these rocks and those of the Huronian, occurring to the north-east, crosses the Sturgeon River a short distance above the "Elbow". The actual junction is not visible, but exposures of the flesh-red granite-gneiss of the Laurentian and the light greenish compact quartzite of the Huronian occur within a short distance of one another. Junction of Laurentian and Huronian.

The Montreal River.

The Montreal River is, next to the Ottawa and Sturgeon rivers, the largest stream included within the area covered by the present Report, draining an area of about 2500 square miles.

The general course of the river, so far as it is included in the Lake Temiscaming sheet, is south-east, and the length almost forty-seven miles in a straight line. This may be divided into three parts, the first and third of which are approximately parallel in direction, while the second, or short intervening stretch lies almost at right angles. General course of Montreal River.

The lower portion of the river, from Lake Temiscaming to Mud Lake portage, is now superceded as a canoe-route by the shorter and easier passage by way of Haileybury, Mud and Sharp lakes. There are numerous rapids, and the river, throughout this distance, flows in a narrow valley, generally from 400 to 450 feet deep. Only a few small streams enter this portion of the river, as the highest land occurs in close proximity to the banks on either side. The lowest three miles of the river, before it reaches Lake Temiscaming, is a series of rapids with a fall of 160 feet. At the "Notch," near the mouth, the river flows through an extremely narrow channel, with rocky perpendicular walls, composed of dark-greenish greywacké slate, much jointed and broken. This gorge has a breadth varying from sixteen to thirty-three feet and is a little more than a hundred yards long, with perpendicular walls about forty feet high. The rapids above referred to are overcome by a portage about three miles long. Lower part of the river. The Notch.

For about six miles above this portage the river is crooked, with a fairly gentle and uniform current, its channel being cut through a narrow plain of stratified drift material. There are only occasional outcrops of rock, and these show a comparatively fine-grained arkose, Rocks seen.

See Plate IV.

forming the transitional beds upward from the greywacké and slate to the quartzite grit that characterizes the summits of the hills extending westward to Bear Lake.

Fountain Fall and Ragged Chute.

Three rapids occur in the next stretch, before Fountain Fall is reached, the total fall in this part of the river being over thirty feet. The rock, wherever exposed, is a dark-green somewhat coarse diabase or gabbro, the felspar, especially in the coarse phase, being frequently of a reddish colour. Fountain Fall has a sheer descent of twenty feet over an outcrop of breccia-conglomerate. Ragged Chute is situated a short distance above, and has a fall of about thirty feet. The hills on either side of this wild rapid rise precipitously from the river, and the portage, which is situated on the north-east bank, runs over a very high and steep hill. The rock exposed is the usual breccia-conglomerate, showing a dark-green chloritic matrix which is often present in comparatively small proportion, in which is embedded an abundance of fragments of felspar, granite and diabase. About a mile above Ragged Chute, the slate is superimposed upon the conglomerate, dipping S. 70° N. < 20°. Two more rapids of considerable dimensions occur in the spaces between Ragged and Hound chutes, having a combined fall of thirteen feet. At the latter place, the waters of the river make a clear leap of twenty-five feet, over an outcropping ledge of diabase.

Hound Chute to Mud Lake portage.

From the head of Hound Chute to Mud Lake portage, the banks on either side of the stream, and especially that on the north-eastern side, exhibit perpendicular cliffs composed of diabase, greatly resembling and co-extensive with a large mass which reaches the west side of Lake Temiscaming, there forming the cliffs known as the Manitou and Devils Rock. The current in this interval of nearly five miles is very swift, showing a total fall of about eight feet, but with no distinct rapids.

Rocks near Mud Lake portage.

Immediately below Mud Lake portage is a high hill of diabase that rises precipitously from the water on the north-east side, while a short distance above, on the opposite side, smaller elevations composed of similar rock were noticed in close proximity to the stream. In the vicinity of the first rapid above Mud Lake portage, the banks are again high and rocky, composed of the coarse diabase or gabbro with much fresh-red felspar, giving it somewhat the appearance of a basic granite. A small rocky island about twelve chains below the rapid, shows this diabase to possess a very perfect series of jointing planes with a direction of N. 50° E. and dipping S.E. <70°. The strike of these planes corresponds closely with the trend of the stream at this point and may have been the cause of its direction. The rapids, which are very strong, have a fall of seven feet, and are caused by a barrier composed of outcropping ledges of the diabase aided by an accumulation of loose boulder material. There are no exposures of rock between the head of these rapids and Bay Lake, while the river, between the two other intervening rapids, is marked by the occurrence of comparatively wide lake-like expansions, which in places show a considerable current.

Bay Lake.

Bay Lake, known to the Indians as Pakeegama or Mattagamashing, occupies a rather deep depression in the rocky plateau, being bounded, especially on the south-west side, by high rounded hills of slate and quartzite. It runs in a north-west and south-east direction, with a length of seven miles and an average breath of a little over a quarter of a mile. A large bay near the north-western extremity runs in an easterly direction for about two miles and a half. The portage from Loon Lake, on the road to Temiscaming, reaches the north-east corner of this bay, while the Hudson's Bay Company's post is situated on the point on the north-west shore of the lake near the entrance to Portage Bay.

Rocks of south-western end of Bay Lake.

The south-western shore, near the south-western end of Bay Lake, shows excellent exposures of well banded and evenly jointed greenish-grey slates, while the north-eastern shore in this direction is low and covered with thick green bush. About a mile and a quarter north of the outlet, the slates are overlain in conformable sequence by the yellowish-green quartzite-grit, the whole having a north-westerly dip < 5° to 12°. The slate as usual shows a gradual transition through a more massive slate into a greywacké or felspathic sandstone, which merges upward into the comparatively coarse-grained arkose sandstone or quartzite-grit that rises into hills varying from 250 to 300 feet above the lake, in places forming precipitous cliffs of considerable height.

Lithological character of the slate.

A specimen of this rock was examined by the late Prof. G. H. Williams and was taken to represent the transitional portion near the immediate junction between the coarse greywacké and the quartzite or arkose. The small hand specimens showed a banded coarse and fine conglomeratic sandstone or greywacké. The coarser portion of the specimen presents the ordinary characters of the prevailing quartzite-grit, holding good sized fragments of quartz both angular and rounded in outline, embedded in a moderately abundant sericitic matrix. The finer-grained portion, which has a somewhat darker hue, is a rather typical greywacké, showing "an aggregate of angular and sub-angular quartz grains with some felspar. Between these grains much chloride has been developed, which, together with the magnetite present, gives the dark colour to this layer."

Quartzite and greywacké.

This quartzite, as usual, occurs in very thick and massive beds and the dip cannot be made out with any certainty except in a few places. It is exposed all along the south-west shore of the lake as far as the inlet and forms the south-western portion of the point that separates Portage Bay from the main body of the lake. Further up the river this rock is underlain, first, by a massive brownish greywacké or slate, exposed a short distance below Pork Rapid, and next, in descending order, by the well banded greenish slates, dipping S. 55° E. < 10° to 15°, which continue as far as and a little beyond the inlet from Lady Evelyn Lake. The structure is therefore that of a somewhat shallow syncline, the basal bed being represented both by the banded slates exposed in the south-eastern part of Bay Lake and those occurring in the vicinity of the outlet from Lady Evelyn Lake, the overlying quartzites resting in the trough thus formed.

Diabase of Portage Bay.

The point on which Bay Lake post is situated, is composed of coarsely crystalline diabase or gabbro, the felspar frequently possessing a distinct flesh-red colour. The massive and rounded exposures of this rock are cut by irregular ramifying dykes, composed of a fine-grained pale-grayish or pinkish aplite. This basic irruptive forms the shores of Portage Bay, as well as the north-eastern part of the point separating this bay from the main body of the lake. To the north-west of the lake, it continues for a considerable distance inland, forming a series of high, though rounded hills in this district, while to the east, as far as can be learned from the occasional outcrops, it is continuous with the mass which forms the southern part of Sharp Lake extending as far as the western shore of Lake Temiscaming.

Bay Lake to Mountain Lake.

Between the head of Bay Lake and the head of Lady Evelyn Lake (Mattawapika), the river is in general a fine, wide stream, with occasional short stretches of swift current. Pork Rapid (Kokooshbuwatik), has a total fall of nearly seven feet, the portage being on the south-west bank. The north-eastern banks of the river are low, and the country for many miles is flat and swampy. On the south-east side in that direction there are only occasional low rounded exposures of the greywacké and slate, and these are situated some distance away from the stream, forming a series of rounded hills. Between the Mattawapika and Round or Mountain Lake the river is, as a rule, wide and navigable, with only two interruptions by rapids One of these is a little over a mile and the other about four miles below Round Lake, the portage in both cases being on the northern or north-eastern bank of the river. The combined fall of these two rapids is about eight feet, the upper one being the larger with a descent of five feet.

The shores in the vicinity of the Mattawapika, show exposures of a well banded slate which dips S. 55° E. <10° to 15°, and continues for about a mile above this point, where it is interrupted by a mass of diabase or gabbro, which, on the south-east side, rises into a series of precipitous hills. This rock may extend across the stream to the northward, but any hills on this side are much lower and less pronounced, and are therefore more likely to be underlain by the gray-wacké slate. This mass of diabase extends to within a quarter of a mile of the outlet from Mocassin Lake, and is an extension northward of the mass of similar rock which forms the western shore of the last stretch of Lady Evelyn Lake. To the north-west, this diabase is replaced by the quartzite grit or arkose which forms smaller and less conspicuous eminences extending northward and inland for some miles; while to the north-west, the general surface outline would seem to indicate its continuous presence as far as the south-eastern extremity of Indian Lake, although no exposures could be seen. The rock is the usual greenish or reddish-gray, coarse arkose, so prevalent throughout this district. A specimen of this rock was examined by the late Prof. G. H. Williams, who says that "it shows an even-grained mixture of somewhat rounded quartz grains with an equal amount of felspar (orthoclase, microcline and oligoclase). The minerals and their proportions are those of a granite, and yet the appearance of the grains and their relations to one another at once disclose the clastic character of the rock. The felspar, except a few of the largest grains, is quite changed to kaolin or sericite, although its external characters are still plainly discernible."

Rocks of Lady Evelyn Lake.

Microscopic character of greywacké.

Indian Lake is only an irregular expansion of the river crossing its downward course at a considerable angle, and discharging from the south-west side nearly a mile from the foot of the lake. Near Indian Lake, the banks are somewhat higher and are composed of grayish stratified clay, which makes a good soil. The shores of Indian Lake are as a rule low and grassy, presenting no rock exposures, but the comparatively high hills that border the south-western end of the lake are probably composed of quartzite-grit. From Indian Lake to Round or Mountain Lake, the river flows with a very gentle current between banks of moderate height composed of stratified gray clay. As the first rapid is approached, these banks are appreciably higher, but above the second rapid the area on either side of the river becomes much lower, while the immediate outlet from Round Lake is flat and swampy. Both of the rapids below Round Lake are caused by boulder obstruction. The south-western shore of Round Lake shows high hills composed of the coarse diabase or gabbro, and

Indian Lake.

Indian Lake to Mountain Lake.

Diabase or gabbro.

exposures of this rock were noticed on the north-eastern side near the outlet, but to the north-eastward of the lake the whole region seems to be comparatively level, the soil being a clay loam. The diabase and gabbro contains much flesh-red felspar, greatly resembling in this respect the coarser portions of the rock exposed at Quinn Point on Lake Temiscaming as well as on the north-east shore of Bay Lake. When subjected to the weather this felspar kaolinizes, thus producing a moderately coarse-grained rock, closely resembling in macroscopic appearance a basic hornblendic granite.

THE MATABITCHOUAN RIVER.

Matabitchouan River.

The Matabitchouan and Montreal rivers reach Lake Temiscaming almost at the same point, but while the general course of the latter is from the north-west, that of the Matabitchouan is from the south-west. The proximity of the mouths of these two streams has, in the past, been the cause of some little confusion in the names applied to each. Matabitchouan seems to have been the original Indian name of the Montreal River, while what has of late years been called the Matabitchouan is known to the Indians as the Wabos-na-ma-ta-bi-sipi (or Rabbit-sitting-down River. The names have, now, however, become fixed as here employed. The Matabitchouan is one of the most important streams in this district, and for many years was the only canoe-route in common use between lakes Temiscaming and Temagami. Its head-waters lie to the north and west of White-bear Lake. The smallest branch takes its rise in Caribou Lake, on the main canoe-route, within a quarter of a mile of the north-east arm of Lake Temagami, and this small lake sends another and larger stream into Lake Temagami. The largest or main branch of the river rises in Mountain Lake, to the south-east of Annima-nipissing and Bay lakes. Two other branches of some size drain lakes that lies close to the hills bordering the lower stretch of the Montreal River, debouching in the north-eastern corner of White-bear Lake within a short distance of one another.

Its watershed and branches.

Lower part of Matabitchouan.

From the mouth on Lake Temiscaming to Mountain Lake, the distance, in a straight line bearing N.70° W. is nineteen miles, while following the general canoe-channel, this distance is increased to thirty-seven miles. This whole space is divided into two main directions of flow, forming an angle of 70° with one another, these constituting two sides of a triangle, while the third has the length and direction already mentioned. The first of these stretches, which extends from the mouth of the river to Rabbit Point on Rabbit Lake, has an upward bearing of S. 44° W. for thirteen and a half miles, although the channel usually travelled measures about sixteen miles. The third side of the triangle, which reaches from Rabbit Point to Mountain Lake, shows a general direction of N. 26° W., with a length of nineteen miles, although the most direct canoe-channel measures about twenty-one miles. From the mouth of the Matabitchouan to the first portage, the river has cut a fairly deep channel through drift material, the bands on either side being composed of a stratified gray clay. The strength of the current in this interval varies with the height of the water, for during times of freshet, the water of the lake backs up, forming a comparatively deep channel to within a short distance of the first portage; while, during ordinary stages, the stream has a swift current almost to the mouth. The northern banks are as a rule much lower than those on the south side of the stream. A short distance south of the river is a high and prominent hill, known as the King of the Beavers, also sometimes called the Montreal Mountain or Beaver Mountain. According to barometrical observations, this hill has an elevation of 660 feet above Lake Temiscaming, or 1248 feet above the sea.

Beaver Mountain.

The summit of Beaver Mountain, for 340 feet, is composed of a greenish-grey medium textured diabase, much sheared and broken, the planes of shearing being abundantly coated with greenish decomposition products. Below this rock is a greenish slate, which marks the lower and more gradually sloping portion of the mountain. The strike of the slates curves around, conforming beautifully with the line of outcrop of the diabase, dipping into or beneath what seems to be an irruptive mass of lacolitic origin.

Rocks found in Beaver Mountain.

The first, or Matabitchouan portage, occurs a little over two miles from the mouth of the river, where a series of rapids and falls occur with a descent of 260 feet. The stream here describes a sharp bend to the north, while the portage, to overcome these obstructions cuts, across the bend thus formed, running over a hill, the highest point on the trail being 330 feet above the level of the river at the foot of the portage. The ascent of the portage is steep, passing first over stratified gray clay, and clay and boulders, but near the summit it is rocky. This is the breccia-conglomerate, containing pebbles chiefly of a flesh-red granite embedded in a dark-green chloritic matrix. The west end of the Matabitchouan portage comes out on the first of a series of four Bass lakes, numbered in ascending order. These are small expansions, united by narrow shallow channels, with an appreciable current.

Matabitchouan portage.

The south-east shore of the Second Bass Lake, consists of high perpendicular cliffs composed of a fine-grained hornblende-granite, evidently

Second Bass Lake.

an extension of the large mass of somewhat similar rocks coloured as Laurentian further to the south. At the base of the cliff, near the upper end of the lake, this granite may be seen in contact with the breccia-conglomerate, that constitutes the basal member of the Huronian.

Rocks of Third Bass Lake.

Precisely similar rock forms the eastern shore of the Third Bass Lake, but is so massive that no lines indicating original sedimentation could be discerned. A thin section of the finer portion, or matrix, of this conglomerate obtained from an exposure immediately below the rapid that separates this lake from the next succeeding one above, shows the rock to be a highly felspathic sandstone or greywacké, consisting of subangular grains of quartz, orthoclase and plagioclase with a considerable amount of a green chloritic decomposition product occurring for the most part between the quartz and felspar grains and giving the rock its general greenish tint. A few grains of pyrite are also present. The majority of the grains are composed of felspar, which is a good deal decomposed, while the quartz shows evidence of having been subjected to great pressure. On the western shore of the lake, near the upper or south end, exposures of greenish banded slates may be observed, dipping to the westward at a low angle and overlying the breccia-conglomerate of the eastern shore. These slates constitute a belt about a quarter of a mile in width, and to the west merge gradually upward through a massive and uniformly fine-grained greywacké into the sea-green sandstone or quartzite-grit that forms most of the shores of Trout Lake, (a small expanse of water to the north-west of Third and Fourth Bass Lakes).

Rocks between Third and Fourth Bass lake.

A rapid with a considerable fall intervenes between the two upper Bass Lakes. Macdonald Creek, an important tributary, enters the Fourth Bass Lake from the south, draining a number of lakes in that direction. On the west shore of the bay into which this creek empties, are high rounded exposures of the breccia-conglomerate, while at the small rapids at the upper or south-west end of the lake are ledges of the overlying greenish banded slates, striking about north-east and dipping to the north-west.

Fourth Bass Lake to Kanebeatika portage.

Above the Fourth Bass Lake a small rapid occurs, and a short distance beyond five rapids follow in quick succession. During times of low water a portage known as the Kanebeatika (or Along-the-rocks) portage, is made on the south side of the river, commencing at the foot of a small fall and running for a distance of nearly three-quarters of a mile. Frequently, however, the passage either up or down is made by keeping close to the stream and utilizing the shorter trails. The north side of the river shows precipitous cliffs of greenish banded slates, which rise abruptly from the water's edge to a height of over a hundred feet, having at the base a talus of angular blocks. Only a quarter of a mile separates these from the Devils Rapid, where the water pours through a narrow cañon of slate, with a portage on the south side of the stream. The banded slates here exposed have a strike of N. 20° E., with a dip to the north-west. A quiet stretch of similar length separates this from the next succeeding rapid, at the foot of which the green banded slates strike N. 64° E. and dip northerly < 50°. The upper end of this portage shows exposures of a somewhat coarse gabbro or diabase, a belt of this rock about three-eighths of a mile wide crossing the river at this point and interrupting the slates and greywackés. A stretch of three-quarters of a mile of comparatively deep and navigable water, with swift current at only one point, occurs in the interval before the foot of the next portage, which is the last before Rabbit Lake is reached. This portage which is a little over half a mile in length, passes two rapids and a chute, the latter exhibiting a very pretty fall of about fifteen feet at the immediate outlet of the lake. A specimen obtained at the foot of the portage is a very fine-grained reddish-gray rock, resembling a felsite macroscopically.

Devils Rapid.

Thence to Rabbit Lake.

Rocks near outlet of lake.

At the outlet, the rock is a fine-grained greenish-gray felsite or felspathic sandstone very similar to the last in composition with a strike N. 60° E. and a dip to the north-west < 50°. It is impossible, however, to be sure that these planes represent original lines of sedimentation, for a little over a mile to the south of Rabbit Chute, on the west side of Outlet Bay, the greenish banded slates were seen dipping about west < 50° and superimposed upon the breccia-conglomerate which forms the eastern shore of this bay wherever the rock is seen.

Rabbit Lake.

The present name, Rabbit Lake, by which this stretch of water at the head of Rabbit Chute is known, is an abbreviated translation of the Indian designation Wabos-na-ma-ta-bi (or Rabbit-sitting-down Lake) because of the occurrence at one of the most prominent points of a large angular mass of greywacké which has a fancied resemblance to a rabbit in a sitting posture.

The lake has a general trend of north-east and south-west, and the distance from Rabbit Chute to the end of South-west Bay is ten miles in a direct line, although the distance from portage to portage on the canoe-route is a little over eleven miles. The average width of the lake is about three-eighths of a mile, while its total area is about eight square miles, and its height about 939 feet above sea-level. The lake has a rather irregular outline, with a number of large bays, which are, in their turn, cut up into many smaller inlets. At the southern end of Outlet Bay, one of these indentations stretches away to the south-east, crossing the strike of the rocks for a distance of over two miles. During extreme high-water a small stream flows out of the end of this bay into Ross Lake, at the head-waters of Macdonald Creek, which flows into the Matabitchouan River at the Fourth Bass Lake. The bay running to the north-west forms a portion of the main route of travel between Temiscaming and Temagami lakes. With a gradual curve from the north to the north-west it reaches the foot of the portage to White-bear Lake, about five miles from Rabbit Point. The South-west Bay is really a continuation in this direction of the main body of the lake.

Outlets of lake.

Diabase of Outlet Bay.

Near the southern end of Outlet Bay, a mass of greenstone (diabase and gabbro) crosses South-east Bay, and, running parallel to Outlet Bay but a short distance inland, this doubtless connects with the belt of such rocks that crosses the Matabitchouan at the third rapid below Rabbit Chute. This band is a little over half a mile in width, and in the vicinity of Outlet Bay is followed by the massive breccia-conglomerate, which is in turn overlain by the fine-grained brownish, and greenish-gray slaty rocks with a strike of N. 5° W. and a dip west $<$ 20°. This diabase, as it may be named, is by no means homogeneous in composition, and patches of granitic aspect and composition occur without any sharp line of division, merging by degrees into the more basic portion of the mass. In places these granitic patches are cut by dykes of fine-grained diabase evidently of somewhat later origin.

To the south of this greenstone mass, a belt of the breccia-conglomerate comes in, but the actual contact is hidden in a low valley at the foot of a small bay on the south-west shore. On the south-west side of the bay, the conglomerate band has a width of a quarter of a mile, but on the north-eastern shore it is somewhat wider. The matrix is a fine-grained, compact, dark greenish-gray rock, breaking with a conchoidal fracture. Under the microscope it is seen to consist of a very fine-grained mosaic of quartz and felspar, filled in with minute scales of chlorite and sericite and granules of epidote. In this are scattered larger fragments of quartz, orthoclase, plagioclase, microcline, hornblende, biotite (both the latter minerals largely altered to chlorite) and sphene. In this fine-grained portion are imbedded occasional pebbles and fragments often of considerable size, composed, chiefly of red and gray granite. Near the contact with the granite rocks to the south, the rock is seen to have undergone extensive deformation by pressure, the resulting shearing-planes being abundantly coated with the usual

Microscopical character.

Contact with granite.

greenish products of decomposition. The pebbles themselves, which are relatively much more abundant, are seen to have been stretched and rolled out as a result of such extreme dynamic action; while a very marked foliation has been developed in the finer-grained portion of the rock, which is seen to wrap around and conform as closely as possible to the outline of each individual fragment.

Granitic inclusions in conglomerate.

Besides these lengthened pebbles there are granitic inclusions, running for the most part with the cleavage, but which in most cases present a somewhat more irregular and indistinct outline. These appear to be of the nature of small apophyses of granite, although it is exceedingly difficult to discriminate in every case between these irruptive dyke-like intrusions and the distinctly rolled fragments which have been considerably flattened as a result of pressure. The cleavage or foliation of this conglomerate has a direction varying from S. 18° W. to S. 21° W., with a prevailing south-easterly dip at a high angle.

Junction of conglomerate and gneisses.

The junction between this rock and the granites and gneisses exposed to the south, was seen crossing the lake about three-quarters of a mile from the foot of South-east Bay. The line of outcrop of the granitite-gneiss seems to form a considerable angle with the planes of foliation of the conglomerate, intersecting these in a direction of S. 53° W. Further to the south, the granitite-gneiss is considerably mixed with a much more basic rock, doubtless either a gabbro or a gabbro-diorite, which, however, appears to have been an integral portion of the same magma from which the granitite-gneiss has solidified. The gneiss is, as a rule, very granitoid in aspect, sometimes very coarse-grained and even porphyritic in structure, while in other places not far distant it is of medium texture and distinctly foliated, this structure being determined by the alternation of reddish and greenish-yellow bands. The strike of this foliation varies from N. 23° E. to N. 33° E., while the dip is to the north-west $<45°$ to 50°. Under the microscope, a precisely similar rock from the South-west Bay is seen to be a granitite-gneiss, composed of orthoclase, plagioclase, quartz, chlorite (derived from biotite originally present) and epidote, with small quantities of sphene, apatite, and secondary calcite. The alternation of reddish and greenish-yellow bands so characteristic of this rock, is due to the parallel disposition of certain layers of felspar stained by iron oxide, with others in which the felspars present have undergone extensive saussuritization; the resulting scales and granules of sericite and epidote arranging themselves in a more or less definite position at right angles to the direction of pressure. This granitite-gneiss, and associated

Structure of gneisses.

granitite, with a much smaller proportion of "greenstone," occupy all of the southern end of South-east Bay, and is continuous with the large mass of essentially similar Laurentian rocks exposed in the region to the south.

Contact of irruptive character.

The contact between the granitite-gneiss and the slate-conglomerate is very evidently of an irruptive character. The slate-conglomerate is everywhere, near the line of contact, much squeezed, and is in places penetrated by small dykes of the irruptive rocks; while fragments of the former may be seen caught up and embedded in the gneissic-granite, even at a considerable distance from the line of junction, on both sides of the bay. Near the line, the matrix of the conglomerate is much hardened, as a result of such igneous action, or rendered much more chloritic and epidotic as a result of the presence and percolation of heated waters. On the north-east shore, near the contact between the two rocks, the foliation of the granitite-gneiss dips to the north-west $< 30°$, while the conglomerate has an almost if not quite vertical attitude; although further to the north it dips to the north-west $< 50°$.

Southern shore of Rabbit Lake.

The southern shore of the main body of Rabbit Lake, is composed of a very distinctly and evenly bedded slaty greywacké, of gray and greenish-gray colours, the greenish colours being due to the relatively greater abundance of sericite and chlorite. The strike varies from N. 18° E., on the shore opposite Rabbit Point, to N. 40° E. near the north-eastern part of the stretch, curving gently with the trend of the shore. The banks rise rather abruptly from the water's edge, in places forming low vertical cliffs of slate, especially near the north-eastern portion. The effects of glaciation are very marked. The graywacké-slate rests conformably upon the breccia-conglomerate which forms the north-eastern shore of this portion of the lake wherever any outcrops of rock occur, the banks shelving gently, as a rule, towards the lake with a gravel or shingle beach along the water's margin.

To the south-west the breccia-conglomerate extends to Rabbit Point, as well as along the east shore of North-west Bay for some distance north of Rabbit Point. The various exposures of this conglomerate show no special features worthy of mention in this place.

Rabbit Point.

Rabbit Point is a narrow projection that extends into the lake from the north side of the junction between the main lake and North-west Bay, a little over six miles from Rabbit Chute. The rock composing it is the prevailing breccia-conglomerate, but, as in most cases it is exceedingly difficult if not impossible to determine any lines of stratification, and the cleavage or foliation which is the most obvious and only distinct structural feature present, has a strike of N. 15° E., and a dip S. 75° E. < 80.°

Rocks exposed on islands.

There are two small islands about the centre of the lake a short distance to the west and north-west of Rabbit Point. The larger and more northerly of these is composed of dark greenish-gray breccia-conglomerate, the matrix of which has a distinct slaty cleavage. The pebbles and boulders are composed chiefly of red and gray granite, and sometimes of reddish-gray gneiss. The inclusions vary in size from the smallest pebbles to boulders two feet and over in diameter. Besides these composite fragments there are a great many angular pieces of felspar, which, where they are abundant, give the rock a pseudo-porphyritic appearance. Most of the fragments are composed of a deep flesh-red granitite, showing a preponderance of red felspar with a less quantity of gray translucent quartz, and a trifling amount of green chlorite resulting from the decomposition of biotite. Next in abundance is a reddish-gray granite somewhat more basic in composition than the last, while in certain instances occasional rounded fragments of a distinctly foliated reddish-gray gneiss were noticed. Besides these there are fragments that seem to be referable to some of the finer and more compact slaty greywackés of the Huronian.

Inclusions of pegmatite.

In addition to this distinctly clastic material, some granite inclusious were seen with an irregular though lenticular outline, pegmatitic in structure and origin. Such patches or areas were sometimes six and even eight feet in length, which coincides with the direction of the foliation of the inclosing rock. The strike of the foliation, which is distinct, is N. 6° E., with an almost vertical attitude. The smallest of these islands is composed of a very similar rock, but more massive in structure. Around the included masses, especially the larger ones of granite, the rock has an apparent flow-structure, with lines conforming as closely as possible with the outline of the included fragments. The whole rock-mass has very evidently been subjected to intense pressure, which has completely destroyed any bedded structure which may have originally existed and replaced it by a more or less perfect jointed structure.

Conglomerates of eastern shore.

Opposite these islands, and forming the eastern shore of the lake, is the same greenish-gray breccia-conglomerate, with a foliation striking N. 8° E., and a dip to the east varying from 60° to nearly vertical. To the south, as the mass of diabase or gabbro is approached, the breccia becomes much more contorted and broken up. The included fragments are flattened and rendered irregular in outline, and the whole mass exhibits abundant signs of pressure and alteration.

Contact with diabase.

At the immediate contact, the conglomerate does not contain many fragments, and the finer slaty matrix is sometimes alone represented; but a short distance away the fragments are so abundant that there is very little of the finer interstitial material. The junction between the two rocks is situated a little over a mile and a half south of Rabbit Point. It is very sharply defined, and the slaty rock along the line of demarcation is much broken up and jointed, although the cleavage planes conform in a rude way with the line of outcrop of the greenstone. The slate is likewise much hardened, as a result of the intrusion, and breaks with a splintery fracture. The greenstone, which is essentially similar to most of these basic masses, is doubtless a diabase, possessing a dark greenish-gray colour and of medium texture. In places it has a decided reddish tinge, owing to the felspar being stained with hydrous oxide of iron. This greenstone contains a considerable body of chloritic and epidotic schist, which may have resulted from the shearing of a portion of the eruptive itself, or may represent an extremely altered form of the finer matter of the breccia-conglomerate caught up and embedded in it.

Contact of gabbro and quartzite.

Towards the end of the outcrop, which altogether occupies scarcely a quarter of a mile of shore-line, the rock is of a prevailing gray colour, and much coarser and gabbro-like in structure. Southwards, it gives place, at the end of a small bay, to a greenish-gray felspathic quartzite associated with some very vitreous flesh-red quartzite. In general, near the contact, these rocks have a north-and-south trend, but about an eighth of a mile to the south-east the greenish-gray greywacké was seen apparently striking N. 23° W. and dipping north-easterly $<60°$, but it is improbable that the planes represent true bedding.

Granitic rocks of Reuben Lake.

The mass of greenstone described above seems to be closely connected genetically with the large mass of granite and similar basic rock, portions of the former occasionally being exposed along the southern and western shores of Reuben Lake to the west. By far the greater portion, however, of the shores of Reuben Lake, show outcrops of the breccia-conglomerate, full of granitic and other inclusions and fragments and much hardened and altered. It seems probable, that, not only is the large mass of granitic and other eruptive rock in close proximity to the west, but also that at no very great depth beneath similar rocks prevail. The southern and eastern shores of the south-western extremity of South-west Bay, are composed of the breccia-conglomerate with a decided slaty or schistose structure. On the south shore, the direction of foliation varies from S. 28° W. to S. 38° W. and the dip south-east $< 65^{\circ}$ to 70°. The rock, although of a prevailing light greenish-grey colour, frequently presents pearly-green cleavage-planes, due to the development of sericite. In this schistose matrix are embedded pebbles and fragments composed chiefly of the red granite.

Streams entering South-west Bay.

Two streams enter the small bay forming the south-western end of South-west Bay. Both of these small streams come from the west, the more northerly forming the outlet of Reuben Lake, flows down steeply over angular and detached blocks of slate. The other larger and more important stream comes in about an eighth of a mile from the foot and drains many small lakes situated to the west and north-west.

Rocks of this vicinity.

The north-western and western shores of this small bay are occupied by the greenish-gray slaty greywacké and breccia-conglomerate, and at one place near the stream from Reuben Lake, massive and jointed slaty felspathic sandstone forms high perpendicular cliffs. These rocks extend for a little over a quarter of a mile along the shore from the mouth of this stream, where they are interrupted by an irruptive mass composed of a greenish-yellow and flesh-red granite-gneiss in alternating layers. Near the contact the granitic inclusions in the breccia-conglomerate become more irregular in outline, and many of them evidently represent dyke-like apophyses of an originally plastic mass which have been injected through the various cracks and fissures in the slaty rock.

Contact with gneisses.

Character of the gneisses.

This gneiss is of medium texture, and the foliation, which is very distinct, is caused by the parallel arrangement of flesh-red and greenish-yellow bands in alternating sequence. The microscope shows the rock to be composed chiefly of orthoclase, plagioclase, quartz, chlorite, (representing the biotite originally present) and epidote with smaller quantities of sphene, apatite and secondary calcite. In this gneiss the reddish bands owe their colour to the predominance of felspar stained by iron-oxide, while the yellowish-green portions represent bands in which the felspar has undergone extensive saussuritization. The strike of the foliation is S. 58° W. and the dip N. 32° W. < 70.

Extent of the gneisses.

The gneiss occupies the shore southward as far as the stream, which comes from the west, a distance of a little over an eighth of a mile. It evidently represents an extension of the much larger mass of similar rocks exposed in the region to the south and south-west. A mass of the slate-conglomerate was seen included in this gneissic rock with granitic intrusions of irregular outline traversing it in various directions. This mass does not extend further, for the eastern shore shows continuous exposures of a very fissile and altered greywacké-slate. This slaty rock was noticed in several places to contain fragments of granite

Slaty rocks.

and felspar, while at other places they are rare. The rock has evidently been subjected to somewhat extensive alteration and deformation, the exposed edges showing the characteristic wrinkled surface of slaty rocks which have been exposed to great pressure. The strike of the foliation varies from N. 20° E. near the foot of the bay to N. 30° E., near the north-east end. The western shore, south of the mouth of the small stream near the end of the bay, is likewise composed of similar slaty rocks, which vary in strike from N. 3° E. to N. 13° E. These evidently belong to a wedge-like strip, which, inland, quickly ends, and to the south-west is represented only by a number of detached masses caught up and embedded in the granitoid gneiss exposed on the south-eastern shores of Rankin and Miller lakes.

Rocks of North-west Bay of Rabbit Lake.

The western shore of the North-west Bay of Rabbit Lake, is composed of the prevailing breccia-conglomerate, but generally so massive that no distinct stratification can be made out, although usually the rock seems to strike with the trend of the shore and dip towards the lake. At one place it forms a cliff named Echo Bluff, over a hundred and fifty feet in height. A little over a mile and a half north

Diabase.

of Rabbit Point, this slaty rock is replaced by a greenish-gray diabase which occupies the shore as far as the first narrows, nearly two miles further to the north-west. Towards each side of the mass, the texture of the diabase is rather fine-grained, but near the centre it is much coarser and granitoid in structure, and as a great deal of the felspar assumes a flesh-red tint, the rock bears a marked macroscopical resemblance to a basic hornblendic granite. In general, however, the rock is medium-grained and diabasic in structure and composition. This basic eruptive extends across the lake to the north-east shore, where it forms a small patch, the strike of the neighbouring slaty rocks

Clastic rocks north of Rabbit Point.

curving around its line of outcrop. A large patch of the greenish-banded slates was noticed caught up in this mass of greenstone, still preserving its bedded structure, with a dip of N. 65° W. $<$ 45°. North of Rabbit Point, on the east shore of North-west Bay, the breccia-conglomerate merges gradually upward into a fine-grained greenish-gray felspathic sandstone, interlaminated with much finer-grained and darker coloured, banded greenish slates, the cleavage striking N. 4° E., with easterly dip $<$ 80°. The dip of the bedding seems to be to the north-east at a comparatively low angle. This compact greenish-gray fine-grained greywacké was examined under the microscope, and found to consist chiefly of irregular and subangular fragments of quartz, orthoclase and plagioclase embedded in a matrix composed chiefly of chlorite and sericite, which give the prevailing greenish tint to the rock. The other minerals noticed were zircon, sphene, ilmenite, accompanied by leucoxene, tourmaline and large grains of apatite and epidote. These minerals have evidently suffered but little abrasion through the action of water.

To the north of the small area of greenstone exposed on the north-east side of this bay, the shore is occupied by greenish slates, banded by the alternation of dark-green and purplish layers which merge into one another. These slates have a strike of S. 42° E., and a dip to the north-east < 40°. The thin section shows the character and composition of these bands very clearly. Some of the lighter ones exhibit an augen structure, the lenticules being composed of small angular fragments of quartz, with a lesser proportion of felspar. Surrounding and curving around them are the darker-coloured bands which derive their colour from the relatively greater abundance of small opaque fragments of magnetite. The rock in general may be said to be composed of a fine-grained groundmass of felspar, which is now greatly decomposed into sericite, occurring in the form of minute light-yellow-green scales, chlorite and granules of epidote. Irregular areas composed of aggregates of chlorite scales, together with small grains of magnetite, are scattered throughout the section.

Slates north of diabase on North-west Arm.

At the first narrows, about three miles and a half north of Rabbit Point, beautifully banded slates of a prevailing pale greenish-gray colour occur. The colour striping is produced by the occurrence of darker and almost black folia lines, which doubtless represent a relatively greater abundance, in these portions of the rock, of grains and dust-like particles of magnetite; while the lighter-coloured bands, originally highly felspathic, contain a considerable quantity of yellowish-green sericite in minute scales and flakes, developed at the expense of the felspar, together with a little chlorite derived from the alteration of the bisilicate material originally present in the rock. The outcrop is not far removed from the greenstone mass exposed on the opposite or south-west shore, and seems to have undergone considerable disturbance as well as alteration at the time of the intrusion of the greenstone, the slate dipping to the north-west < 30°.

Banded slates.

Beyond this the lake narrows and for about three-quarters of a mile has the characters of a stream, including a small rapid. A little above, it widens out again into a small lake-like basin, the south-western shores of which are composed of the massive greenstone.

Extremity of North-west Arm.

The portage into White-bear Lake begins at the north-western end of this small lake, which is usually considered as a part of Rabbit Lake, although not on the same level. The path is scarcely half a mile in length, and runs on the north side of the stream, which here trends nearly east-and-west.

Portage to White-bear Lake.

White-bear Lake.

White-bear Lake was so called for a former chief of the Temagami band of Indians. As will be seen by a reference to the map, it has a very irregular outline, and only a little over three miles of the south-western part is traversed on the canoe-route to Temagami Lake, the greatest portion of the lake lying to the north-east. The principal bays, making up the larger portion of the whole surface, have a trend a little east of north, thus coinciding with the strike of the clastic rocks exposed on the shores.

Rocks of south-western part of lake.

These are connected by shorter intervening stretches, excavated almost at right angles to the strike of the rocks. The width of a quarter of a mile or a little over is remarkably uniform. The prevailing clastic rock in the southern and western part of the lake is the breccia-conglomerate. The rock is, as a rule, massive and jointed, and the cleavage, which is the only structure visible, has a strike of about north-and-south with a dip to the east $< 60°$, according in a general way with the line of outcrop of the greenstone. The greenstone or diabase, as it seems to be, occupies the whole of the western shore of the southern bay, as well as the large island near the eastern shore about the central part of the lake. It also forms the extremity of White-bear Point and the high promontory on the south shore separating the eastern from the western portion of the lake. A small mass was likewise noticed on the north-west shore of the lake about a mile south-east of the inlet from Friday and Obashking lakes.

Greenstone or diabase.

Portage to Bogie Lake.

On the long portage between White-bear and Bogie Lake, the rock wherever exposed to the usual breccia-conglomerate, showing a preponderance of granitic fragments inclosed in a dark greenish-gray chloritic matrix. In the north-eastern part of the lake, the lowest clastic rock overlying this breccia-conglomerate is a dark greenish-gray fine-grained greywacké, having in places a somewhat slaty cleavage corresponding with the bedding. The dip is in general about S. 75° E. $< 25°$. This passes gradually upward, through an interlaminated lighter coloured felspathic sandstone, into a yellowish-green or greenish-gray quartzose sandstone or grit, much coarser in texture and more massive in structure than the greywacké.

North-eastern part of lake.

Portage from White-bear to Crooked Lake.

A short portage intervenes between the shallow muddy bay forming the western extremity of White-bear Lake, on the road to Temagami, and another shallow arm of Crooked Lake or Kinabigo-sminise (Snake Island Lake.) The lake has its greatest length from north-west to south-east of nearly two miles. The rock, wherever exposed, is the massive breccia-conglomerate, in many places containing numerous pebbles and fragments, chiefly of red granite, embedded in a dark-grayish

Rocks of Crooked Lake.

compact felspathic matrix. The strike of the most distinct structural planes, doubtless those caused by pressure, is S. 47° E. with a dip to the north-east <65°. A portage of less than a quarter of a mile separates Crooked Lake from Caribou Lake, the trail passing over a considerable rise composed of the breccia-conglomerate, while another portage of nearly the same length intervenes between Caribou Lake and the small bay which marks the north-eastern extremity of the north-east arm of Lake Temagami. Caribou Lake, or Sagibanwanapikunk is scarcely three-quarters of a mile long and the rock seen is the massive breccia-conglomerate, the same rock continuing over the portage to Lake Temagami. This lake has two outlets, the ordinary and larger one flowing out of the west end into a small bay to the south-east of the one entered by the portage, while during times of high water another small stream flows out of the eastern end into Crooked Lake.

Caribou Lake to Lake Temagami.

Caribou Lake.

Three important tributaries or branches of the Matabitchouan River enter the northern part of White-bear Lake. The main branch, reaches the north-western corner of the main body of the lake about half a mile north of White-bear Point. This stream takes its rise in Mountain Lake while many important tributaries enter from the west, draining the larger portion of the rocky granite plateau situated between it and the lakes draining towards Lake Temagami. Another stream flows into the small bay marking the north-eastern extremity of White-bear Lake, affording an outlet to a chain of waters which extends to within a distance of two miles south-west of the Montreal River. The third branch empties into the same bay about three-quarters of a mile to the south-west of the mouth of the last, draining several lakes, the largest of which is known as Waibikaiginaising or Rio Lake.

Streams entering White-bear Lake.

Ascending the main branch of the Matabitchouan, a portage of nearly half a mile separates Net Lake from White-bear Lake, into which it flows, the trail being to the north-east of the connecting stream. The lake has a general trend of N. 36° W. and the distance from portage to portage in a straight line is nearly seven miles. The narrows from which the lake takes its name is situated a little over three miles from the White-bear portage. This contraction is a little over half a mile in length with an average width of about two hundred feet. South of the narrows a bay extends from this part to the north-east for about two miles, at the end affording an entrance to a stream that drains a series of lakes to the east and north-east.

Net Lake.

To the north-west of the narrows, a bay extends to the south-west for about a mile and a half. A comparatively large sheet of water, known to the Indians as Kanichee-kinikisink Lake, lies to the north-west of this bay, into which it empties by two outlets, situated about a mile from one another. The northern portion of the lake, towards the inlet, is comparatively narrow, never, as a rule, exceeding a quarter of a mile in breadth, and frequently contracted to a quarter of this distance. The outlet from Thieving-bear Lake discharges at a point a few chains from the northern extremity of the lake, while the stream, from Snare and Mannajigainia lakes, enters this lake nearly a mile to the south-west of this point.

Streams entering Thieving-bear Lake.

Rocks seen on Net Lake.

The rock exposed in the south-eastern end of Net Lake, is a massive compact dark greenish-gray felspathic sandstone, associated with small areas or masses of intrusive greenstone. This is succeeded to the north-west by a flesh-red granitite of somewhat coarse texture, composed of reddish felspar, grayish translucent quartz, and a sparing quantity of greenish bisilicate material, which was originally biotite and is now almost completely altered to chlorite. This rock occupies the whole of the north-eastern shore in the wide space to the south of the narrows. It also composes the south-western shore and the islands with the exception of about half a mile in the vicinity of the narrows, where there are outcrops of a coarse dark greenish-gray greenstone. The shore-line characterized by the presence of these rocks is fairly bold, in somewhat marked contrast to those where slaty rocks prevail. There are no outcrops of rocks in the narrows. To the north-west of the narrows, however, the shores as well as the bay which runs to the south-west, show many outcrops of a light greenish-gray slaty rock, evidently originally a compact greywacké, with an abundant development of sericite along the planes of cleavage. These slates or sericite-schists have a strike in accordance with the general trend of the bay, which is north-east and south-west.

Rocks of Kanichee-kinikisink Lake.

The south-western shores of Kanichee-kinikisink Lake, are generally composed of a somewhat similar though more compact slaty greywacké, but the north-eastern side and many of the islands exhibit greenstone, which seems to be a different portion of the same magma, which to the north and north-east has, for the most part, solidified as a biotite-granite or granitite. The shores of the northern portion of Net Lake are composed of a series of rounded rocky points with intervening marshy or grassy bays, the rock everywhere exposed being a flesh-red granitite in which but little of the ferro-magnesian constituent can be seen. Occasional small patches of greenstone were also noticed, that appeared to be closely related to the granitite.

Northern part of Net Lake.

A short stream separates Net Lake from Thieving-bear Lake, with a small rapid near the latter and a much larger one near the former. Thieving-bear Lake or Mako-gimodiwi has a very irregular outline, being completely inclosed by comparatively low rounded hills of the flesh-red granitite. It has three feeders from the north. The route from Thieving-bear Lake northward to Mountain Lake follows a succession of five small lakes or ponds, the largest of which is only a little over a quarter of a mile in length, united by shallow streams. The whole distance is about three miles by the stream and the general direction nearly north. The valley is as a rule somewhat narrow and shallow, the hills on either side sometimes rising abruptly from the water. The rock throughout is the prevailing flesh-red granitite.

Thieving-bear Lake to Mountain Lake.

Mountain Lake has a general trend of a little north of east, and is about three miles in length in this direction. The western half of the lake, out of which the portage goes to Breeches Lake, is a long narrow and shallow bay, and the rocks wherever visible are flesh-red granitite. The main body of the lake is nearly three-quarters of a mile wide, while the inclosing rocky shores are everywhere composed of the massive greenstone. The portage from Mountain Lake, which here marks the height-of-land between the Matabitchouan and Temagami waters, passes over the side of a hill, the highest point on the trail being 160 feet above Mountain Lake. Breeches Lake or Kawaganchigania, is small. It empties into a pond which in turn discharges into a bay of Annima-nipissing Lake. A portage of only three chains separates Breeches Lake from the small pond, while another scarcely an eighth of a mile brings the traveller to the large and important sheet of water known as Annima-nipissing Lake.

Mountain Lake.

Portage to Temagami waters.

Ascending the stream flowing into the north-eastern bay of Net Lake about four and a quarter miles from the White-bear portage, the channel of the creek is utilized for a little over a quarter of a mile, when a very short carry is necessary to reach Ferguson Lake. Duncan Lake, the next expansion encountered, is practically on the same level, being separated by about a quarter of a mile of stream with little current. The shores of both Duncan and Ferguson lakes slope gently and show no rock. The second portage going from the west end of Duncan Lake at the stream from Petrout Lake is about forty-five chains in length, and runs over hills which are composed chiefly of the flesh-red granitite. Within a short distance of the east end of the portage, this rock is succeeded by breccia-conglomerate of the usual character, which outcrops on the west shore of Petrout Lake a short distance north of this portage. On the opposite side of the lake, a coarse

Ferguson and Duncan lakes.

Petrout Lake.

greenish-gray quartzite-grit may be seen resting directly upon the dark greenish-gray slaty rock. The junction is close to the edge of the water and is sharp, without any of the customary transition from one rock to the other. Both rocks dip to the east at a comparatively low angle. The southern end of Petrout Lake is a shallow muddy bay, and the portage into Lily Lake is along the boulders in the stream. The rock on the west side of Lily Lake is the breccia-conglomerate, showing the usual fragments of red granite, while on the east side the slates, which are above, are themselves overlain by the quartzite-grit that rises into rather high hills a short distance east of the lake.

Lily Lake.

A portage of seven chains separates Peeshabo Lake from Lily Lake into which it empties. The rock on the northern and south-western shores of the lake is the breccia-conglomerate presenting no unusual feature. A mass of flesh-red granite, evidently co-extensive with the one exposed on the south-eastern portion of Net Lake, comes out on the west shore of the lake, occupying a little over half a mile of shore-line and an off-lying island. On Bogie Lake, to the south of Peeshabo Lake, the prevailing rock is again breccia-conglomerate. A portage of three chains separate it from Peeshabo Lake. A trail nearly a mile and a half long runs from the south-western end of Bogie Lake to a hunting camp on the north shore of White-bear Lake, about half a mile north-east of the inlet from Net Lake. The rocky ridges over which it runs are all composed of the greenish-gray breccia-conglomerate.

Rocks seen in this vicinity.

Granite Lake

To the north of Petrout Lake, a portage thirteen chains in length leads into Granite Lake, about a mile and a half in length, although it is only about three-quarters of a mile from the portage at the outlet, to that at the mouth of the inlet on the east side, about half way up the lake. A short carry of a little over a quarter of a mile of creek intervenes before James Lake is reached. Granite Lake, as the name implies, is completely surrounded by granite, with the exception of small masses of greenstone on the southern and south-eastern shores. The shores of the southern part of James Lake show exposures of greenstone, associated with patches and areas of a dark greenish-gray felspathic sandstone through which it seems to be intrusive. The northern end of the lake is all composed of the flesh-red granitite.

James Lake.

Waibikaiginaising Lake.

The portage from James Lake to Waibikaiginaising Lake, starts from a point on the east shore of the former, about half a mile north of the outlet. It is nearly thirty-five chains in length, and comes out on the west side of a small basin, forming the south-western extremity of Waibikaiginaising Lake. The outlet of this lake flows to the south from this basin-like expansion, ultimately reaching White-bear Lake

Narrows. Rocks seen.

about three-quarters of a mile south-west of its north-eastern extremity. Waibikaiginasing or Reb Lake is a little over six miles in length, and has, in general, a trend of a little west of north. About half a mile from the northern end, a boulder obstruction, doubtless of morainic origin, runs almost completely across the lake at right angles to its general direction, leaving only a very narrow channel near the western side. The western shore of the lake, wherever rock exposures were seen, is underlain by the breccia-conglomerate presenting the usual dark greenish-gray matrix with embedded fragments and pebbles of eruptive material. The eastern shores of the southern half of the lake show rather continuous exposures of the well banded greenish, compact greywacké-slates, upon which is superimposed the coarse yellowish-green quartzite-grit, both rocks dipping to the east <25°. Both shores of the northern part of the lake are composed of the quartzite-grit as far as the inlet from Johnny Lake.

Johnny Lake.

The portage into Johnny Lake is nearly eighteen chains long and runs to the north-east of the creek connecting the two lakes. Here a mass of greenish-gray diabase intersects the quartzite, rising into somewhat high and precipitous cliffs. This belt of diabase is about half a mile in width and is evidently an extension eastward of the huge mass exposed on the shores of Annima-nipissing and Mountain lakes. The shores and islands of the northern part of Johnny Lake are composed of the massive and compact breccia and conglomerate, much jointed and broken and filled with very numerous pebbles and fragments of various eruptive rocks.

Cliff Lake. Cliff Lake to Summit Lake.

The stream from Cliff Lake empties into Waibikaiginaising Lake at a small indentation of its eastern side, a little over two miles from the south end. The portage is about thirty chains in length and runs a short distance north of the stream. The canoe-route utilizes only the northern part of Cliff Lake, coming in at the north-west corner and going out at the end of the small bay running to the north-east. The lake itself is about a mile and a quarter in length and has a general trend a little west of north. The yellowish-green quartzite-grit rises into high hills on either side of the lake, especially towards the east, where high precipices mark the western faces of hills that rise to an elevation of from 400 feet to 500 feet above the lake. These hills present less abrupt though still steep slopes on their eastern side to the west of Friday Lake. The strike of these greenish quartzites runs from N. 25° W. in the southern part of the lake to nearly north at the northern extremity, while the dip is to the east < 20° to 25°. The portage from Cliff Lake to Summit Lake follows up a steep gully, between high ridges of quartzite to the south and others of diabase to the north. The highest point on the trail is 190 feet above Cliff Lake and is only six chains west of Summit Lake, while the fall towards the latter is seventy feet. The lake itself is only a small pond about a quarter of a mile in length, the outlet flowing from the north-east comes into a beaver-meadow and thence eastwards to Friday Lake. The north-west shore of Summit Lake is composed of diabase, an extension in this direction of the band crossing the foot of Johnny Lake, while the rest of the shore-line shows outcrops of the greenish quartzite. The next portage runs from the north-east end of Summit Lake to a beaver marsh, along the eastern margin of which the path runs for some distance, when it turns eastward towards Friday Lake. Friday Lake is completely inclosed by hills of coarse sea-green felspathic sandstone or quartzite-grit. The lake has a general direction of a little west of north and is four miles in length, with an average width of a quarter of a mile. A trail a little over half a mile in length, runs from a small bay on the east side of the lake, about a mile from the north end, to a small expanse of water that we called Wilson Lake and which has the distinction of being the highest lake of which we have a record throughout the entire area of the present map-sheet, being about 1177 feet above the sea.

Summit Lake.

Friday Lake.

Wilson Lake.

Prudhomme Lake.

To the north-west of Friday Lake, a short portage runs to Prudhomme Lake, the southern part of which is extremely shallow and is inclosed by the greenish quartzite, but the narrows beyond show outcrops of diabase which appears to belong to a belt over an eighth of a mile in width, forming a continuation in this direction of the mass exposed to the north-west of Summit Lake. North-westward it runs toward the large mass which characterizes the district on either side of the Montreal River in the vicinity of Horner Chute, with which it seems to be continuous. The south-western shores of the northern part of Prudhomme Lake show outcrops of the greenish quartzite striking N. 25° W. and dipping S. 65° W. $<$ 36°, while on the opposite side the underlying slates dip S. 70° W. $<$ 35°.

Stream from Friday to White-bear Lake.

Between Friday and White-bear lakes the distance in a straight line is about six miles and a half, and the valley occupied by the connecting stream and lakes shows a gradual bending around from a little east of south to south-west. The river shows alternating deep stretches, some of them through extensive beaver-meadows, connected by narrow rocky or bouldary spaces which require to be portaged. Five portages at least have to be made before reaching the small lake crossed by Nivens meridian line, to avoid these rough pieces of stream. The streams utilized for about three-quarters of a mile below this small lake where a portage over half a mile in length is made to avoid the rough and obstructed river. A trail a little over half a mile long, runs from the foot of this portage to Bear Lake to the east of this point. Below this portage the stream meanders with a comparatively deep though crooked channel, for a distance of nearly a mile, when a short portage is made on the north-east side of the stream into Obashkong Lake. This lake is about two miles in length. Portage to Bear Lake.

Bear Lake, which flows into the Matabitchouan River below Rabbit Chute, has a general trend of nearly north-and-south, and is a little over six miles in length. It rarely measures a quarter of a mile in width. The shores are everywhere composed of greenish quartzite with some associated intrusive greenstone at the southern end. There are two outlets, both of which, however, unite in a small lake to the south. The stream is rarely travelled and the country on either side is exceedingly rough and uneven. Three small lake-like expansions intervene between Bear Lake and the Matabitchouan, united by rough rocky and usually rapid channels. The slate which underlies the quartzite is not met with till the immediate vicinity of the Matabitchouan River is reached. Bear Lake.

MACDONALD CREEK.

The rocks seen along this stream are particularly interesting and throw considerable light on the structural relations existing between the Laurentian and Huronian. The stream has never been much used as a canoe-route, and therefore need not be described at length. It consists of a series of lakes united by shallow rocky or bouldery channels, which necessitate frequent portages. From the outlet at the north-east corner of the Fourth Bass Lake on the Matabitchouan River to Moxam Lake, it occupies a gently curving valley with a general southerly direction, but the extension of this depression southward meets rising land which forms a watershed in this direction. The upper portion of the stream from Moxam to Ross Lake occupies a valley trending almost north-west. Ross Lake, marking the head-waters, is only a couple of feet lower than Rabbit Lake, a decided hollow connecting the two lakes, and during times of freshet a certain amount of the water of Rabbit Lake escapes into Ross Lake. The first three expansions at the head of this stream, viz: Ross, Burwash and Moxam lakes, differ little in level, and the short stream connecting them exhibits very little current. From Moxam Lake, however, down to the mouth, the fall is seventy feet, most of which occurs between Cooper Lake and the Matabitchouan, this distance of a little over half a mile showing a fall of fifty feet. Macdonald Creek.

Ross Lake.

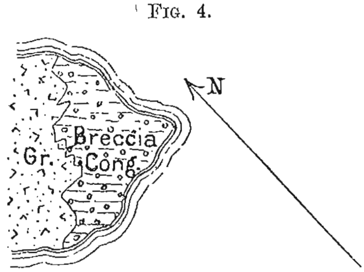
The shores of Ross Lake are composed of a coarse red granitoid-gneiss, evidently by its composition a granitite. Some portions are more basic in composition and darker in colour where the biotite has segregated during its consolidation, and these patches or areas show a very distinct foliation. In some outcrops the rock is porphyritic and the phenocrysts of flesh-red felspar are developed in a finer-grained felspathic groundmass showing streaks of yellowish-green epidote. At one point on the west shore, a mass of fine-grained greenstone was seen associated with the granite in such a way that both had apparently solidified from the same magma, differing only in their rate of cooling. The gneissic rock is certainly newer than the greenstone, irregular dyke-like masses of the former penetrating and ramifying through the the latter.

Conglomerate.

The point on the south-eastern shore of this lake towards the outlet is occupied by the prevailing breccia-conglomerate holding pebbles chiefly of reddish and reddish-gray granite. These inclusions vary greatly in size, some being as much as three feet across. Occasional fragments are quite angular in outline, some are subangular, while the majority have been more or less perfectly rounded. The contact between this comparatively small area of clastic rock and the granitite-gneiss in which it is doutless embedded was not seen, although only a short distance intervened between the exposures of the two rocks. The greater portion of the small island in the southern part of the lake is composed of coarse reddish granitite-gneiss. The island runs in a north-east and south-west direction and is about three chains in length. Its north-eastern point is composed of the breccia-conglomerate, full of small pebbles as well as angular fragments, chiefly of red and gray granite. The contact between the two rocks is sharp and jagged and re-entering angles filled with the material of one rock penetrate the substance of the other.

Contact with granite.

FIG. 4.



Scale 40 ft. inch.

SKETCH SHOWING THE LINE OF JUNCTION AT NORTH-EAST POINT OF SMALL ISLAND IN BASS LAKE.

Rocks of Burwash Lake.

The rock near the north-west end of Burwash Lake is, as a rule, well foliated and of a deep flesh-red colour, the strike being N. 19° E. and the dip north-west at a high angle. Some of the gneiss is very massive and granitoid, in places porphyritic, the phenocrysts of felspar being very sharply outlined in a dark-greenish chloritic matrix. This rock seems to be the prevailing flesh-red granitite-gneiss, the biotite originally present being decomposed to chlorite. Similar rock is present on the north-west shore of Moxam Lake, striking N. 29° E. and dipping south-easterly < 60°.

On the south-east side of Moxam Lake, in the southern part, and also in the bay running to the south-east, the gneiss is not only very distinctly foliated, but well lamianted. It is the usual interlamination of the reddish and grayish granitite, presenting the common alternation of lighter and darker coloured bands. The strike is N. 48° E., and the dip south-east < 53°. Moxam Lake.

The gneissic rocks in the vicinity of the narrows in the north-eastern part of the lake, show a gradual curving around in strike from N. 4° W. at the southern end to N. 40° E. a little to the north of this contraction, while the angle of inclination varies from 45° to 60°. At one point on the north-west shore, nearly three-quarters of a mile from the outlet, the granitite-gneiss is of a deep flesh-red colour weathering on exposure to a brick-red. It is massive, distinctly foliated, but much affected by jointing, so that it is exceedingly difficult to obtain a hand specimen. Small patches of a dark-green chloritic slate are embedded in this rock, running for the most part with the foliation. The slate is evidently much altered and full of shearing planes, which are abundantly coated with the usual greenish products of alteration. This clastic rock contains small lenticular granitite dykes, besides some ill-defined areas of a similar rock somewhat coarser in texture, that doubtless represents squeezed and stretched pebbles and fragments. The hand specimen from which the thin section examined was taken, shows a dark-green slaty rock penetrated by tongues or dykes of a dark-red felsite. Under the microscope, the dark-green portion is seen to be a typical clastic rock with subangular and rounded fragments of orthoclase, plagioclase and quartz embedded in a finer-grained groundmass composed chiefly of epidote and chlorite, which have doubtless resulted from the mutual reaction of the felspar and bisilicates originally present. Sphene in irregular grains, and some pyrite, were noted scattered through the section. The little tongues or dykes of felsite are seen to be composed of orthoclase and quartz chiefly, together with some plagioclase. The minerals are much bent, cracked and broken, and have been recemented by chlorite and epidote. The whole rock has been profoundly sheared and has evidently been derived from a fine-grained greywacké formed from the degradation of a granite, this rock being subsequently penetrated by the fine-grained felsite dykes. These dykes are all intensely shattered, and the felspar affords beauti-

Gneissic rocks in north-eastern part of Moxam Lake.

Lithological character.

ful examples of twinning striations resulting from pressure. The cracks are filled with sericite, chlorite and epidote.

Rocks on eastern shore of Moxam Lake.

On the shore south-east of the island in the northern part of Moxam Lake, the gneiss is very evenly foliated by the alternating sequence of massive red felspathic layers, which in themselves show marked parallelism, and dark-green chloritic bands, the whole dipping S. 47° E. $< 75°$. A few chains to the north-east, the ordinary grayish granitite-gneiss with very even foliation dips S. $< 40°$ E. 40°. At a point on the east side of the lake a little over an eighth of a mile from the outlet, there is a dark-green distinctly bedded rock (greywacké) associated and interfoliated with bands and irregular patches of the massive reddish granitite-gneiss intrusive through it. The rock resembles very closely a highly altered felspathic sandstone, when broken phenocrysts of felspar were noticed embedded in the grayish groundmass. The strike of the foliation is N. 13° W. and dip N. 77° E. 70°.

Slaty rocks on portage from Moxam Lake.

On the opposite side of the lake also the dark-red massive granitite-gneiss contain a good deal of the highly altered greenish-gray slaty rock. At the lower end of the portage going north from Moxam Lake, the usual reddish granitite-gneiss occurs, striking N. 30° W., and dipping east $< 50°$. Apparently caught up in the mass of this gneiss are some patches of a dark-gray slaty rock, very much hardened and altered and beautifully banded by the occurence of layers rich in yellowish-green epidote. To the north of this, almost in the bed of the stream, are outcrops of similar gneiss containing many dark-greenish bands composed chiefly of chlorite and epidote. They doubtless represent portions of highly altered clastic material and associated with these are some larger irregular patches of undoubted felspathic sandstone. These smaller interfoliated bands have evidently undergone extensive recrystallization, thus masking their original structure, but this stratified appearance is in marked contrast to the intrusive aspect of the granitite-gneiss. The foliation, produced essentially by pressure, has a strike of N. 2° W., and a dip easterly $< 65°$. A little north of the mouth of this creek, outcrops of the massive red granitite-gneiss contain squeezed fragments of clastic material often of very irregular outline, the strike of the whole exposure being N. 21° E.

Small lakes below Moxam Lake.

On the east side of the small lake below Moxam Lake, a rock composed of alternating folia of red and dark-green material was seen striking N. 2° W., and dipping to the east at a high angle. A similar rock outcrops at the southern end of Glasford Lake, the strike being N. 9° W., and the dip towards the east $< 60°$. The hand specimen examined showed a foliated rock consisting of a fine-grained chloritic groundmass of a dark-green colour, through which runs irregular wavy tongues of a bright red, fine-grained felsitic-looking rock. In its microscopic character it bears a marked resemblance to the rock occurring on the west shore of Moxam Lake, but in the case of the chlorite which is abundantly developed throughout it, its origin is plainly seen to be from hornblende, cores of this mineral occurring surrounded by the chlorite. The felspar is very turbid and is stained throughout by oxides of iron ; a bright yellow, strongly pleochroic epidote is very abundant in the section.

The southern part of Glasford Lake is occupied by the massive red gneissic granite which seems to be composed chiefly of flesh-red felspar and greenish chlorite or hornblende, or perhaps both. The strike curves around from north to north-east with an easterly to south-easterly dip 45° to $<60°$. This is followed by a compact grayish slaty rock with granite inclusions, some of which are pebble-like in outline and appearance, while others evidently represent approximately parallel small lenticular intrusive dykes of the neighbouring granitic rock. This characterizes the shore for nearly a quarter of a mile, and may represent a tongue or extension of the main mass of similar Huronian strata to the south-west. Gneissic granite at southern end of Glasford Lake.

To the northward it may be continuous with an outcrop of breccia-conglomerate, that occurs on the west shore of Cooper Lake, near its southern end. The northern part of Glasford Lake is occupied by massive red granitite-gneiss, with which is associated some greenstone, such areas seemingly representing the primary or first formed secretions from the same magma the cooling of which produced the associated granitite-gneiss. From this to the second little expansion below Glasford Lake gneiss is the prevailing rock, the strike being N. 19° E. At one point in the narrows this gneiss contains bands and small irregular inclusions of a dark-green hornblendic rock. The inlet into Cooper or Macdonald Lake is occupied by a massive red and reddish-green, often porphyritic, granitite-gneiss, striking N. 3° E and N. 11° E., and dipping to the east at high angles. Granitite-gneiss in northern part of Glasford Lake.

The shores of Cooper Lake are occupied chiefly by a flesh-red granitite-gneiss, in some cases porphyritic, weathering grayish, especially when burnt over. The foliation, which is not very apparent in places, is sometimes brought out more strongly by the more or less parallel alignment of certain ill-defined patches of more basic material. The rock is composed essentially of flesh-red felspar, chiefly orthoclase, more or less grayish quartz, this latter material being often present in vein-like streaks and patches, evidently pegmatitic both in origin and structure. The little ferro-magnesian material present is apparently biotite, which has undergone somewhat advanced chloritization. This is associated with a massive medium-textured greenstone, the irruptions of the two rocks evidently being very closely synchronous. The Shores of Cooper Lake.

prevailing strike of the foliation, wherever apparent, is from north-east to south-west. On the west shore of the lake, south of the narrows, a patch of the dark greenish-gray breccia-conglomerate comes in, apparently forming a huge mass caught up during the intrusion of the granite. It contains the usual pebble-like and other forms of granitic material, while the matrix in which these are contained has the customary dark greenish-gray colour. This rock occupies the shore for about an eighth of a mile. The contact between this clastic and the red granitite-gneiss to the north is irregular and ill-defined, irregular dyke-like forms and patches of the latter penetrating the mass of the slate. The bedding of the slaty rock abuts on the dim foliation of the gneiss, the slate striking N.N.W., while the direction of the foliation of the granitite-gneiss is south-west.

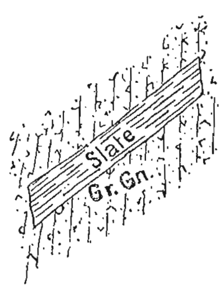
Breccia-conglomerate on west shore.

This patch of slate is interrupted to the south by a red, very felspathic, granite, which continues along the shore for about six chains, when it in turn gives place to the dark-greenish slaty rock, similar to the mass already described, which occupies this side of the lake to its southern extremity, where the low ground conceals the rock beneath. These masses may either represent detached portions of the clastic Huronian strata caught up and floated off during the intrusion of the association granitite, of whose irruptive character there cannot be a doubt; or, on the other hand, they may belong to a band or tongue co-extensive with the main mass of similar clastics to the south-east, but whose continuity at the surface is broken, or concealed by the dense forest growth. The island in the narrows of this lake, as well as the west end of the comparatively large island to the north, is composed of a greenish-gray green-stone or diabase. At the outlet of Cooper Lake, the foliation of the prevailing granitite-gneiss is marked by the parallel disposition of plates and aggregated patches of chloritized biotite. It is sometimes rather obscure, and the rock is very massive and granitic in character. The strike is N. 3° E. Embedded in this gneiss and crossing its foliation is a rudely rectangular mass of a grayish slaty greywacké. The mass is about two feet wide by about fifteen feet in length, the direction of its longer diameter being about north-east, while the foliation of the gneiss is only a few degrees east of north.

Slate interrupted by granite.

Foliation of rocks at outlet of Cooper Lake.

Fig. 5.



The rough and bouldery stream which separates Cooper Lake from the Matabitchouan River, shows outcrops of the massive reddish gneiss, the strike apparently being about N. 13°

Stream separating Cooper Lake from Matabitchouan River.

E. At a narrow gorge, through which the stream runs, a patch of greenish chloritic and epidotic schist was noticed embedded in the intrusive gneiss. The hand specimen showed a dark-green, rusty-weathering, compact, foliated chloritic rock, with numerous minute particles of pyrite scattered through it. The microscope shows it to be a typical epidotic and chloritic schist in which all traces of the original structure have been destroyed. It bears a close resemblance to those described by Dr. F. D. Adams, from the Eastern Townships*, and consists of a schistose aggregate of felspar, quartz, pale-green chlorite, epidote and pyrite. The epidote is in granules of varying dimensions, and also in crystals, which present sharply defined rhombic sections. It is strongly pleochroic. The chlorite forms pale-green folia, running through the fine-grained mosaic of quartz and felspar forming the groundmass of the rock. Many of these schists have been proved in other regions to have resulted from the shearing of a basic eruptive, and it is quite possible that this rock has had just such an origin, but, on the other hand, taken in conjunction with the other occurrences of very similar, though perhaps less altered patches of stratified material just described as having been caught up in the gneiss, it probably represents a completely recrystallized basic greywacké-slate.

Schists resulting from shearing of basic eruptives.

Between this point and the Matabitchouan there is only another rock exposure consisting of the breccia-conglomerate, situated on the west side of the small bay into which Macdonald Creek discharges, and about thirty chains to the south-east of the main channel of the river. The junction, therefore, between the granitite-gneiss, here constituting the Laurentian, and the slaty breccias of the Huronian may be put down with tolerable accuracy as running across the south-eastern end of this small bay.

OTTERTAIL CREEK.

Ottertail Creek.

Ottertail Creek (Nikig-wai-no-wai-sipi) rises in a number of small streams, draining the extensive swamps that occupy the greater portion of the north-western corner of the township of Hammell as well as nearly the whole of the timber limit 21 E. situated to the north of this township. The main branch of the creek may, however, be stated to take its rise in a small swampy lake, situated in the fifth concession of the township of Hammell on the line between lots 8 and 9. The distance from its mouth, nearly four miles north of the Opimika Narrows on Lake Temiscaming, to this small lake, is about twenty miles in a straight line bearing S. 50° W., but following the bends of the stream

*Report of Progress, Geol. Surv. Can., 1880-82.

Branch used as route to interior.

this distance is increased to a little over thirty miles. The most important branch, however, forming as it does a portion of the route occasionally used by travellers to reach the interior, takes its rise in a small beaver-pond a short distance north of the northern boundary of timber limit 12 E. This pond is separated by a portage of only a quarter of a mile from another small expansion known as Bush Lake, that flows into the Martin River, about three-quarters of a mile southwest of the inlet from Mackenzie Lake. The distance from this small beaver-pond to the mouth, following the course of the stream is twenty-two miles and a half but in a direct line, bearing S. 71° W., it is only a little over sixteen miles.

Portages on route inland.

The first portage on the route inland by way of this stream, starts from Grenier's clearing, a short distance north of the mouth of the stream and is a little over a mile in length. It runs from the valley over the high hills, that border Lake Temiscaming. The upper portion of these hills shows the usual hummocky outline which elsewhere occurs with extended exposures of the reddish gneiss. This rock is massive and granitoid in appearance, but distinctly foliated, the strike being to the north-east while the dip is to the north-west $< 65°$. The highest point on this portage is 365 feet above low water on Lake Temiscaming, while the creek reached by the west end of the portage is 180 feet above the same datum. The descent, therefore, towards the creek, though less (285) than that towards the lake, is very abrupt and steep. Four more portages intervene before the lake at the forks is reached, these showing a combined fall of nearly eight-four feet. The portages are all on the north-east bank of the river and are short, the longest being a little over half a mile. These are to overcome low rapids caused chiefly by bouldery obstructions. Between these rapids the creek is comparatively deep and about twenty yards in width, flowing with a gentle current between banks composed of coarse, yellowish sand. The water is of deep brownish colour, showing its swampy origin. The rock, wherever exposed, is the common granitite-gneiss, very massive and granitoid in structure, but with distinct foliation, striking N. 30° E., and dipping to the north-west $< 65°$.

Origin of water indicated by colour.

The main forks, where the north branch joins the main stream, is about four miles from the mouth, the creek throughout this distance having a general course of N. 76° W. The lake at this fork represents in reality the last stretch of the north branch before it enters the main stream. The name Wabamik, by which it is known to the Indians, refers to the legend that a huge white beaver formerly lived on its shores. The immediate banks of the lake are for the most part low and marshy, but two exposures of rock which were noticed resembled

Lake at forks of Ottertail. Creek.

the massive reddish granitite-gneiss striking N. 35° E., and dipping to the south-east < 70°. A few hills rise to the south of the forks, but at a considerable distance away from the creek, while the valley of the creek immediately above is wide and level. To the south-west of the lake, a rather prominent hill rises in close proximity to the shore, while to the north-east the numerous rounded rocky ridges of the usual flesh-red granitite-gneiss rise from 200 to 250 above White-beaver Lake. Hills south of forks.

Between the forks and the intersection of the Lake Temiscaming colonization road, the distance by the stream is about eleven and a half miles. In this distance there are nine portages, to overcome as many rapids and chutes. Seven of these are low rapids where the stream is obstructed by boulders, while two are chutes, the channels being comparatively narrow and cut for the most part along the strike of the foliation of the gneissic rock. The intervening stretches of quiet water, between these interruptions to navigation, average nearly a chain in length, the water being tolerably deep, and the banks on either side fringed with a dense growth of alder and willow. The stream in many places pursues a rather tortuous course through the narrow sandy flat, although some of the more prominent bends reach the solid rock on either side of the valley. Eleven portages.

At the first rapid above the forks, the stream falls about ten feet through a gorge excavated in flesh-red granitite-gneiss, well foliated and laminated, and striking N. 38° E., while the dip is to the south-east <45° The gorge or cañon runs for the most part with the foliation, but at one place it breaks across the strike of the gneissic-rocks. At the lower end of the third portage, the gneiss is the dark-gray, almost black, variety, which is at once hornblendic and micaceous, and to which the name quartz-mica-biotite has been applied. It is a glistening evenly foliated gneiss stained in places with iron oxide. The strike at this place is about north-east, thus corresponding with the general trend of the stream. Under the microscope, the rock is seen to be composed of plagioclase, orthoclase, quartz, hornblende and biotite with sphene, apatite, zircon, pyrite and limonite as accessory minerals. First rapid above forks.

At the sixth portage, (made to overcome a rapid which also flows through a rocky gorge cut out along the strike), the rock is dark-gray and micaceous, well laminated as well as foliated and striking N. 22° E. with a dip to the south-east < 45°. At the seventh portage, the rock is the fine-grained reddish granitoid variety, doubtless a granitite-gneiss. Between the bridge on the Lake Temiscaming colonization road and the forks with the main branch above, there are Rocks on sixth and seventh portage.

three obstructions in the stream. Two of these are caused by boulders, but the third, which is intermediate between the other two, shows a descent of nearly thirty feet with a portage on the south side. The rock at this place is massive and much jointed, and represents the prevailing red granitite-gneiss. At the third rapid above the bridge, the rock present is massive, rather fine-grained, reddish in colour and distinctly gneissic in structure. The thin section under the microscope shows it to be a granitite-gneiss, composed of orthoclase, plagioclase, microcline, quartz, biotite and primary epidote, the orthoclase being by far the most abundant constituent. The accessory minerals noted were apatite, zircon and sphene.

Navigation obstructed by beaver-dams.

A short distance above the rapid, the surface of the country flattens out, while the creek itself, for a distance of over two miles, pursues a tortuous course through an extensive beaver-meadow, and numerous beaver-dams obstruct navigation. It is expedient to make one long portage avoiding this portion of the creek and coming out at the south-east end of Ruth Lake. Ruth Lake, and the beaver pond beyond, marking the head of the Ottertail in this direction, are practically on the same level, and the portage connecting them runs on the south-west side of the creek. On this portage some birches, over nine inches in diameter which had been felled by beaver, were noticed. The strike of the rock in Ruth Lake is about south-west. It shows the usual alternating reddish and grayish bands which, in themselves foliated, give by their even and parallel disposition, not only a very marked foliation, but a distinct lamination to the whole mass. Under the microscope, a specimen obtained from the north-east shore shows the rock to be of the variety here designated granitite-gneiss. It is composed of orthoclase, microcline, plagioclase, quartz-biotite and primary epidote with apatite, zircon, sphene and a little iron ore as accessory minerals.

Portage from Ruth Lake to Fanny Lake.

From Ruth Lake, a portage a little over a mile and a half in length runs to Fanny Lake, at the head-waters of one of the tributaries of the Martin River. The south-western end of the portage passes over a somewhat low, though in places rocky tract, grown up with small trees. There is little soil, and the rock, when exposed, was seen to represent red and gray banded granitite-gneiss. The last half-mile near the north-east end of the portage approaching Fanny Lake is over lower land, very marshy in places.

The portage from the beaver-pond to Bush Lake is about a quarter of a mile in length, and the barometer showed the latter to be ten feet lower than the beaver-pond. The shores of Bush Lake are comparatively high and for the most part rocky. A hill rises close to the south-west shore of the lake to a height of about 150 feet. The rock which, is frequently seen is a granitite-gneiss, well foliated, but somewhat massive and granitoid in structure. The strike is N. 45° E. and the dip south-east < 50°. The portage from Bush Lake to the Martin River, into which it empties, shows a fall of about forty feet. The trail starts from the north-east side of the creek, but crosses over to the south-west side. It shows evidence of having been but slightly used. Indeed the whole route inland by way of Ottertail Creek is but little known and therefore rarely used, and as the beavers have been nearly all exterminated in the vicinity of its banks, it has been but little frequented of late years for hunting purposes. Occasional beavers, however, still reside along the course of the creek, as abundant work done quite recently showed.

Route by Ottertail Creek little known.

Bay Lake to Lake Temagami, by way of Annima-nipissing, Carrying, and Red Squirrel Lakes.

This route commences at a small marshy bay on the south-west side of Bay Lake, about one and three-quarter miles south-east of Bay Lake post. The narrow and crooked, though navigable, channel of the small inlet that enters the lake at this point, is followed, a short distance, to the foot of the portage. The portage is in reality a winter road, built in 1891 by Father Paradis to take in supplies from Bay Lake to Temagami, and is a little over one mile and a quarter in length of almost continuous climbing, reaching Annima-nipissing Lake at the extreme north-eastern corner. The trail follows up a valley, which, as the summit is approached, becomes very narrow, the hills of quartzite-grit on either side approaching each other very closely, while a talus of angular blocks detached from the heights above still further obstructs the narrow pass. At the summit, a sort of *cul de sac* occurs, the steep slope facing towards Bay Lake, but once this sharp incline of fifteen feet is surmounted, there is a gradual descent of about ten feet to Annima-nipissing Lake. This lake is about one hundred and eighty feet above Bay Lake or 1073 feet above the sea, while the highest point on the portage, only a short distance from Annima-nipissing Lake, is only ten feet higher.

Route from Bay Lake to Lake Temagami.

Annima-nipissing Lake.

Annima-nipissing or Aminipissing Lake, (the name meaning the head of the Nipissing waters), runs in a general direction of S. 30° W. for nearly ten miles. It is separated from McLean Lake, to the south-west, by a small narrows, containing a rapid, and which although showing a decrease in level of about two feet, is sometimes described as

General description.

forming part of the larger expanse. This important sheet of water is divided into three portions, separated by two narrows. The most northerly of these stretches, has a length of four miles and three-quarters and varies from a quarter of a mile to a mile in width. The central portion is much smaller and presents a much more irregular outline. One of the bays running to the south-east affords an entrance to an inlet from Breeches Lake, on the road to Mountain Lake, at the head-waters of the main branch of the Matabitchouan River. A somewhat longer arm running a little west of south, approaches very close to the waters of Mannajigaina Lake, while still another extension, running to the north-west, receives the small creek from Pickerel Lake, from which it is separated by a portage only a few chains in length.

Description of southern part.

The southern part is about three miles and a half in length and is over half a mile wide. It likewise has an irregular shape, a large bay running to the north-west for nearly two miles from the northern end of the stretch. About a mile and a half from the outlet into McLean Lake a small stream enters, forming the outlet of Whitewater and Diabase lakes. Several soundings were taken in places reported to be exceedingly deep. One of these places, situated about the middle of the lake, opposite Crow Rock and a little over a mile from its northern end, showed a depth of ninety-three feet, while another sounding, taken about the middle of the large open space in the central part of the lake, gave 100 feet. The water has the clear and limpid character and light sea-green tint of Temagami, although in point of clearness and purity both of these lakes are excelled by Whitewater Lake, lying to the west of the southern part of Annima-nipissing Lake.

Arkose of Bay Lake extending to Annima-nipissing Lake.

The coarse quartzite-grit or arkose occurring on Bay Lake, extends to the tract passed over by the portage entering the north end of Annima-nipissing Lake. It also extends down the eastern shore of this lake for nearly three-quarters of a mile, when it gives place to a coarse gabbro that occupies the shore for over a mile further south. The rock, as here exposed, is rather coarse in texture, and is characterized by the presence of reddish felspar, in this respect resembling certain portions of similar irruptive masses to the north-west of Bay Lake, as well as at Quinn Point on the east shore of Lake Temiscaming. Near the line of junction with the gabbro, the quartzite has been considerably altered by its intrusion, the alteration consisting chiefly in a hardening due to the secondary enlargement of the original quartz grains and the deposition of intersticial silicia. On the west side of the lake, this arkose forms a perpendicular cliff about a hundred feet in height, known as Crow Rock, and, continuing down

Quartzite altered by intrusion of gabbro.

along this shore occupies the greater part of the southern shore of the bay running to the south-west. The large island, as well as the much smaller one to the north-east, is composed of massive greenstone or gabbro, but the island lying close to the shore to the south-west of these is formed of the slaty greywacké, underlying the arkose. On the point to the south-west of the large island, a considerable inlier of banded slate appears to have been caught up in the mass of the greenstone during its irruption, and the bedding of the slate well marked by the alternating colour-bands, shows an inclination N. 50° W. < 15°.

Distribution of greenstone and greywacké.

The relative distribution of the greenstone and slaty greywacké, the latter being the prevailing clastic rock, is shown on the map. The diabase gabbro forms a series of high hills which are in marked contrast to the flat topography characteristic of the areas underlain by the slates. On the west side of the lake this greenstone sometimes forms the shore-line, while elsewhere it is replaced by a strip of the slaty greywacké only a few chains in width. The clastic rocks in this portion of the lake have a prevailing dip to north-east or north-north-east at a low angle, usually less than 10°. The southern and south-eastern shores of the central portion of the lake show somewhat extended exposures of greenstone, both gabbro and diabase being present in the same mass. To the south, these rocks seem to merge gradually (through a massive grayish or pale-pinkish gneissic granite well exposed on Mannajigaina Lake), into the mass of flesh-red granitite and granitite-gneiss, that prevails over such a large area to the south and south-west. The field relations of these several rock-types, seems to furnish considerable proof that all three have originated from the same magma, differing only in their rate and manner of cooling. The irregular point of land on the north-west side of the lake, between its northern and central portions as well as the extreme point on the east side of the narrows, is composed of rather flat-lying slaty strata. On the west side of the southern stretch of Annima-nipissing Lake, is a range of hills composed of irruptive material, chiefly a rather coarse-grained granite.

Field relations of irruptives show same origin.

Breccia-conglomerate.

Closely associated with the last-named rock, is that to which the name breccia-conglomerate has been applied in this Report. The matrix is, in general, a dark grayish-green chloritic and epidotic greywacké, inclosing numerous fragments of various irruptive rocks, those of flesh-red granite being the most abundant. These are often quite angular in outline, occasionally showing re-entering angles, although usually they possess a more or less perfect rounded outline. These larger fragments include pieces of flesh-red felspar and grayish quartz or quartzite, red and reddish-gray granite, fine and medium-textured diabases and sometimes diorites of several species. Occasionally fragments of a greenish slate, apparently identical with some classified as Huronian, were also noticed. This coarse material is occasionally so abundant that little of the finer matrix is represented, while, elsewhere, only an occasional pebble or fragment was noticed, the rock passing upward into a distinctly banded slate, which is usually entirely free from such inclusions.

Component fragments.

Hills chiefly of granite and diabase.

The greater portion of these hills is composed of a very pale flesh-coloured granite, which is associated with and apparently merges into a greenstone or diabase. One point shows a prevalence of the granite with bands and patches of the greenstone scattered through it, while other outcrops, not very remote, exhibit a preponderance of the greenstone, with irregular dyke-like forms of granite penetrating it in all directions. Both granite and greenstone invade the breccia, while fragments of the latter are caught up in both of these intrusives. The contact between what is evidently a pyroclastic rock and the igneous intrusives, is a curious wavy line, which in places can be laid down with exactitude, while a short distance away there is apparently a comingling of the two rocks through fusion, that causes a seeming transition from one to the other. The history of the formation of these several rocks, would seem to indicate that the granite and greenstone represents differentiated irruptives, forming the original deep-seated portions of an old centre of volcanic activity, which subsequent erosion and denudation have exposed at the present surface. The breccia-conglomerate, on the other hand, doubtless constitutes the lower portion of the associated volcanic breccia, formed by the accumulation and consolidation of portions of the various strata rent asunder during the progress of the eruption, this resulting pyroclastic material being spread out upon the bottom of a shallow ocean, where it has become rolled, sorted, and possibly mixed with ordinary aqueous sediments. The overlying slates show very little sign of aqueous abrasion, while in their composition and appearance under the microscope they closely resemble fine-grained tuffs, representing the consolidation of the first volcanic ash beds.

Mode of formation of rocks probably different.

Whitewater Lake.

Whitewater Lake (Kawabish-kagama) is an irregular sheet of water running in a general direction of a little north of west for about three miles. It empties from the west into Annima-nipissing Lake about one mile and a half north-east of the outlet into McLean Lake. A short portage, over exposures of breccia-conglomerate, follows to the north of the discharging creek. A belt of diabase runs from the western shore of Annima-nipissing Lake to the south of this lake, forming the points of the small peninsulas near the west end of the lake, and connecting with the large mass of similar rock to the west and north. The clastics associated with this greenstone include the massive, dark greenish-gray greywacké with or without large inclosed pebbles and fragments. Diabase Lake, about a mile in length, is separated from Whitewater Lake to the south, into which it empties, by a short portage, and, as its name implies, is completely inclosed by greenstone, that to the north-west of the lake rises into considerable hills. Gull Rock Lake is reached by a portage considerably over half a mile in length from the north-west end of Pickerel Lake. It is so shallow that the Indians assert that during severe winters it is frozen solid to the bottom. Its outlet, leaving the north-west angle of the lake flows into the Montreal River a short distance below Pork Rapid. It is completely surrounded by low hills of the coarse quartzite-grit or arkose. Diabase Lake.

Mannajigama (Ugly-running) Lake and Snake Lake (Nakwaganak) lie a short distance to the south-east of the southern part of Annima-nipissing Lake, the former being reached by a portage about thirty chains in length, running from the extremity of a bay on the east side of Annima-nipissing Lake, about two miles and three-quarter from its outlet to McLean Lake. The shores and islands of Mannajigaina Lake, which runs west for about two miles, are composed of a grayish and pale flesh-coloured gneissic granite, the foliation, though at times somewhat indistinct, being nearly always discernable. Snake Lake, the lower of these two expansions, is also surrounded by a very similar intrusive rock, with the exception of the south-eastern corner, where a comparatively large patch or area of the breccia-conglomerate is exposed. The immediate shore-line, on this side of the lake, is occupied by a narrow strip of granite, while, immediately to the south, the breccia-conglomerate forms a rather high hill, with a dip to the south $< 8°$. The contact between the breccia and the granite is at times very sharp and distinct, when it exhibits a curved or sinuous line, but at other times there is a narrow brecciated zone, caused by the invasion of the breccia by the granite and the inclusion of fragments of the former in the latter. Lakes south-east of Annima-nipissing Lake.

The eastern shore of the southern part of Annima-nipissing Lake, is composed of the dark greenish-gray greywacké-slate, containing fragments and pebbles of granite and other irruptive rocks. The slaty rocks characterize a band on this shore varying from an eighth to a quarter of a mile in width, while the south-eastern part of the two small Rocks on south-eastern shore of Annima-nipissing Lake.

bays that indent this shore-line, show continuous outcrops of a flesh-red gneissic granite. On the south side of the more northerly of these two indentations, the immediate contact between the granite and the slates was noticed, the latter rock dipping N. 50° W. <50°, while the foliation of the granite has an inclination S. 87° E. <70°. At the foot of the more southerly of the two bays, the foliation of the granite-gneiss has a strike of N. 47° E., and a dip to the north-east <45°

McLean Lake. The greater part of the north-western shore of McLean Lake, is composed of a very much squeezed and altered chloritic greywacké-slate. This likewise occupies the points on the south-eastern shore, but the granite-gneiss crops out all along the bottom of the bays as well as along the sides towards the south and south-east. *McLean Lake to Carrying Lake.* The portage from McLean Lake to Carrying Lake (Kecheonai) is nearly thirty-five chains in length, and the rock, abundantly exposed, is a coarse flesh-red gneissic granite, the foliation being marked by the parallel disposition of chloritized scales of biotite. In composition the rock is a granitite, being composed chiefly of orthoclase, quartz, biotite, decomposed to chlorite, with smaller quantities of epidote and sphene. The strike of the foliation on Carrying Lake is N. 42° E., with a dip to the south-east. The contact between the granite and the breccia-conglomerate runs across Carrying Lake near its centre, the clastic rock having a strike of N. 72° E., and a dip to the north-west < 60°.

Portage to Red Squirrel Lake. The portage into Red Squirrel Lake (Atchimo) is over half a mile long, and shows, at the beginning, exposures of breccia-conglomerate. Outcrops of the same rock are very abundant on Red Squirrel Lake, and on one of the small islands, the granitic and diabasic fragments and pebbles are so abundant that very little of the dark-greenish chloritic matrix can be seen. On the south-east side of the lake, this rock rises into hills about three hundred feet in height, dipping S. 17° E. <45. To the west and south-west of Red Squirrel Lake, steep hills of diabase rise to a height of nearly four hundred feet above it. The portage from Red Squirrel Lake runs to a small marshy expansion of the Annima-nipissing River, starting from the end of a small bay on the west side in which is the outlet.

Trail crossing Annima-nipissing River. The trail is about fifty chains in length, crossing the Annima-Nipissing River or outlet by means of a small-rocky island about a quarter of a mile from the lower end. The rock at this point is the prevailing breccia-conglomerate containing chiefly granite fragments. Between Red Squirrel Lake and the crossing of the river, the portage passes over a sharp and steep esker-like ridge of sand that runs about north-and-south, corresponding with the direction of ice-flow in this locality. From the foot of the portage it is nearly three-quarters of a mile down the stream to its mouth on Sandy Inlet at the north end of Ferguson Bay on Lake Temagami.

SHARP ROCK INLET (TEMAGAMI) TO MATTAWAPIKA (MONTRAL RIVER.)

Nonwakaming and Lady Evelyn lakes, which occupy this interval, have of late years become rather well-known topographical features, as they form a considerable portion of a favourite canoe-route between Lakes Temiscaming and Temagami, commencing at the long portage which runs from Haileybury post-office to Sharp Lake. The distance by the Haileybury route, following Sharp and Mud lakes and the Montreal River, is about seventy miles, to the Hudson's Bay Company's post on Bear Island in Lake Temagami, while from the mouth of the Matabitchouan River on Lake Temiscaming to the same place the distance is only forty-three miles following the canoe channel. *Nonwakaming and Lady Evelyn lakes.*

The first portage from Lake Temagami to Nonwakaming Lake, is about a quarter of a mile in length and is situated on the north-east side of the stream, which, during the earlier months of summer, only serves as a northern outlet of Lake Temagami. The trail is strewn with angular fragments of the subjacent light-green banded slate, this fact having suggested the name "Sharp-rock Portage," by which it is known. Nonwakaming Lake is sometimes also called Diamond Lake. The first-mentioned name is of Chippawa derivation, referring to the fact that five portages afford an exit from the lake in as many different directions. These include, first one running to the south-east towards Lake Temagami. The western bay affords a route going to the south-west towards Wakémika Lake and another to the north-west, a long portage connecting the waters of this lake with an expansion that empties into Sucker-gut Lake. The two other trails issue from the northern bay, one running north-west to Sucker-gut Lake, while the other turns to the north-east into Lady Evelyn Lake. From Sharp Rock portage to the route affording an entrance to Lady Evelyn Lake, the distance is three and three-quarter miles, in a general direction a little west of north, the portage and the outlet of the lake being situated close together on the east side of the lake, about three-quarters of a mile from the end of the long bay that extends in this direction. *Portage from Lake Temagami to Nonwakaming Lake.*

The larger part of the area of the lake is an arm running in a direction a little north of west, for about five miles, with an approximate average width of half a mile, ending in two subsidiary bays, the smaller one running to the north-west, while that to the *Description of Nonwakaming Lake.*

south-west continues for nearly two miles further. The eastern side of the lake is flat and the ends of the bays are low and marshy, while the shores along the west side present the steeply sloping sides of bold rocky hills that come close to the edge of the water.

Rocks exposed.

The rock exposed on the east shore, is an evenly banded greenish slate, the planes of cleavage corresponding with those of the bedding. This slate occupies the whole of that shore as well as the two smaller islands close by. In strike, it exhibits a gradual curve from N. 20° W., in the south-eastern part, to N. 20° E. in the vicinity of the portage going to Lady Evelyn Lake; while the angle of dip, always in a westerly direction changes from 8° in the southern portion to 45° along the east side near the north end. This rock exhibit a transition upward through a more massive dark greenish-gray slaty rock, that occasionally shows the colour-bands so characteristic of the strata beneath, into a compact greenish felspathic sandstone, which, in turn, merges above in a rather coarse quartzite-grit or arkose. The gradual transition is well shown on the two larger islands situated near the centre of the open space formed by the junction of the several bays. The arkose occurs in very thick beds, generally well jointed, but so massive that, usually, it is difficult to ascertain its true dip or strike. As a rule, the rock is of a pale yellowish-green or grayish colour. The fragments usually apparent to the eye, consist of a pale reddish or grayish felspar with a much larger proportion of grayish or colourless quartz, embedded in a matrix composed chiefly of minute scales of yellowish sericite. In places along the north shore of the western bay, some of the beds are of a distinct flesh-red colour, being with difficulty distinguishable from ordinary granite, from the degradation of which they have evidently been formed. Under the microscope this phase of the rock is seen to differ from the prevalent greenish type, in that the felspathic and quartzite fragments are little rounded and accompanied by little sericite.

Their strike.

Transition from slates to arkose.

Shores of western bay composed of quartzite-grit.

This quartzite-grit occupies the shores of the western bay of Nonwakaming Lake exhibiting a prevailing dip to the east of north-east < 12° to 15°. The small bay forming the south-western end of the lake shows an intricate labyrinth of narrow channels, separated by small rocky, hummocky or subangular masses of the quartzite-grit, the brook emptying the little expansion to the south-west through a narrow valley of a somewhat similar character. The rocky portage, which is scarcely a quarter of a mile in length, leads to a little lake which is completely inclosed by ridges of the arkose. The trail from this pond to the north-west bay of Wakémika Lake is somewhat longer, and passes over ledges of the quartzite-grit. Wakémika Lake is a little over three miles in length, and the main portion shows a width of over two miles. The north-eastern bay is almost completely separated from the rest of the lake by two opposing ridges of sand which leave a very narrow intervening channel with a gentle current. A considerable bay on the western side of the lake is formed by the projection of a long narrow point or peninsula from the southern shore. The outlet of the lake is into Obabica Lake, about two miles distant to the south-east, with only two intervening portages. The lake has been excavated for the most part in the massive or upper part of the prevailing banded slates, that here a dip N. 75° E. < 12°. At one place on the south shore this slate is seen to have developed a perfect cleavage, striking N. 20° W., and dipping west < 80°. These slates show the usual transition upward, through a narrow belt or zone of fine-grained greenish felspathic sandstone, into the coarse-grained light grayish-green arkose, whose massive beds dip to the east < 15° The eastern shore of Wakémika is composed of the same arkose dipping east < 12°. These quartzite-grits on the east side of Wakémika Lake, as well as those forming the shores of the western portion of Nonwakaming Lake, occupy the upper part of a low synclinal basin, resting conformably upon the slates and slaty greywackés exposed on the southern shores of Wakémika Lake and on the eastern side of Nonwakaming Lake.

Wakémika Lake.

Outlet into Obabica Lake.

On the west side of the northern bay of Nonwakaning Lake, the greenish arkose is overlain by a grayish vitreous quartzite, very much sheared and broken, the pressure- and fracture-planes being coated with brightly glistening scales of yellowish-green sericite. The rock is made up almost wholly of grayish translucent quartz with a lesser proportion of felspar, some of which has been converted into this hydrous form of muscovite by dynamic action.

Greenish arkose and quartzite.

The portage from Nonwakaming to Lady Evelyn Lake is about twelve chains in length, and is used to avoid a chute and rapids below with a total fall of about twenty-five feet. Lady Evelyn Lake (so named in 1888 by Dr. Bell) is known to the Indians as Muskananing (the haunt of the moose). It measures nearly twenty-two miles in length from the portage entering the south end to the rocky obstructed chute which marks the outlet into the Montreal River. The trail reaching the south end shows exposures of greenish slate, containing coarser interlaminated beds of a fine-grained greenish-gray felspathic sandstone, all having a distinctly bedded character. These partings of greywacké, which vary from a few inches to a foot or even

Lady Evelyn Lake.

Rocks seen.

more in thickness, weather to a pale-purplish colour. The strike changes from N. 40° E. to N. 20° E., the various exposures showing marked evidences of considerable tilting and dislocation; the angle of inclination being unusually high, from 38° to 53° in a north-westerly direction. For three miles north of this portage the lake is narrow, being for the most part either obstructed by the loose masses of the prevailing slate or cut up into a number of channels by a series of small islands.

Microscopical character of clastic rocks.

The general trend of the shores, on either side, corresponds rather closely with the strike of the inclosing slates which is N. 20° E., while the dip is in a direction of N. 70° W. < 5° to 10°. The hand specimen collected as typical of the rock occupying this interval, is a light greenish-gray fine-grained felsite, of which the jointage-planes are coated with hydrated peroxide of iron, while the weathered surface exhibited a pale flesh-red tint. A thin section shows the rock to be composed of orthoclase, quartz and plagioclase, the first-named mineral being the most abundant, while only occasional individuals of plagioclase were noticed. The fragments are very uniform in size and show little or no interstitial matter. They are angular or subangular in outline, frequently interlocking with one another. The section evidently represents a clastic which has suffered little from aqueous abrasion, while subsequent incipient recrystallization has concealed, in many instances, some of the rounded outlines due to the action of water. Irregular scales and plates of chlorite are present, as also a small quantity of iron ore, the abundance of the former giving to the whole rock-mass its decided greenish colour.

Rocks south of wide part of lake.

About three-quarters of a mile to the south of the large opening that constitutes the main body of the lake, these fine-grained felspathic sandstones or felsites are interrupted by a mass of medium-textured diabase that crosses the lake. Northward it extends along the east shore for a distance of over four miles, being succeeded in this direction by a compact fine-grained greenish greywacké that dips to the west <10°. On some of the islands lying near this shore, a beautifully banded or foliated tufaceous rock was noticed which is intimately associated with the diabase. The latter likewise occupies the south-west shore of the main body of the lake, and also the three large islands in that neighbourhood as well as a small strip on the western side, the continuity of the mass being broken by the appearance at the coast of an area of very massive vitrious pinkish or grayish quartzite which dips to the west <45°.

For the next succeeding six miles, the lake has an average width of over two miles, while it is sometimes as much as three miles. A chain

Rocks of the islands.

of islands, however, that runs up the centre, as well as a considerable number of islands, both large and small, near the eastern side, conceal much of its true size. The islands in general are low and have a somewhat irregular outline. Those in the southern part are composed of a dark greenish-gray felspathic sandstone, with a decided slaty cleavage, in places corresponding to certain distinctly alternating bands of grayish-green colour, which show a prevailing dip to the east < 5° to 12°. Under the microscope, the rock is seen to be a felspathic sandstone made up of orthoclase, quartz and plagioclase, imbedded in an abundant felspathic matrix, much of which has been decomposed to yellowish-green sericite. This slaty graywacké evidently occurs in a series of low undulating troughs, for on the west shore in the vicinity of perpendicular rocky cliffs, a somewhat similar rock is seen dipping N. 70° W. <12°; while still further north along the same shore the dip is S. 70° E. <3°. A hand specimen of the rock from these cliffs, shows a dark greenish-gray rather fine-grained, felspathic sandstone weathering to a deep brown colour. Under the microscope it is seen to be composed of angular, subangular or rounded grains of quartz, orthoclase and plagioclase, imbedded in a groundmass relatively small in quantity, composed of a confused aggregate of minute yellowish-green sericite scales. Occasional fragments of zircon are present and a considerable quantity of iron ore, some of which is ilmenite, as it is seen altering to leucoxene. A large amount of chlorite is present in irregular scales and plates scattered through the rock, and this, together with the sericite and iron ore, give the rock its prevailing dark greenish-gray colour.

Lithological character.

Islands in northern part of lake.

The islands in the northern part of the main body of the lake are composed of more massive and quartzose sandstones, which, as the Obisaga Narrows is approached, assumes more closely the appearance and composition of the prevailing arkose.

Flesh-red arkose.

On the north-east side of the hill, near Wendabin's house, to the north-west of Lady Evelyn Lake, the arkose shows massive beds of a pale flesh-red colour. To the eye the rock closely resembles a granite, but under the microscope its clastic character is clearly seen, and the texture varying considerably in different parts of the section. Quartz, orthoclase and plagioclase are thickly crowded together and are connected by comparatively little sericitic matrix. This can, however, be seen forming at the expense of the felspar. There has been some enlargement of the grains by subsequent growth, so that in spite of their clastic character they often interlock with irregular sutures.*

* Annual Report, Geol. Surv. Can., vol. V. (N.S.), p. 68 F. Section, No. 25.

Country west of Lady Evelyn Lake.

To the west of Lady Evelyn Lake, the country is comparatively flat for a considerable distance, and is composed, for the most part, of a fine-grained, somewhat massive dark, greenish-gray greywacké. This merges gradually upward into the coarse quartzite-grit or arkose, that constitute the range of high hills of which Maple Mountain (so-called by Dr. Bell in 1888), the highest part, is situated almost directly over the western border of the Lake Temiscaming Sheet. Specimens of the rock obtained by Dr. Bell, in his ascent of the mountain from the east side, showed the lower portion of this arkose to be a rock not unlike a rather fine-grained granite. This is interlaminated with small greenish bands in which sericite is relatively much more abundantly developed. The rock was examined by Dr. G. H. Williams and shown to be an arkose sandstone, although the grains are mostly angular and often much fractured. They consist of quartz, orthoclase and plagioclase. Neither mica nor chlorite occur in this section, except as a component of the sericitic groundmass, which is somewhat abundant. Stains of ferric hydroxide are plentiful and impart the reddish colour to the rock. At the High Pond on Maple Mountain, the rock is a pale yellowish-gray quartzite, showing distinct, more or less rounded pebbles, which in appearance closely resemble their matrix. Sericite is also abundant, visible to the unaided eye. The microscope shows this rock to be composed of angular, or but slightly rounded grains of granitic quartz, full of fluid inclusions, which are embedded in a groundmass of sericite and finer quartz fragments. These quartz grains or fragments differ greatly in size, but are under a millimeter in diameter. Felspar substance is now rare, although once present, it seems under the influence of dynamic action to have passed into sericite or muscovite. In a matrix of this character medium sized pebbles are embedded. These differ from the matrix principally in having a more silicious groundmass, *i.e.*, they are freer from the sericite. They are, however, coated with a membrance of sericite, as is apt to be the case with squeezed conglomerates or grits. The rock shows distinct evidences of the action of pressure, and the development of its mica is probably due to this agency.*

Quartzite-grit of Maple Mountain.

Obisaga Narrows.

At the Obisaga Narrows, the pale greenish-yellow or pale flesh-red arkose forms perpendicular cliffs on the south side, a talus of angular blocks lying at the foot. It occurs in thick, massive, much jointed beds dipping to the south-west $<28°$. This rock occupies the shore on both sides of the narrows, extending beyond for a distance of about three-quarters of a mile, where it gives place to and is underlain by the banded slate. There is again a gradual transition downward

* Annual Report, Geol. Surv, Can., vol. V. (N.S.), p. 63 F.

through a massive and compact slaty greywacké into the readily cleavable and thinly bedded, distinctly banded slate beneath. This succession may be well seen on the south shore of this portion of the lake about three-quarters of a mile west of the Obisaga Narrows. The prevailing topography of the country to the eastward undergoes a marked change in outline and from the narrows, known to the Indians as Obashingwakoka, to the point where the lake turns abruptly to the northward, the shores on either side, especially that to the south, are low and marshy, with only small hillocks, points and beaches of yellow sand. The lake is correspondingly shallow, with but a narrow channel among water-weeds.

Northern portion of Lady Evelyn Lake.

Before entering the portion of the lake known to the Indians as Ko-ko-ko-wa-bikon, and often referred to at the present time as the Mattawapika, (although this name should rightly be restricted in its application to the immediate vicinity of the outlet of the lake) the water is divided into two channels, separated from one another by an intervening low swampy island. The channels on either side are only about thirty feet in width and both of them show a considerable current, which is likewise sensibly felt in some of the shallower and more obstructious portions to the west. A mass of diabase of dyke-like aspect crosses the eastern point of the island, forming the rocky barrier broken through by the waters of the lake. The diabase band, (which is an extension to the northward of the large or main mass of similar rock), is about a quarter of a mile in width, and runs parallel to the lake forming its immediate western shore-line for the greater part of this last stretch before emptying into the Montreal River. This western side is, as a rule, steep and precipitous and the basin occupied by the waters of this part of the lake has been excavated, for the most part, along the line of junction between the diabase and the neighbouring slates exposed on the east side These slates are banded and rise into rather prominent and steep eminence, the beds dipping to the east at low angles. The contact between the two rocks is well exposed at a point on the west shore about one mile and a half south of the outlet. The diabase is distinctly intrusive through the slates, disturbing and altering them, while veins of quartz containing disseminated sulphides fill the irregular fissures formed during the irruption. At the outlet, the slates present beautiful alternating colour-bands of greenish and purplish shades running with and indicating the lines of stratification, the dip being to the south-east $< 18°$. The outlet shows a series of small rocky islets composed of these slates between and over the outcropping ledges of which the water pitches in a fine cascade about twenty-five feet in height. The presence of this chute with its

Steep cliffs on western side.

rocky environment suggested the name Mattawapika, by which this locality is known to the Indians.

Lake Temiscaming (Haileybury P.O.) to Bay Lake (on Montreal River).

Routes from Haileybury to Bay Lake.

From Haileybury, situated on the west side of Lake Temiscaming, in the township of Bucke, to Bay Lake, on the Montreal River, there are two alternative routes. The shorter and more direct, by Sharp and Loon lakes to the north-east end of Portage Bay, is, however, that least used, chiefly on account of the greater length of the portages. But apart from this, the route offers many advantages over the other. The portage from Haileybury (Matabisataganing) to Sharp Lake is by a tolerably good wagon-road, a little over six miles in length, that crosses a somewhat flat country, with, however, a general slope towards Lake Temiscaming. The rock beneath is concealed by what seems to be a good depth of soil, composed chiefly of clay, although in the vicinity of Sharp Lake there are occasional outcrops of the greywacké slate. The forest growth in this interval is chiefly remarkable for large specimens of both cedar and poplar, probably the finest noticed in the whole district.

Sharp Lake.

Sharp Lake (Agwasabanishing) is comparatively narrow, running north-and-south, and a little over two miles in length. The northern portion presents occasional outcrops of the well banded slate, dipping in a northerly direction at an angle not far removed from the horizontal. On the west shore of the lake, in close proximity to the slate exposures at the first narrows south of the portage, and extending for a distance of a quarter of a mile, are outcrops of a medium-textured greenish and greenish-gray diabase, which evidently forms the extension in this direction of the large mass that runs towards Lake Temiscaming and the Montreal River. The southern half of Sharp Lake has low, sloping shores, which are for the most part densely wooded and show no rock exposures of any kind.

Portage to Loon Lake.

The portage to Loon Lake, starts from the bay on the west side near the southern end of the lake, and is nearly two miles in length, passing through a level country underlain by coarse sand and gravel. Loon Lake itself is only about three-quarters of a mile in length, of a rudely oval outline, exhibiting low swampy shores, composed for the most part of coarse sand with no outcrops of rock. The Indians call this lake Ka-mang-onsiwing. The portage from Loon Lake to Bay Lake is about two miles and a half in length, and also runs through a comparatively level stretch of country, apparently underlain by diabase. A portage between a quarter and half a mile in length separates Sharp Lake from Mud Lake (Ka-wabijish-keewaga) into which it drains. This is somewhat larger in size than Sharp Lake, though very shallow, and has the same general direction. The shores of Mud Lake are low, and there is not a single rock exposure throughout the whole extent of the shore-line, which consists of coarse sand and rounded boulders. The portage from Mud Lake to the Montreal River is a little short of half a mile, running through a sandy flat between hills of diabase, which rock occasionaly, outcrops close to the path. To the north and east of Mud Lake there are several small lakes, most of which drain north-eastwards towards Farr Creek. Bass Lake is a beautifully clear and limpid sheet of water, and is apparently fed by springs. This lake is almost on the same level with Mud Lake, into which it empties, and from which it is separated by a short portage.

Mud Lake.

Bass Lake.

The portage to Clear Lake, at the head of the west branch of Farr Creek, starts from the north end of Mud Lake, about an eighth of a mile south-east of that going to Sharp Lake, and is over three-quarters of a mile in length. It passes through woods composed chiefly of poplar and soft maple, and over ridges of greenish diabase or gabbro, the summit rising about two hundred feet above Mud Lake. Clear Lake, as well as the much larger one to the north-east, into which it empties, and which on account of its numerous islands and bays, is called Sasaganaga Lake, are surrounded on all sides by well wooded ridges composed of diabase and gabbro. Fragments of the banded slate were noticed embedded in the eruptive. Both these lakes and the stream which forms this outlet, constitute portions of a route to Lake Temiscaming which is now practically abandoned.

Clear Lake and Sasaganaga Lake.

Lake Temagami.

This name is of Chippewa derivation, meaning "deep water." Other names, Temagaming, Temagamang and Tamagamingue, often applied to it, are different methods of spelling the same word, while the additional ending "ing" or "ingue" is simply a locative affix denoting "at" or "towards the place of."

Lake Temagam

In shape, the lake presents long and often branching arms reaching out in various directions from a somewhat stunted body. The main part of the lake, which occupies an approximately central position with regard to the different large bays, covers roughly an area of about twenty-five square miles, although the greater portion of this space is dotted with islands, some of which are of large size. The water superficies of the various large arms represent an additional seventy-five square miles, making a total of one hundred square miles. It has a general north-and-south direction, and its greatest length, from the southern end of the south-west arm to the northern extremity of Whitefish Bay, is twenty-eight miles and a half in a straight line, although the most direct canoe channel between these two points measures thirty miles. In width, from the western shore of the main body of the lake to the portage running to the Caribou Lake portage, it is sixteen and a half miles in a direct line. The most important of the many bays that form so large a part of this lake, is the North-east Arm, extending from Point Matagama to the Caribou Lake portage, a little over twelve miles, in a direction about N. 60° E., and varying in width from half a mile to a mile. To the south of this, Muddy Water, Cross and Portage bays indent the eastern shore-line, the first-mentioned being about four miles long and half a mile wide. The South Arm lies almost directly north-and-south, and is about seven miles in length, from a mile to over two miles in width. The southern and south-eastern shores present a series of smaller bays, the largest of which affords an exit to the chief outlet of the lake, a steep rapid known as the Temagami Chute, separating these waters from those of Cross Lake. The South-west Arm is almost completely cut off from the main lake by Narrows Island. The connecting channel to the south-east of this island, is very narrow and crooked, while that between the island and the western mainland has a width of a little over an eighth of a mile. From this narrows the bay extends for about three miles, gradually bending around to the south, which trend is maintained for a little over six miles further, when it branches into two smaller bays, one running to the south-west and the other to the south-east for a distance of about two miles in each case. The width is very variable, in some cases the shores being separated by a distance of over two miles, while in the more contracted portions they usually approach within a quarter or a half a mile of one another.

North-east Arm.

South-west Arm.

North Arm.

To the north, the largest extension has been called the North Arm, from its general trend. Nearly eight miles north of the Hudson's Bay Company's post, this arm is divided into two subsidiary bays, the eastern one being known as Ferguson Bay, running towards the inlet from Annima-nipissing Lake, a distance of nearly five miles further; while the western extension runs a little west of north for about eight miles, being again subdivided at the upper end into two parts known as Whitefish Bay and Sharp Rock Inlet. The latter portion is almost completely separated from the rest of the lake by Deer and Beaver islands, leaving narrow and crooked channels at either extremity, in which more or less current is usually discernible, especially after violent winds from the south.

Between the North and North-east arms, there are several minor indentations, known as Ko-ko-ko, Young Loon and Spawning bays. Of these the first-mentioned is the largest, running in a direction a little east of north for a distance of about four miles, and receiving at its head the waters of a rather large lake bearing the same name. The North-west Arm (Wuskigama) runs a little west of north, with an average width of over half a mile, for a distance of a little over four miles from Naipaga Point, when it changes abruptly to the west, which general course is maintained, with slight deviations, for a further distance of nearly three miles and a half. Bays between North and North-east arms.

Like other lakes of the Archæan region, this is characterized by great irregularity of its shore-line and by the vast number of islands with which it is filled. These islands vary in size from mere rocks to some which are several square miles in area and complex in form. As shown by the detailed survey of the lake, there are over thirteen hundred of these islands scattered over the surface, the main body of the lake especially containing a large number. Vast number of islands.

The most important factors that have determined the distribution of land and water, are the strike of the foliation or planes of pressure-cleavage and the unequal resistance offered during the progress of erosion by the different varieties of the surrounding rocks. The various bays or arms have been excavated for the most part in the slaty bands, in a direction corresponding with the strike of the foliation; while the shore-lines frequently and for long distances are composed of the hard and unyielding massive diabases or gabbro. As a rule, the banks of the lake are high and rocky, in many places, especially where the diabasic rocks prevail, raising in cliffs from a hundred to two hundred feet in height. Marshy tracts are few and small, and with the exception of occasional reefs, the water is comparatively deep to within a very few feet of the shore. Sandy or shingle beaches are, as a rule, rather rare and of small extent, although at the northern end of the lake, forming the northern shore of Sandy Inlet (Kawaminashing) there is a fine sandy shore. Shores of lake as a rule steep and rocky.

The deepest of a few soundings made, at a point within about thirty chains of the western shore of the main body of the lake, was 167 feet, while another within about half this distance from the same Depth of lake.

shore, showed 127 feet. About mid-channel between Bear Island and the group of islands opposite to the west, the depth varies from 75 to 85 feet. Several soundings taken at various places about the central part of the channel of the North-east Arm, clearly showed the existence of a deep and practically unobstructed navigable channel to within a short distance of the portage to Caribou Lake. The greatest depth was found about a mile south-west of Broom Island, 120 feet, while in the centre of the large open space about three miles and a half from the Caribou Lake portage the depth is only 95 feet. At the several contracted places along the course of the channel the water is much shallower, the depth opposite the mouth of the Tétapaga Lake being only 51 feet, while in the narrows, about a mile and a half from the portage, the depth is only 29 feet. The water of the lake is pure and clear and of a light sea-green tint, while the fish, chiefly trout, white-fish, bass, pickerel, pike and ling, are noted for their size and quality.

Clastic rocks exposed on shores of lake.

The clastic rocks exposed on the shores of this lake include at the base the usual and widespread breccia-conglomerate. This rock has already been described, and here presents no unusual features requiring special mention. Here, as elsewhere throughout the region, it passes upward through a massive dark-greenish greywacké or felspathic sandstone, comparatively free from the larger fragments or pebbles, into a banded slate which is the highest member of the Huronian noticed in the tract of country immediately bordering this lake. Along the North-east Arm, the prevailing rock is a light greenish-gray sericite schist containing a great deal of quartz in the form of small lenticular patches and veins running parallel to the foliation. Interlaminated with these hydromica schists are rudely oval patches or masses of a light greenish-gray silicious dolomite. The quartzose impurities are arranged in narrow vein-like forms which reticulate in all directions through the mass, so that when subject to ordinary weathering processes these stand out in relief, leaving irregular hollow interruptions composed of the softer and more easily distinguished material. One of these masses occurs on the smaller point to the east of the outlet from Hay Lake on the north shore, while several were noticed along the lower portion of the outlet from Tétapaga Lake as well as at several points along the shore in this neighbourhood. A large mass occurs on some islands a little over half a mile west of the portage into Caribou Lake. The sericite schist curves around these ovoid masses of impure dolomite, the latter having been but little deformed by the pressure which has tilted and altered the schists.

Sericite-schists and dolomites.

Origin of hydromica schists.

These hydromica schists or slates have evidently resulted from the shearing and decomposition of the Huronian slates, due to the close proximity of the two large masses of granite that occur to the north and south of this bay. It seems probable that these two masses of granite are united at a short distance below the present surface, and that the schists therefore occupy a comparatively shallow and narrow trough of highly inclined strata which have sagged down somewhat into the originally plastic mass beneath. This supposition best explains the abundance of the quartz veins and masses of pegmatitic or secondary origin, as well as the extreme but uniform alteration of the clastic material, indicating the former presence of an abundant supply of super-saturated and heated silicious waters and vapours connected with the intrusion of the granite. On Ko-ko-ko Bay, likewise, the clastic rocks have in many places undergone extensive alteration, and the pebbles and fragments of the prevailing breccia-conglomerate are embedded in a highly squeezed sericitic or chloritic matrix, which has a flow-like arrangement round the inclusions, caused by the greater hardness of these offering more effectual resistence to the pressure to which the softer matrix has yielded.

Origin of quartz-veins.

Fig. 6.

PEBBLES IN SERICITE SCHIST, KO-KO-KO BAY.

Throughout the whole of the southern part of the lake, the numerous and wide exposures, almost without exception, show the granitic and diabasic pebbles and fragments characteristic of the basal breccia-conglomerate; but in some places the massive greywacké occurring above is present, while in occasional localities at the north-west point of High Rock Island and the north-western part of Cross Bay, the still higher banded slates rise into hills of more than a hundred feet.

Distinct structural feature in rocks.

The most distinct and persistent structural feature which obtains in the more massive forms of the greywacké and breccia-conglomerate, is a pressure-foliation or cleavage. In most places there is little or no sign of stratification, especially in the basal beds, the pebbles and fragments being irregularly distributed in a massive and compact matrix, but the colour bands of the overlying slates are a certain criterion of sedimentation, and these show plainly that the various clastic rocks lie in low, broad undulating folds, dipping for the most part at gentle angles. The development of the foliation seems to have been determined by the pressure exerted during the intrusion of the large masses of irruptive material with which the clastic rocks are so intimately and so frequently associated. The breccia-conglomerate greywacké and banded slates are very evidently graded forms of the same rock, differing only in their relative degrees of coarseness. In origin they plainly represent pyroclastic material, and may be connected generally with the irruption of the massive plutonic rocks, although the clastic rocks have very evidently been disturbed and altered to a certain extent during the progress of their irruption. Such structural relationship is not, however, inconsistent with known facts of contemporaneous volcanic action, the associated volcanic ejectamenta being frequently pierced and altered by dykes and masses of the parent plutonic.

Irruptive rocks.

The irruptive rocks present on the lake comprise diabase, gabbro and granite. The diabase and gabbro are usually intimately associated in the same mass, differing only in their structure, which is sometimes macroscopically apparent, but, as a rule, only under the microscope. In composition they are made up chiefly of plagioclase and augite, the latter usually showing incipient alteration to green trichroic hornblende, while occasionally, especially in the vicinity of certain small shrinkage-cavities, the reddish-brown augite is completely decomposed to hornblende that has assumed the actinolitic habit. Usually biotite is present, sometimes in considerable quantity and some allotriomorphic quartz, filling in the interspaces between the other constituents. Ilmenite, showing the characteristic alteration to leucoxene, pyrite, chalcopyrite and pyrrhotite, may also be noticed. A portion of the north-east shore of the main body of the lake, presents exposures of coarse flesh-red granitite, forming the extension in this direction of the mass which covers so large an area to the north-east. The rock is exceedingly coarse and massive, often pophyritic, the phenocrysts being mostly Carlsbad twins of orthoclase, often from one to two inches in diameter. The biotite, originally present in small quantity, has been almost wholly converted to chlorite. The whole mass is intersected by numerous, often large, dykes of pegmatite and fine-grained felsite.

Lakes in area surrounding Lake Temagami.

In the area immediately surrounding Lake Temagami are several small lakes, some of which are worthy of brief description. The largest of these, Obabica (Rocky Narrows) Lake is about fifteen miles long, with an average width of over three-quarters of a mile. The inlet, and the outlet, are situated within three quarters of a mile from one another, on the west side, near the northern end of the lake. Two short portages, nearly half-way down the lake on the east side, afford an entrance through a small lake into the North-west Arm of Lake Temagami. A short portage separates this lake also from Wawiagania or Round Lake, which extends beyond the western boundary of the map, constituting an important link in a canoe-route towards the

Sturgeon Rapids, and thence to Wahnapitæ Lake. In the northern portion of Obabica Lake, the rock exposed along its somewhat flat shores, is the banded green slate, the light-and dark-greenish bands indicative of the bedding dipping E.N.E. $< 12°$ to 15°. Diabase comes out on the eastern shore to the south of the small bay on the route to Lake Temagami, while the breccia-conglomerate in very massive beds, out-crops all along the eastern shore in the southern part, and the overlying evenly banded slates at one point on the western shore, form nearly vertical cliffs of considerable altitude, with a north-westerly dip $< 3°$.

Round Lake.

The immediate shores of Round Lake are low, that on the south side exhibiting a good many low hummocks of slate, with intervening swampy stretches. The western shore to the north of the outlet are formed by comparatively high cliffs, the lower portion of which, up to a height of about fifteen feet above the water, is composed of a green, well banded slate, dipping at a low angle (about 3°) to the west, while superimposed upon this, probably as a sill is a massive greenish diabase containing abundantly disseminated pyrite. The northern shores show only one exposure of slate, the intervening spaces being low and swampy.

Route from Gull Lake to Wahnapitæ Lake

Gull Lake (Gyasgosenda), to the west of the main body of Lake Temagami, forms a part of the most direct canoe-route across country to Wahnapitæ Lake. Three different routes may be taken from Temagami to Gull Lake. The most northerly is made up of two portages and an intervening small lake; the first portage leaving a small bay on the west side of Lake Temagami, a short distance south of Naipaga Point at the entrance of the North-west Arm, while the second portage debouches on the extreme northern end of Gull Lake. A second route and the one most frequently used, consists of a single long portage, which goes up a gully on the west shore of the lake directly opposite the Hudson's Bay Co.'s Post, while a third leaves the South-west Arm, about two miles south-west of the narrows, and passing through two lakes, comes out on the east side of the southern half of Gull Lake. The canoe-route thence to the Sturgeon River has seven portages, none of which are of any great length, while the lakes encountered, Turtle, Manito-peepage and Wawiashkashing, are all of them rather large and important.

Rocks on north-west side of Gull Lake.

On the north-west side of Gull Lake, the rock is the greywacké slate, while the eastern shore, as well as the southern part of the lake, show outcrops of the massive greenstone (diabase and gabbro). The contact between this irruptive diabase and the associated slates, on the most northerly of the canoe-routes entering Gull Lake, comes in near the south-west end of the first portage from Lake Temagami, the dark greenish-gray felspathic slates in conjunction dipping S. 70° W. <65°.

Direction of contact between sandstone and breccia-conglomerate.

From this point the line of demarcation curves around to the south-west, striking the east shore of Gull Lake about three-quarters of a mile from the north end. Crossing Gull Lake, the islands in this portion of which are composed of slate, it leaves the bay, running to the south-west immediately north of the narrows. To the south, the contact between the greenish felspathic sandstone and breccia-conglomerate leaving the west shore of Lake Temagami, about three quarters of a mile south of the narrows at the entrance of the South-west Arm, crosses the first portage on the most southerly of the three routes to Gull Lake. Thence, with a south-westerly strike, it cuts across the southern ends of Gull and Turtle lakes, and running to the east of Manito-peepagee, and parallel to its general trend as far as its southern extremity, where it turns abruptly to the west, crossing the southern end of this lake, and the small lake on the route immediately to the west. The slates and felspathic sandstones in conjunction with this greenstone are all hardened and otherwise altered in the immediate vicinity of the contact, while the pressure-cleavage which is the only visible structural feature, conforms with the line of outcrop of the diabase.

Night Owl Lake.

Ko-ko-ko, or Night Owl Lake, enters the northern end of a narrow arm or inlet, which bears the same designation, running in a northerly direction from the main body of Lake Temagami. The shores exhibit excellent exposures of the breccia-conglomerate on the east side, with which rock is associated an overlying compact felspathic sandstone. These are penetrated by a massive intrusive greenstone, chiefly diabase in composition and structure, which occurs in a large mass coming out on the north-west side of the lake.

Canoe-route from main body of Lake Temagami to North-east Arm.

Young Loon and Spawning lakes enter smaller bays off the east side of the main body of Lake Temagami, the latter, together with McLaren, Commanda and Hay lakes, forming a canoe-route, which, with short intervening portages affords a means of communication between this portion of the lake and the North-east Arm, near Broom Island. With the exception of Hay Lake all are surrounded by hills of a coarsely crystalline flesh-red granitite, composed chiefly of flesh-red felspar, grayish-white quartz and a sparing quantity of chloritized biotite. Occasional exposures are rather fine-grained, and contain proportionately a greater amount of the coloured constituents, while, on the other hand, the coarser-grained material is almost entirely free from he bisilicates. At one point near the south end of Young Loon Lake, a dyke of dark-greenish compact material was seen cutting the granite and running N. 28° E. The contact between the mass of granitite and the sericitic schists exposed to the south on Hay Lake and the North-east Arm of Lake Temagami crosses about half way over the portage between Commanda and Hay lakes.

Tétapaga Creek.

Tétapaga Creek which enters the North-east Arm of Lake Temagami, a little over two miles east of Broom Island, serves to drain Tétapaga and Vermilion lakes, which, together with two small beaver-ponds and Kanichee-kinikisinik Lake beyond, form a short and direct canoe-route to Net Lake. From the east end of Tétapaga Lake a portage runs to Turtle Lake, which empties into a bay on the south-west side near the lower end of Net Lake, and a short carry over some ledges of sericite-schist, from the south side of Turtle Lake, affords an entrance to the North-east Arm of Lake Temagami to the north of Ferguson Mine Point. Tétapaga Creek, which runs in a south-westerly direction, is navigable for canoes for a distance of over a mile from the lake, and a portage of less than half a mile on the south-east side of the stream, is all that intervenes before Tétapaga Lake is reached. The rock exposed along the river is the dark greenish-gray and greenish hydromica and chloritic schists, striking from N. 50° E. to N. 60° E., and dipping to the north-east < 60°. These schists are interfoliated with occasional large oval patches or areas of a rusty weathering silicious dolomite.

Rocks on Tétapaga and Vermilion Lakes.

On Tétapaga Lake, the rock is, for the most part, a light greenish-gray sericite-schist, nearly vertical in attitude, and with a strike of N. 78° E. On Vermilion Lake the rock is very similar in character, but has an average strike of N. 57° E., dipping to the south-east < 80°; while on the south-east shore, a quartzose slate contains beds of red hæmatitic matter interlaminated with others of finely granular magnetite. In places the rock is associated with chlorite, and is greatly decomposed, showing large quantities of pyrite and pyrrhotite, the whole striking N. 70° E. and dipping south-east < 75°. On the portage running northwards from the beaver-pond that lies to the north-east of Vermilion Lake, the rock exposed is a light greenish-gray sericitic schist, striking from N. 44° E. to N. 59° E., and dipping south-east < 70°.

APPENDIX I.

List of Elevations.

The following elevations were obtained from a careful compilation of the profiles of the Canadian Pacific Railway, the Northern and North-western Division of the Grand Trunk Railway, the location survey of the Nipissing and James Bay Railway, together with a list published in 1860, by Thomas C. Clarke, C.E., in a report on the surveys of the Ottawa Ship Canal. These were corrected by a comparison with the recently perfected levels of the United States Lakes Survey, as published by Mr. L. Y. Schermerhorn in the American Journal of Science, April, 1887.

The heights of the various lakes on the Mattawa River are from a list compiled by Mr. James White, Geographer to the Geological Survey of Canada. *

Elevations marked thus (*) have been deduced from actual levelling, while the others have been determined by means of the aneroid barometer checked at frequent intervals.

All heights are in feet above mean tide water at Quebec.

Miles from Montreal.	——	Height in Feet.
	1. Elevations on Canadian Pacific Railway (Main Line.)	
318	Mattawa	*564
324	Calvin	*696
330·1	Eau Claire	*591
336·9	Rutherglen	*837
343·9	Bonfield	*782
347·9	Nasbonsing	*785
357·5	Thorncliffe	*699
360	Nipissing Junction	*674·6
363·5	North Bay	*659
373·5	Beaucage	*673
378	Meadowside	*661
386·8	Sturgeon Falls	*685
389·7	Cache Bay	*652
397·4	Verner	*669
406	Warren	*689

* See Trans. Roy. Soc. Can., 2nd Series, vol. 1., Sec. VI., pp. 188-189.

Miles from Junction.	———	Height in Feet.
	2. Elevations on the Canadian Pacific Railway (Temiscaming Branch.)	
	Junction with Main Line	*571
11·25	Snake Creek Siding	*543
24·30	Lumsden Station and Siding	*551
	Kippawa Junction	*580
37·95	Gordon Creek Station	*593
38·67	Lumsden Mills Siding	*801
	Bridge over Long Lake	*831
	Bridge over "Y" Lake	*861
45·77	Kippawa Station and Siding	*885
	Kippawa Lake Dam	*883

Miles from Toronto.	———	Height in Feet.
	3. Elevations on Grand Trunk Railway (N. & N. W. Division.)	
216·9	Crossing with the Nipissing and Nasbonsing Railway	*743
219·6	Callander	*670
223·3	Nipissing Junction	*674·6

———	High Wa te.	Mean Level.	Low Water.
4. Elevations on Ottawa River.	feet.	feet.	feet.
Ottawa River Junction with Mattawa River (1859.)	*509.5	....	*495·2
" " " (1890.)	*509	....	
" " " (1891.)	*506	....	
" " " (1892.)	*503	....	
" " " (1893.)	*507·5	....	
" foot of La Cave Rapids	*509·5	....	*495·5
" head of La Cave Rapids	*519	....	*505
" foot of Les Erables Rapids	*520·31	....	*506·31
" head of Les Erables Rapids	*532·63	....	*518·63
" foot of Mountain Rapids	*533·13	....	*519·13
" head of Mountain Rapids	*540·13	....	*522·23
" foot of Seven League Lake	*540·13	....	*522·23
" head of Seven League Lake	*542·63	....	*522·73
" foot of Long Sault Rapids	*542·63	....	522·73
" head of Long Sault Rapids	*591·63	....	*577·63
" head of Long Sault Rapids (1887)	*591	....	*572
" head of Long Sault Rapids (1894)	*591	....	*571
Lake Temiscaming below Presqu'île	*591	....	*577
" above Presqu'île	*591	....	*577
" below Opimika Narrows	*591	....	*577
" above Opimika Narrows	*591·8	....	*577·8
" below Old Fort Narrows	*591·8	....	*577·8
" above Old Fort Narrows	*592	....	*578
Lac des Quinze		845	

Miles from Montreal.	—	High Water.	Low Water.
	5. Levels on Mattawa River.	feet.	feet.
308·00	Mouth of Mattawa River	*509·5	*495·2
310·40	Foot of Plein Chant Rapid and Chute	....	*500·6
310·80	Head of Lac Plein Chant	....	*517·5
316·25	Foot of Des Epines Rapids	....	*517·7
316·30	Head of Des Epines Rapids	....	*523·3
316·85	Foot of Rapide de Le Rose	....	*523·5
317·00	Head of Rapide de La Rose	....	*529·1
318·20	Foot of Rapide des Rochers	....	*530·5
318·30	Head of Rapide des Rochers	....	*535·3
319·00	Foot of Rapides des Aiguilles	....	*535·4
319·01	Head of Rapides des Aiguilles	....	*535·8
321·65	Foot of Chute de Paresseux	....	*535·8
321·85	Head of Chute de Paresseux	....	*569·6
322·20	Foot of Little Paresseux Rapids	....	*569·6
322·35	Head of Little Paresseux Rapids	....	*577·8
323·38	Foot of Lake Pimisi (Eel Lake)	....	*590·6
324·53	Foot of Talon Chute	....	*590·6
324·71	Head of Talon Chute	....	*633·3
325·18	Rapid below Lake Talon	....	*633·3
325.33	Foot of Lake Talon	*639·3	*639·2
to 332·34	Head of Lake Talon	....	....
336·08	Foot of Turtle Lake	*665·9	*664·1
339·36 to 347·79	Trout Lake	*667·8	*665
351·98	Lake Nipissing (East Shore)	*647·8	*640·5

—	High Water.	Mean Level.	Low Water.
6. Levels on Sturgeon River.	feet.	feet	eet.
Lake Nipissing	*647·8	....	*640·5
Sturgeon River, below Sturgeon Falls	....	645	
" above Sturgeon Falls	....	676	
" below Sandy Falls	....	680	
" above Sandy Falls	....	696	
" below Rapids	....	697	
" above Rapids	....	703	
" below Smoky Falls	....	704	
" above Smoky Falls	*732·14	....	*722 14
" mouth of Tomiko River	*736·51	....	*723·51
" mouth of Pike River	*740·60	....	*725
" mouth of Snake Creek	*748	....	*730
" mouth of Temagami River	*752	....	*735
" at mouth of Maskinonge River	*795	....	*785
" at mouth of Wawashkashing Creek	....	815	811
First Lake (on Maskinonge River)	....	813	
Second Lake	....	814	
Third Lake (Murray Lake)	....	815	
Fourth Lake	....	826	
Maskinonge-wagaming Lake	....	836	

——	High Water.	Mean Level.	Low Water.
6. Levels on Sturgeon River—Cont.	feet.	feet.	feet.
Small Lake (on Kookaganing Creek)	....	844	
" " "	....	856	
" " "	....	864	
Kookaganing Lake	....	882	
McLaren River (at foot of portage from lake)	....	872	
Mattagomashing Lake	....	871	
Small lake flowing into Wahnapitae	....	859	
Wahnapitae Lake	....	858	
7. Levels on Temagami River.			
Mouth of Temagami River	*752	....	*735
Island Lake	....	889	
Red Cedar Lake	....	900	
Head of Swift Current	....	903	
Head of Sand-bar Rapid	....	919	
Head of Burnt Portage Rapid	....	930	
Head of Rapid	....	936	
Head of Log-jam Rapid	....	951	
Head of Twin-Rapids	....	957	
Head of Flat Rapid	....	958	
Lake Cross	....	959	
Temagami Lake	....	964	
8. Levels on Marten Creek.			
Red Cedar Lake	....	900	
Marten Creek, above Rapid	....	903	
" " Swift Current	....	904	
" " Rapid	....	909	
" " Swift Current	....	909	
" " Rapid	....	911	
" " "	....	914	
" " "	....	919	
" " "	....	920	
" " Falls	....	935	
" " Rapids	....	936	
Marten Lake	....	936	
Small Lake (on lot 6, con. v, Gladman)	....	990	
" (on lot 5, con. iv, Gladman)	....	990	
Wicksteed Lake (Lake)	....	941	
Forks of Boices and Mackenzie Lake outlets	....	944	
Boices' Lake	....	956	
Lower Red Water Lake	....	1003	
Upper Red Water Lake	....	1004	
Mackenzie Lake	....	956	
Simpson Lake	....	966	
Expectation Lake	....	968	
Desperation Lake	....	983	
Salvation Lake	....	1008	
Breadalbane Lake	....	986	
McDiarmid Lake	....	992	
Fanny Lake	....	994	
Bush Lake	....	981	
9. Levels on Tomiko River.			
Mouth of the Tomiko River	*736·51	....	*723·51
Tomiko Lake	....	795	

	High Water.	Mean Level.	Low Water.
9. Levels on Tomiko River—Cont.	feet.	feet.	feet.
Lake Chebogomog	....	798	
Cameron Lake	....	803	
Tilden Lake	......	928	
Lake lots 6 and 7, con, iii, Gladman	....	930	
Lake lot 7, cons. iii and iv, Gladman	....	932	
Kaotisinimigouang Lake	....	948	
Poplar Lake	....	949	
South Spruce Lake	....	978	
North Spruce Lake	....	978	
10. Levels on Ottertail River.			
Mouth of Ottertail River, on Lake Temiscaming	*591·8	....	*577·8
White-beaver Lake (Wabaunk Lake)	....	841	
Ruth Lake	....	991	
Beaver Pond (head of river)	....	991	

	Height.	High Water.	Mean Level.	Low Water.
11. Levels on Matabitchouan River.	feet.	feet.	feet.	feet.
Lake Temiscaming, at mouth of river	....	*591·8	....	*577·8
Summit of Matabitchouan Portage	927	....	....	
Beaver Mountain (King of Beavers)	1247	....	....	
First Bass Lake	....	....	858	
Second Bass Lake	....	....	858·5	
Third Bass Lake	....	....	859	
Fourth Bass Lake	....	....	864	
Rabbit Lake	....	....	*938	
White-bear Lake	....	....	*942	
Crooked or Snake Island Lake	....	....	*953	
Net Lake	....	....	965	
Thieving-bear Lake	....	....	975	
Small Lake	....	....	981	
Small Pond	....	....	991	
Lake	....	....	1006	
Marshy stretch on river	....	....	1022	
Small Pond	....	....	1027	
Mountain Lake (head of Matabitchouan River)	....	....	1029	
Ferguson Lake	....	....	971	
Duncan Lake	....	....	971	
Petrout Lake	....	....	996	
Lily Lake	....	....	1001	
Peeshabo Lake	....	....	1005	
Bogie Lake	....	....	1007	
Granite Lake	....	....	1006	
James Lake	....	....	1023	
Waibikaiginaising or Rib Lake	....	....	1013	
Cliff Lake	....	....	1048	
Summit Lake	....	....	1168	
Beaver Meadow	....	....	1158	
Friday Lake	....	....	1103	
Wilson Lake	....	....	1173	

——	High Water.	Mean Level.	Low Water.
12. Levels on Macdonald Creek.	feet.	feet.	feet.
Mouth of Creek on 4th Bass Lake, Matabitchouan River	....	864	
Cooper or Macdonald Lake	....	914	
Small Lake	....	924	
Glasford Lake	....	927	
Small Lake	....	927	
Moxam Lake	....	933·5	
Burwash Lake	....	934	
Ross Lake	....	936	
Rabbit Lake South-East Bay	....	*938	
13. Levels on the Montreal River.			
Mouth of Montreal River (Lake Temiscaming)	*591·8	....	*577·8
Farm House (Lumber Depot) on Long Portage, 860 feet	....	....	
Summit of Portage, 880 feet	....	....	
Montreal River at head of Long Portage (3 miles fr mouth)	....	736	
" above First Rapid	....	748	
" " Second Rapid	....	760	
" " Third Rapid	....	770	
" foot of Fountain Falls	....	773	
" head of Fountain Falls	....	793	
" " Ragged Chute	....	823	
" above Fourth Rapid	....	830	
" " Fifth Rapid	....	836	
" " Hound Chute	....	861	
" at portage to Mud Lake	....	869	
" at foot of Sixth Rapid	....	871	
" at head of Sixth Rapid	....	878	
" " Seventh Rapid	....	882	
" at foot of Eighth Rapid	....	883	
" at head of Eighth Rapid	....	890	
" Bay Lake	....	890	
" at mouth of Temagami Branch	....	903	
Indian Lake	....	901	
Round Lake (Mountain Lake)	....	911	
14. Levels on Route, Temagami to Red Cedar Lake.			
Lake Temagami	....	964	
Olier Lake	....	984	
Denedus Lake	....	1022	
Wasacsinagama Lake	....	1025	
Beaver Meadow	....	1035	
Green Lake	....	1046	
Brophy Lake	....	1056	
Ingall Lake	....	1050	
Jumping Caribou Lake	....	1048	
Upper Twin Lake	....	993	
Lower Twin Lake	....	977	
Mann Lake	....	975	
Norris Lake	....	935	
Hanging-stone Lake	....	918·9	
Red Cedar Lake	....	900	
15. Levels of Various Lakes.			
Pike Lake (Lac aux Brochets) on Gordon Creek	....	....	*794
Long Lake, on Gordon Creek	....	....	*820·5

——	High Water.	Mean Level.	Low Water.
15. Levels of Various Lakes—Cont.	feet.	feet.	feet.
"T" Lake	*856	....	*849·5
Lake Keepawa	*880	....	*870·70
Summit of portage between Keepawa and Douglas	....	957	
Douglas Lake	....	852	
Little Obashing Lake	....	832	
Forest Lake	....	862	
Birch Lake	....	862	
Devil Lake	....	834	
Bastien Lake	....	877	
Thompson or McConnell Lake	....	874	
David Lake	....	869	
Obashing Lake	....	822	
Summit of Road between Obashing Lake and Ottawa River, 942 feet	....	....	
Small Lake at head of Snake Creek on old Winter Road	....	847	
Second Lake on Snake Creek on old Winter Road	....	827	
Long Lake on White Creek	....	852	
White Lake at head of White Creek	....	872	
White Beaver Lake (East of McMartins Point)	....	883	
First Lake on Indian portage-route to Keepawa	....	883	
Emerald Lake	....	1009	
Small Lake at head of Opimika Creek	....	1167	
Sharp Lake	....	905	
Mud Lake	....	900	
Bay Lake	....	890	
Lady Evelyn Lake	....	930	
Nonwakaming Lake	....	955	
Big Whitefish Lake	....	1010	
Lynx Lake	....	1025	
Cole Lake	....	1045	
Turner Lake	....	1057	
Annima-nipissing Lake	....	1070	
Breeches Lakes	....	1085	
Mannajigaina Lake	....	1075	
Trout Lake	....	857	
Wakémika Lake	....	935	
Obabica Lake	....	932	
Wawiagama Lake	....	917	
Small Lake south of Nonwakaming Lake	....	961	
" between Nonwakaming and Wakémika Lake	....	960	
Bear Lake	....	997	
Angus Lake	....	1051	
Free Portage Lake	....	966	
Rankin Lake	....	976	
Miller Lake	....	977	
Kettle Lake	....	1015	
Lake Nasbonsing	*781	*776	

APPENDIX II.

On some Cambro-Silurian and Silurian fossils from Lake Temiscaming, Lake Nipissing and Mattawa outliers.

By H. M. AMI.

LAKE TEMISCAMING.

Cambro-Silurian (Ordovician.)

In describing the Niagara formation on Lake Temiscaming Sir Wm. E. Logan remarks :—*There are found lying on the Niagara limestone, loose angular fragments of dolomite resembling that of the Birds Eye and Black River formation of Lacloche and Lake Nipissing, and holding *Strophomena alternata*, species of *Maclurea* like *M. magna*, and *M. Atlantica*, *Orthoceras anceps*, and *O. proteiforme*. He adds :—"The source of these fragments has not yet been ascertained."

From the assemblage of forms ider tified by the late E. Billings and recorded in Sir Wm. Logan's remarks above, there is no doubt that there must be represented somewhere in the vicinity of Lake Temiscaming, one Cambro-Silurian horizon at least, i.e., the Birds Eye and Black River formation. It remains still to be ascertained whether any older members of the Cambro-Silurian occur under the somewhat extensively developed Silurian rocks. The Black River formation of the district, is known so far, only by loose, but angular and, apparently not far-travelled pieces of limestone. It can scarcely be conjectured that these pieces of limestone came from any other district than the Temiscaming area, as there are no outcrops of rocks of Black River age known in the region to the north of Lake Temiscaming.

Silurian.

Silurian fossils abound on Lake Temiscaming and are well preserved in the several outliers. From the "Head of Lake Temiscaming" the first collections were made by Sir Wm. E. Logan in 1845. These are recorded by Mr. E. Billings and enumerated on the page already referred to. The cccurrence of *Halysites catenularia*, and of *Favosites Gothlandica*, was sufficient evidence to enable Mr. Billings to definitely

*Geology of Canada, (1863,) p. 335.

state that the rocks from which they came were Silurian. Some thirteen species were determined at the time.

Notes on certain species.

The collections made by Dr. Bell and Mr. Barlow are very extensive. One of the most prominent and characteristic features in the fauna represented, is the prevalence of Corals, not less than seventeen species of which have been recognized by Mr. Lambe. Of these corals, the "chain-coral" *(Halysites catenularia)* and the "honey-comb coral" (*Favosites Gothlandica*) occur in great profusion. They are preserved for the most part in a silicified condition—not the best by any means for study—in a manner much resembling that in which the fossils of the Black River formation are found at Paquette's Rapids on the Ottawa River below Pembroke, Ontario.

Few of the higher forms of organisms characteristic of the Silurian period are found directly associated with the corals, but *Clathrodictyon vesiculosum*, Nicholson and Murie, one of the Hydromedusæ, does occur very abundantly and is associated intimately with the corals.

The Crinoidea are very rare; only three species having been recorded as yet from this basin.

The Annelids are represented by a single specimen of a Conodont, whilst the Bryozoa, so abundant in certain rocks of the Niagara and Clinton formations in the province of Ontario and in New York State, are rather sparsely distributed in the Lake Temiscaming rocks.

Brachiopoda occur in certain bands by themselves and at times are very abundant. Such is the case with *Atrypa reticularis*, Linnæus. *Pentamerus oblongus*, Sowerby, a form characteristic of the Wenlock in England and of the Niagara of the Interior Continental plateau of Palæozoic rocks in North America, occurs in vast numbers in a certain band of yellowish-gray limestone on Mann or Burnt Island.

The Lamellibranchiata or Pelecypoda are very rare, only two genera having been noticed from all the collections.

The Cephalopoda are well represented, and of these *Discosorus conoideus*, Hall, is the most conspicuous and interesting—although the Orthoceratites include amongst others:—*Actinoceras vertebratum*, Hall, (said to be identical with *Actinoceras Backi*, Stokes, described from the Arctic regions of North America,) and several other forms peculiar to the Niagara formation of New York and Ontario.

The trilobites are few. Two forms recorded may be the North American representatives of the two European species *Calymene Blumenbachii*, Brongniart; and *Encrinurus punctatus*, Wahlenberg. The Ostracoda are likewise very rare. A few fragments of Algæ occur in Mr. Barlow's collections and appear to represent two species previously recorded from rocks of similar age in New York State.

The whole fauna comprises eighty-eight species, representing fifty-nine genera. These species are for the most part forms referable to the Niagara formation, although a number of forms, such as the corals and brachiopods, are also well known to occur in rocks assigned to the horizon of the Clinton formation.

There are specimens of *Favosites Gothlandica* from Mr. Barlow's collection of 1894 which measure a little more than fifteen inches in diameter or over four feet in circumference. The mode of growth of these Favosites is similar to that described by Prof. G. H. Girty in the case of *Favosites Forbesi* var., *occidentalis*, and very perfect examples of such large dimensions are not rare on Burnt Island. They exceed in size and perfection of structure the large masses of Favosites from the Hamilton formation of Thedford, Ont. Large and small specimens of this species occur together, and such is the case also with specimens of the *Clathrodictyon vesiculosum*, Nicholson and Murie. This is the species which was described by Billings as *Stromatopora concentrica* of Goldfuss. The largest specimen met with measures fourteen, by ten, by eight inches.

Syringopora verticillata, Goldfuss, was described from specimens which came from Lake Huron. It is found in tolerable abundance in the Silurian of Lake Temiscaming. This fact, together with the occurrence of several other species which are common to the Silurian of Lake Huron in the Manitoulin Island, in Michigan and Ontario, assist in confirming the view that the sea in which the Silurian deposits of the Lake Temiscaming basin were deposited was connected with the Silurian sea of the Lake Huron region.

Notes on Mr. Barlow's collections.

Chiefs Island, Lake Temiscaming.—The fossils from this locality are poorly preserved, and occur in a rather coarse sandstone showing clear grains of quartz embedded in a light yellowish-gray dolomite. The beds from which they were obtained appear to form the basement or lowermost strata of the Silurian as developed at this point. The presence of *Halysites catenularia*, Linnæus and of *Discosorus conoideus*, Hall, with other forms from this island serve to indicate the presence of Silurian rocks on the southern side. These strata which rest unconformably upon the denuded Archæan rocks, whose surface is very irregular and uneven, must necessarily have contacts at various horizons or levels. It would not be at all surprising, indeed, to find arenaceous beds not only belonging to the Niagara formation and holding fossils representing different life-zones in this formation, but also similar beds holding older types of organisms, belonging to older formations in the lower levels of this old Palæozoic outlier or basin.

Burnt or Mann Island.—The bulk of the large collection obtained during the years 1893 and 1894 came from this locality. Forty-three species are represented. The rock in which they are preserved is a light-yellowish and fine-grained dolomite teeming with the remains of corals and hydroids. Certain bands, none calcareous, hold brachiopoda belonging to the species *Atrypa reticularis*, Linnæus. Several interesting and thin slabs of crinoidal limestone contain crinoid heads as well as stems. These are of special interest and deserve to be further studied. It is the only locality on the lake where tolerably perfect crinoid heads have been obtained, only imperfect fragments of columns or stems had been noticed previously.

Percy Island.—From this place Mr. Barlow obtained only a few specimens from which nine species were recognized. Additional collections from this locality would probably reveal other forms of special interest. As already stated, the occurrence of *Halysites catenularia* and *Discosorus conoideus* on this island is sufficient evidence upon which to refer the strata from which they came to the Silurian System.

The Fossil Corals.

In 1896, Mr. L. M. Lambe, of this Department, made a special study of the corals obtained, and he has prepared the following lists of species.—

Burnt or Mann Island, Lake Temiscaming, collected by A. E. Barlow, 1893-1894.

Heliolites (Plasmopora) affinis, Billings.
Lyellia Americana, Milne-Edwards and Haime.
Zaphrentis Stokesi, Milne-Edwards and Haime.
Cyathophyllum articulatum, Wahlenberg.
Favosites Gothlandica, Lamarck.
Alveolites Niagarensis, Rominger (not Nicholson).
Limaria (Cœnites) crassa, Rominger.

Halysites catenularia, Linnæus.
Halysites compacta, Rominger.
Syringopora bifurcata, Lonsdale.
Syringopora verticillata, Goldfuss.

North End of Lake Temiscaming, collected by R. Bell, 1887.

Heliolites subtubulata, McCoy.
Zaphrentis Stokesi, Milne-Edwards and Haime.
Strombodes pygmæus, Rominger.
Favosites Gothlandica, Lamarck.
Cladopora cervicornis, Hall.
Alveolites Niagarensis, Rominger (not Nicholson).
Alveolites seriatoporoides, Milne-Edwards and Haime.
Cœnites lunata? Nicholson.
Limaria (Cœnites) crassa, Rominger.
Halysites catenularia, Linnæus.
Halysites compacta, Rominger.
Syringopora Dalmanii, Billings.
Syringopora verticillata, Goldfuss.

The subjoined table enumerates the Silurian fossils found at the several localities in the northern part of Lake Temiscaming, the localities and collectors being as follows :—

1. Collection from "Head of Lake Temiscamang" (*sic*) by Sir W. E. Logan, 1845.

2. From "North End of Lake Temiscaming," Dr. R. Bell, (*sic*) 1887

3. Various collections by Mr. A. E. Barlow from Burnt or Mann Island made in 1893 and 1894, also part of the "Stewart Collection" from Burnt Island, obtained in 1892.

4. Percy Island, Lake Temiscaming, A. E. Barlow, 1894.

5. Chiefs Island, Lake Temiscaming, A. E. Barlow, 1894.

Table showing the genera and species of Silurian fossils from Lake Temiscaming.

	1. Head of Lake Temiscaming.	2. North End, Lake Temiscaming.	3. Burnt Island.	4. Percy Island.	5. Chiefs Island.
PLANTAE.					
Bythotrephis gracilis (?), Hall	....	*	*	....	....
" *palmata*, Hall	....	....	*	....	....
HYDROMEDUSÆ.					
Clathrodictyon vesiculosum, Nicholson and Murie	*	*	*	*	....
CŒLENTERATA.					
Heliolites subtubulata, McCoy	....	*	....	....	....
" (*Plasmopora*) *affinis*, Billings	....	....	*	....	....
" sp., cf. H. Niagarensis, Hall	....	....	*	....	....
Lyellia Americana, Edwards and Haime	....	....	*	....	....
Zaphrentis Stokesi, Edwards and Haime	....	*	*	....	....
" sp	....	....	....	....	*
Caninia or Streptelasma, sp	....	....	....	....	*
Cyathophyllum articulatum, Wahlenberg	....	....	*	....	....
" sp. indt	....	....	*	....	....
Strombodes pygmæus, Rominger	....	*	....	....	....
Favosites Gothlandica, Lamarck	*	*	*	*	....
Cladopora cervicornis, Hall	....	*	....	....	....
Alveolites Niagarensis, Rominger	....	....	*	....	....
" *seriatoporoides*, Edwards and Haime	....	*	....	....	....
Cœnites lunata (?), Nicholson	....	*	....	....	....
Limaria (*Cœnites*) *crassa*, Rominger	....	*	*	....	....
Halysites catenularia, Linnæus	....	*	*	*	....
" *compacta*, Rominger	....	*	*	....	....
Springopora bifurcata, Lonsdale	....	....	*	....	....
" *verticillata*, Goldfuss	*	*	*	*	....
" *Dalmanii*, Billings	*	*	*	....	....
ECHINODERMATA.					
Crinoidal fragments	*	*	*	*	....
Taxocrinus, n. sp	....	....	*	....	....
Dendrocrinus sp., cf. D. longidactylus, Hall	....	....	*	....	....
Thysanocrinus sp., cf. T. liliiformis, Hall	....	....	*	....	....
ANNELIDA.					
Arabellites, n. sp	....	*	....	....	....
BRYOZOA.					
Lichenalia concentrica, Hall	....	....	*	....	....
Phænopora expansa Hall	....	*	*	....	....
Trematopora, sp	....	....	*	....	....
Callopora sp., cf. C. *nummiformis*, Hall	....	*	....	....	....
Stictopora, sp	....	*	....	....	....

Table showing the genera and species of Silurian fossils from Lake Temiscaming—Continued.

—	1. Head of Lake Temiscaming.	2. North End, Lake Temiscaming.	3. Burnt Island.	4. Percy Island.	5. Chiefs Island.
BRACHIOPODA.					
Orthis (*Dalmanella*) *elegantula*, Dalman		*	*		
" *Davidsoni*, de Verneuil		*	*		
Leptæna transversalis, Dalman		*			
Leptæna rhomboidalis, Wilckens			*	*	
Strophonella, sp.			*		
Strophemena, (?) sp., cf. *Leptæna corrugata*, Conrad		*			
Chonetes (?), or *Strophomena* (?)		*			
Platystrophia lynx, Eichwald			*		
Leptocœlia hemispherica, Sowerby				*	
Atrypa reticularis, Linnæus	*	*	*	*	
" *nodostriata* Hall		*			
" *intermedia*, Hall			*		
Rhynchotrema cuneata, Dalman		*			
Rhynchonella neglecta, Hall		*			
" *interplicata*, Hall		*			
" *acutiplicata*, Hall					
" sp.					*
Trematospira, sp. indt.			*		
Spirifer, sp., cf. *S. Niagarensis*, Hall			*		
" sp. indt.		*			
Meristella didyma, Dalman		*			
" *naviformis* Hall		*			
" sp.				*	
Pentamerus oblongus, Sowerby	*	*	*		
GASTEROPODA.					
Bucania stigmosa, Hall		*			
Murchisonia subulata, Hall			*		
" sp. No. 1			*		*
" sp. No. 2					*
Loxonena, n. sp.			*		
" sp.		*			
Euomphalus, n. sp.					
Euomphalus alatus, Hisinger			*		
Cyclonema cancellatum, Hall		*			
Platyostoma, sp.		*			
LAMELLIBRANCHIATA.					
Modiolopsis, sp., cf. *M. erectus*, Hall		*			
Pterinea, sp.				*	
CEPHALOPODA.					
Discosorus conoideus, Hall	*	*	*		
" *gracilis* (?), Foord			*		
" sp. No. 1		*	*	*	
" sp. No. 2		*	*	*	

Table showing the genera and species of Silurian fossils from Lake Temiscaming—Continued.

——	1. Head of Lake Temiscaming.	2. North End, Lake Temiscaming.	3. Burnt Island.	4. Percy Island.	5. Chiefs Island.
CEPHALOPODA—*Continued.*					
Orthoceras, sp.	....	....	*	....	....
" sp., cf. *O. clavatum*, Hall	....	*	....	....	....
" sp., cf., *O. virgulatum*, Hall	....	....	*	....	....
" sp., cf., *O. Cadmus*, Billings (?=O. *subcancellatum*, Hall)	....	....	*	....	....
Orthoceras rotulatum, Billings	*	....	....	....	....
Actinoceras vertebratum, Hall (?=*A. Baeki*, Stokes)	....	....	*	....	....
TRILOBITA.					
Calymene Niagarensis, Hall (=*C. Blumenbachii*, Brongniart)	....	*	....	....	....
Illœnus, sp	....	*	....	....	....
Encrinurus, sp., cf. *E. punctatus*, Wahlenberg	....	*	....	....	....
Proetus, sp	....	*	....	....	....
OSTRACODA.					
Beyrichia, sp., cf. *B. lata*, Vanuxem	....	*	*	....	....
Isochilina, sp	....	*	....	....	....
Leperditia, sp	....	*	....	....	....

References.

1857. Billings, E.—"Report of Progress, Geol. Surv. Canada, for the years 1853-6." Toronto, 1857. On p. 334, *Orthoceras rotulatum* is described from the Head of Lake Temiscaming.

1858. Billings, E.—"Report of E. Billings, palæontologist, in Report of Progress, Geol. Surv. Canada, for the year 1857." On pp. 147 and 171 Mr. Billings describes, and records the discovery of, *Syringopora Dalmanii* and *S. verticillata*, Goldfuss.

1858. Billings, E.—"Canadian Fossils, containing descriptions of new Genera and Species from the Silurian and Devonian formations of Canada." Extracted from Report of the Geol. Surv. Canada for 1857. Montreal, 1858, 31 pp.

1863. BILLINGS, E.—"The Geology of Canada, from the commencement until 1863," pp. 334-336 contains a chapter entitled: "The Niagara Formation on Lake Temiscaming," in which two lists of fossils prepared by Billings are given, p. 335.

1888. FOORD, ARTHUR H.—"Catalogue of the Fossil Cephalopoda of the British Museum," Part I, Nautiloidea, London, England, Dec., 1888:—in which *Actinoceras vertebrale* is recorded from Lake Temiscaming.

1896. WHITEAVES, J. F.—"Canadian Stromatoporoids," Can. Rec. Science, vol. V, No. 2, pp. 129-146, Dec., 1897, in which *Clathrodictyon vesiculosum*, Nicholson and Murie, is recorded from Lake Temiscaming.

1897. AMI, H. M.—"Notes on some of the Fossil Organic Remains from the Geological Formations and Outliers of the Ottawa Palæozoic Basin." Trans. Roy. Soc. Can., Sec. Series, vol. II, Sect. IV, 1896-1897, (Ottawa, 1897).

1899. LAMBE, L. M.—"Canadian Palæozoic Corals," Ottawa Naturalist, vol. XII, No. 11, pp. 219-220, Feb., 1899, where specimens identified with *Cyathophyllum articulatum*, Wahlenberg, are described from Mr. Barlow's collections on Lake Temiscaming.

THE MATTAWA OUTLIER.

In the autumn of 1894, Mr. A. E. Barlow submitted for examination a small but important collection of fossils from a locality on the north shore of the Ottawa River six miles below Mattawa. The fauna represented in the pinkish-gray weathering and arenaceous limestones of this outcrop is that of the Black River and Trenton. The presence of *Receptaculites occidentalis*, Salter, *Orthis tricenaria*, Conrad, indicate an horizon at the close or summit of the Black River formation, whilst the occurrence of *Prasopora Selwyni*, Nicholson, *Solenopora compacta*, Billings, *Rafinesquina alternata*, Emmons, and *Zygospira recurvirostra*, Hall, are eminently characteristic of the Trenton.

The occurrence of this fauna at such a westerly point along the Ottawa Valley and in such proximity to the Lake Nipissing outliers on the Manitou Islands, together with the well-known occurrence of strata of the same age in the islands north of the Grand Manitoulin, serve to show that in Ordovician times the marine waters of the Lake Huron Palæozoic basin were directly connected with those of the

Nipissing and Mattawa or Upper Ottawa regions. Every species recorded from this Mattawa outlier has been found in other deposits in the Ottawa Valley whilst most of them, if not all, are also recorded from the islands north of Lake Huron.

The following is a list of the species recognized in the collection from this outlier :—

PROTOZOA.

Receptaculites occidentalis, Salter.

ECHINODERMATA.

Crinoidal fragments, too imperfectly preserved for identification. They resemble portions of stems of a species which may be referable to the genus *Glyptocrinus*.

BRYOZOA.

Prasopora Selwyni, Nicholson. The microscopic sections prepared of this form exhibit no variation from typical specimens recorded from Peterborough, Ottawa, Montreal and other localities in Canada. This is no doubt the form which received the designations of *Favosites lycopodites*, *Chætetes lycoperdon*, and *Stenopora petropolitana* in the early reports of the New York and Canadian Surveys.

Frondose, and branching Monticuliporidæ.

Solenopora compacta, Billings. A form which may probably be referred to this species.

CŒLENTERATA.

Streptelasma corniculum, Hall.

BRACHIOPODA.

Strophomena incurvata, Shepard.
Rafinesquina alternata, Emmons.
Orthis, sp., cf. *O. tricenaria*, Conrad.
(*Dinorthis*) *proavita*, Winchell and Schubert.
Zygospira recurvirosta, Hall.

GASTEROPODA.

Lophospira bicincta. Hall. A young individual referabl to this species.

TRILOBITA.

A fragment of a trilobite too imperfectly preserved for identification.

LAKE NIPISSING—THE MANITOU ISLANDS.

In 1854, Alexander Murray was the first to note the occurrence of flat-lying limestones on the Manitou Islands of Lake Nipissing. In his Report for that year (p. 124) he refers the occurrence to the

Black River formation. "*Ormoceras tenuifilum*," or as this species is now called, *Actinoceras Bigsbyi*, Stokes, is the characteristic form upon which the determination of the horizon was based.

In 1884, a further collection was made on these islands by Dr. A. R. C. Selwyn. This was subjected to a preliminary examination by the writer.

In 1896, a brief note was prepared for the Canadian Record of Science where seventeen species are enumerated.

In 1889, Mr. T. D. Ledyard, of Toronto, visited these islands and obtained an interesting collection, which was submitted to Mr. E. O. Ulrich for examination. The list of species prepared by the latter and embodied in a paper on the Black River limestone at Lake Nipissing by Prof. N. H. Winchell, in the American Geologist for September, 1896, contains besides other forms a number of Bryozoa not previously recognized from this locality.

In 1892, Rev. J. M. Goodwillie, M.A., of North Bay, made an excellent collection of the fossils, and communicated them to the Geological Survey Department at Ottawa. This collection was found to contain a number of forms hitherto unrecorded in other collections, and a preliminary study of its contents revealed many interesting species, all eminently characteristic of the Black River formation.

In 1894, Mr. A. E. Barlow collected along the west shore of the Great Manitou or Newman Island, on the most southerly of the Manitou islands and on the west shore of McDonald Island. From the first-mentioned of these collections by Mr. Barlow, a Black River fauna was detected and *Columnaria Halli*, Nicholson, *Stromatocerium rugosum*, Hall, *Lophospira helicteres*, Salter, and *Actinoceras Bigsbyi*, Stokes, recorded, all of which are eminently characteristic. The presence of *Zygospira recurvirostra*, Hall, and of a form which is doubtfully referred to *Plectambonites sericea*, Sowerby, from the west shore of McDonald Island give a slight Trenton facies to the assemblage from this locality. It may be that further collecting will reveal a somewhat higher horizon than the zone of *Columnaria Halli* usually indicates.

The following collections of fossils have been examined by the writer :—

Manitou Islands, L. Nipissing, A. R. C. Selwyn, 1884.

Manitou Islands, L. Nipissing, Rev. J. M. Goodwillie, M.A., 1892.

West Shore, Great Manitou Islands, L. Nipissing, A. E. Barlow, 1894.

West Shore, McDonald Island, L. Nipissing, A. E. Barlow, 1894.

Most southerly of Manitou Islands, L. Nipissing, A. E. Barlow, 1894.

The subjoined list of genera and species includes all the forms recognized in these as well as in the other collections above mentioned.

PROTOZOA.

Stromatocerium rugosum, Hall.
Pasceolus globosus, Billings.

CÆLENTERATA.

Columnaria Halli, Nicholson.
Tetradium fibratum, Safford.
Palæophyllum ?, sp.
Streptelasma corniculum, Hall.

ECHINODERMATA.

Crinoidal fragments, too imperfectly preserved for identification.
Sculptured plate of what appears to be a crystidean referable to the genus *Palæocysites.*

BRYOZOA.

Escharopora subrecta, Ulrich.
Escharopora limitaris. Ulrich.
Helopora mucronata, Ulrich.
Rhinidictya mutabilis, var. major, Ulrich.
Phyllodictya varia, Ulrich.
Batostoma Winchelli, Ulrich.
Callopora multitabulata, Ulrich.
Several other Monticuliporoids referable to genera and species not yet examined microscopically, but which appear to belong to such genera as *Pachydictya*, *Amplexopora*, *Dekayia*, *Coscinium*, and *Monotrypella*.

BRACHIOPODA.

Strophomena incurvata, Shepard.
" *Trentonensis*, Winchell and Schuchert
Rafinesquina alternata, (Emmons).
Plectambonites sericea, Sowerby.
Orthis tricenaria, Conrad.
Rhynchotrema inæquivalvis, Castelneau.
Zygospira recurvirostra, Hall.

GASTEROPODA.

Eccyliomphalus Trentonensis ? Conrad.
Pleurotomaria (*Clathrospira*) *subconica*, Hall
Murchisonia (*Lophospira*) *helicteres*, Salter
" " *bicincta*, Hall.
Maclurea ? sp. indt.
Fusispira elongata, Emmons.
Trochonema umbilicatum, Hall.

LAMELLIBRANCHIATA.

Cyrtodonta Huronensis, Billings.
" *Canadensis*, Billings.
" *subcarinata*, Billings.

LAMELLIBRANCHIATA—*Continued.*

Cyrtodonta sp. indt.
Ctenodonta levata, Hall.
Vanuxemia? sp. Hall.

CEPHALOPODA.

Vaginoceras multitubulatum, Hall.
Gonioceras anceps, Hall.
Actinoceras Bigsbyi, Stokes.
Cameroceras proteiforme, Hall.
Nanno aulema, Clarke.
Orthoceras rapax, Billings, or a very closely related species.
" *multicameratum*, Hall.
" *annellum*, Hall.
" *amplicameratum*, Hall.

TRILOBITA.

Asaphus, sp. Portion of the hypostome of a large individual of this genus possibly of *A. platycephalus* or *A. susae.*

OSTRACODA.

Leperditia fabulites, Conrad.
Aparchites neglectus, Ulrich.

References.

1857. MURRAY, ALEXANDER,—"Report of Progress Geol. Surv. Canada, for 1853-6, pp. 101-125, Toronto, 1857. On p. 124 there is reference made to "fossiliferous rocks in the most western island of the Manitou Group," and *Ormoceras tenuifilum*, is recorded as evidence of the Black River age of the rocks in question.

1892. AMI, H. M.—"Palæontological Notes, No. II. On the occurrence of Fossil Remains on the Manitou Islands, Lake Nipissing, Ontario." Can. Rec. Science, vol. V., No. 2, pp. 107-108, Montreal, 1892. Contains a review of Alex. Murray's paper (*loc. cit. supra.*) together with a list of fossils obtained by Dr. Selwyn in 1884, and referred to the Black River formation.

1896. ULRICH, E. O.—in Prof. U. H. Winchell's paper entitled: "The Black River Limestone at Lake Nipissing." American Geologist, vol. XVIII., No. 3, pp. 178-179, Minneapolis, Sept., 1896. A list of the species of fossils collected by T. D. Ledyard, Esq., of Toronto in 1889, and determined by Prof. E. O. Ulrich, is embodied in this paper.

1898. WHITEAVES, J. F.—"On some Fossil Cephalopoda in the Museum of the Geological Survey of Canada, with descriptions of eight species that appear to be new. Ottawa Naturalist, vol. XII., No. 6, pp. 116-127, Ottawa, 1898. On p. 116, Mr. Whiteaves records the occurrence of *Nauno aulema*, Clarke, from the collection made by Alexander Murray in 1854, from the Black River limestone at Western Manitou Island (now called McDonald Island), Lake Nipissing.

THE DEVILS RAPIDS, CHAUDIÈRE RIVER, BEAUCE CO., Q., LOOKING DOWN STREAM.

GEOLOGICAL SURVEY OF CANADA
G. M. DAWSON, C.M.G., LL.D., F.R.S., DIRECTOR

REPORT

ON THE

SURFACE GEOLOGY

AND

AURIFEROUS DEPOSITS OF SOUTH-EASTERN QUEBEC

BY

R. CHALMERS

OTTAWA
PRINTED BY S. E. DAWSON, PRINTER TO THE QUEEN'S MOST
EXCELLENT MAJESTY
1898

TO GEORGE M. DAWSON, C.M.G., LL.D., F.R.S.,

Director of the Geological Survey of Canada.

SIR,—I beg to submit herewith a report on the surface geology and gold-bearing deposits of the "Eastern Townships" and adjacent portions of South-eastern Quebec.

I have the honour to be, Sir,

Your obedient servant,

R. CHALMERS.

GEOLOGICAL SURVEY OFFICE,
OTTAWA, May, 1898.

NOTE.—*The bearings in this report are all referred to the true meridian, and the elevations to mean sea-level.*

REPORT

ON THE

SURFACE GEOLOGY

AND

AURIFEROUS DEPOSITS OF SOUTH-EASTERN QUEBEC

BY

R. CHALMERS.

INTRODUCTION.

The following report contains the results of observations made by me in South-eastern Quebec during the three seasons of 1895, 1896 and 1897. The district included in the report is that which extends from Lake Champlain and the Vermont boundary north-eastward to Montmagny county, and from the province line along the New Hampshire and Maine border, north-westward to the plain of the St. Lawrence valley. A general study of the superficial deposits of the region was made, with special reference to the auriferous alluviums of the "Eastern Townships."* To carry out this thoroughly it was necessary to examine the whole St. Lawrence valley in some detail. Accordingly, considerable time was spent in investigating the glaciation, and the distribution of the boulder-clay, and in tracing this and other superficial materials to the places of their origin. The pre-glacial decayed rock-materials, sedentary † and transported, lying beneath the Pleisto-

District examined.

Character of investigation.

* The name "Eastern Townships" is applied in a somewhat loose and general manner to that portion of South-eastern Quebec lying to the south-west of Beauce county and the seigniory of Lotbinière, and between the St. Lawrence River and the International boundary.

† The terms "sedentary" and "transported" are employed in a restricted sense in this report, in describing the pre-glacial beds of the region. Sedentary materials are those found *in situ*; Transported, are the same after having undergone modification by subaerial and fluviatile agencies, etc.

cene series, were likewise studied in the gold-bearing districts, as it is chiefly in these that the precious metal is found in workable quantities. The great changes of level which took place during the later Pleistocene, evidenced by the marine fossils and shore-lines on both sides of the great valley referred to, are most interesting questions for investigation. These show a differential upheaval, as the latest movement, the gradient of which increases in height above sea-level from the Gulf of St. Lawrence toward the Great Lakes, although apparently with some irregularity. Considerable attention was given to this question.

Changes of level.

A large body of facts relating to the subjects above-mentioned has been collected; but only such as are closely connected with the various questions treated of in this report and mainly embraced within the region under discussion, will be presented in the following pages. The examination of the upper St. Lawrence and Ottawa valleys and region of the Great Lakes is still in progress.

Former observations.

Observations on the surface geology of the area specially included in this report were made early in the history of the survey,* by Sir J. Wm. Dawson,† and by Dr. R. W. Ells,‡ the latter treating of the glaciation, distribution of boulders, and the post-glacial deposits, in some detail.

Topographical and Physical Features, Altitudes, etc.

Topography and elevations.

Topographically, the region under examination may be described as an undulating plateau with an average height of from 1200 to 1500 feet above the sea; but, in its details, it nevertheless presents highly diversified features. Three parallel elevated ranges traverse it, which, although interrupted in places, are yet conspicuous throughout, trending in a north-east and south-west direction, and constituting the extension of the Green Mountains into Canada in two or three spurs known as the Notre Dame Mountains.§ Of the three ranges referred to, the highest and most extensive is that forming the boundary between Quebec, and Vermont, New Hampshire and Maine. The elevation of this range, at certain passes where railway lines cross it, is as follows: On the Grand Trunk railway, just south of Norton Mills station, 1361 feet; on the Maine Central railway, at Beechers Falls, 1214 feet; and on the Canadian Pacific railway, at Boundary station, 1825 feet. Where the old Kennebec road, leading from Rivière du Loup to the

Mountain ranges.

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*Geology of Canada, 1863, pp. 886-930.

†Notes on the Post-pliocene of Canada, Can. Nat., 1872, The Can. Ice Age, 1893.

‡Annual Report, Geol. Surv. Can., vol. II. (N.S.), 1886, pp. 44-51 J; *Ibid*, vol. III., 1887, pp. 98-101 K.

§Annual Report, Geol. Surv. Can., vol. II. (N.S.), 1886, pp. 30-31 J.

State of Maine crosses it the height by aneroid is 1950 feet. Towards the head-waters of the St. John River this range is lower, and between the Chaudière and Daaquam rivers the region has no pronounced hill features, and does not exceed a height of from 1200 to 1500 feet.

The higher summits along the International boundary, between Lake Champlain and Lake St. John, often reach an elevation of 2500 or 3000 feet, and are conspicuous features in the landscape, being observable from almost every part of the "Eastern Townships." Higher summits.

The next parallel range to the north-west is narrow and much broken, stretching from Memphremagog Lake to Lake St. Francis, bearing the general name of the Stoke Mountain range, but known locally by different names, *e. g.*, Massawippi Mountains, Stoke Mountains, Dudswell Mountains, and St. Francis Mountains. Usually, it does not exceed a height of 1200 or 1500 feet, but some peaks rise to 2,000 feet or more.

The third range extends from the International boundary near Sutton Mountain north-eastward to Montmagny county, crossing the Chaudière valley at Beauce Junction, Quebec Central railway and throughout its whole length faces the St. Lawrence plain to the north-west. Its general elevation is from 1000 to 1500 feet; but several summits rise from 2500 to 3000 feet above the sea. Within the region under review, it is a broken range, intersected by numerous passes and river-valleys, notably those of the Etchemin, Chaudière, St. Francis and other rivers. Longitudinal valleys also traverse it. The height is greatest where it leaves the State of Vermont and passes into Canada, lowering towards the valley of St. Francis. Thence it gradually rises north-eastward to the Chaudière River and the township of Cranbourne. Third paralle range.

Between the mountains described are parallel valleys, occupied for the most part by later rocks than those constituting the three ranges. In these valleys thick deposits of superficial materials lie. The widest of these, between the International boundary and the Stoke Mountains, forms an undulating plain with an elevation of from 900 to 1500 feet. Along the line of the Maine Central railway, the height of this plain varies from 800 feet, near Dudswell Mountain, to 1660 feet as the International boundary is approached. The levels of the Grand Trunk railway show it to have a height of about 750 feet on the north-west, rising to 1250 feet or more on the south- Heights of valleys.

east, while the elevation where the Canadian Pacific railway traverses it, is from 750 to 800 feet on the west, to 1700 feet at Springhill near Lake Megantic. Along the Tring and Megantic branch of the Quebec Central railway, the elevation of this plain is from 984 feet at Tring Junction, on the divide between the St. Francis and Chaudière waters, to 1676 feet near Little Megantic Mountain, descending thence to 1325 feet at Lake Megantic.

Crossing this valley in a south-easterly direction from Robertson station, Quebec Central railway, 1195 feet high, on the divide referred to between the St. Francis and Chaudière rivers, and proceeding towards the foot-hills along the International boundary, it is found to be nearly horizontal or rather to have only a slight ascent. But to the east of this, within the drainage basin of the Chaudière River, this interior valley has a north-west slope again, as in the St. Francis River basin, from the divide between the first-mentioned river and the St. John.

General remarks on the contours of the district.

The elevation and contours of this large interior valley, bounded as it is by mountains on both sides, are described, because, though it has doubtless suffered much deformation, it seems to have been a basin for the accumulation of sediments from a very early geological period. The rocks occupying it are slates, sandstones and limestones of Cambro-Silurian age, with granite mountains at intervals rising above the general level. Taking the ranges and included valley together, they indicate that the region must have been for a long time above the level of the sea previous to the Pleistocene period, and have formed an area of profound denudation. This subaerial denudation must have lowered the surface several hundred, perhaps several thousand feet, especially where the rocks were more yielding, and thus the crystalline ranges and mountains have been left standing above the general level. To this evolution of topographic forms must be added the changes of contour which were brought about by orogenic and general changes of level, as well as those due to igneous causes during the protracted geological ages which intervened from the time the region became dry land till the present. These will be referred to in the sequel.

General and Local Changes of Level in the Region.

Changes of level.

An examination of the geological maps of the region shows that it is mainly occupied by three systems of geological formations, extending in parallel bands of greater or less width in a nearly north-east and south-west direction. The rocks composing these geological formations have been classified as follows commencing with the oldest: Pre-Cambrian (probably partly Huronian) consisting chiefly of schists, gneisses, etc.; Cambrian slates, sandstones, and quartzites, and Cambro-Silurian slates, limestones, etc. Intrusive rocks occur in these, most commonly in the Cambrian and pre-Cambrian. The rocks of these geological systems being different in character and hardness, they have, in their degradation, necessarily developed different topographical features, a result due probably to some extent also to differential vertical movements. A considerable body of facts has been obtained relating to these local or orogenic uplifts which will be referred to in the following pages. As will be shown from observations made in the country extending from the International boundary in the vicinity of Memphremagog Lake north-eastward to the Chaudière valley and Cranbourne, the areas occupied by pre-Cambrian and Cambrian rocks, appear to have been unequally uplifted relatively to the broad band of Cambro-Silurian to the south-east. This anticlinal movement seems to have commenced at a very early date in geological history, and was probably repeated at intervals since. Connected therewith, and apparently in some degree related to it, were eruptions of igneous rocks along the same belt. These eruptions have taken place at different geological periods. The fact that such mountains as Owls Head, Orford, Big and Little Ham mountains, Adstock, etc., which consist of igneous rocks, are the highest, or among the highest isolated summits in the "Eastern Townships" renders it probable that they owe their greater elevation, compared with the adjacent range, to their more recent origin, and to their having undergone less denudation. In corroboration of the conclusion that these mountains are of late origin, another fact may be added namely that dislocations of some of the river-valleys, notably the Chaudière at the Devils Rapids, the Famine River at the falls, caused evidently by these eruptive masses, appear to be of such recent geological date that the rivers have not succeeded since in cutting their channels down to the base-level of erosion.

Geological formations.

Orogenic movements.

Late origin of mountains of igneous rocks.

In regard to orogenic movements along the watershed at the International boundary, it is difficult to say whether this axis has been elevated differentially in a similar manner to the mountains near the St. Lawrence River during the pre-glacial existence of the ancient rivers referred to, although it seems probable that it has likewise undergone repeated uplifts from time to time. But which of the three mountain ranges in the "Eastern Townships" is really the oldest may be, after all, doubtful. A number of facts would seem, however, to favour the

Orogenic movements along the International boundary.

conclusion that the watershed along the International boundary was the original watershed. It seems to have been the axis of a wide range of collateral and subsidiary mountains for long ages, and the watershed of a number of very old rivers, and these facts, together with other circumstances, lend support to this view. The Cambro-Silurian plain, dissected by transverse river-valleys, rises towards this axis from the north-west, although its present contours may be quite different from those which existed when the valleys were being eroded. If, however, the rivers whose ancient courses traversed this interior valley flowed northwardly in their early stages, and there is no evidence to the contrary, then it is clear that the attitude which this valley now presents must have been assumed in early Palæozoic time, and it may, indeed, have had a greater slope then than at present, the direct courses and depth of some of these valleys strengthening this inference.

Disturbance of the rocks in the interior valley.

The interior valley referred to, as well as the mountain ranges on either side, bears evidence, however, of great disturbance and change of attitude. The rocks are tilted and faulted in a remarkable manner. As showing the stresses to which they have been subjected even in Post-Tertiary times, reference may be made to the dislocations and slips observed in them, in the areas occupied by Cambro-Silurian and Cambrian slates, in a number of places, since their surfaces were striated by Pleistocene ice. A few examples of these dislocations may be given.

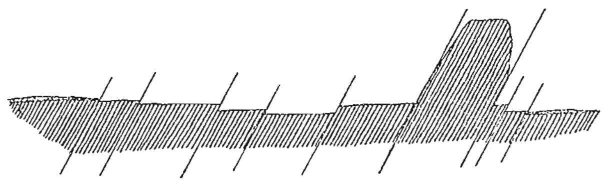
Dislocations of the strata since the glacial period.

In the southern part of the seigniory of Aubert Gallion, a band of slates about five feet in thickness, with a high dip to the south-east had been forced up about six feet higher than the rocks on either side. The displaced mass extends north-east and south-west for several hundred yards, though somewhat irregular as to height and thickness. On each side narrower bands or portions of the strata have also been displaced a few inches.

At St. Evariste de Forsyth.

At St. Evariste de Forsyth, Beauce county, a ridge of slate dipping about S. 30° E. $<$ 60° showed displacements since the glacial period, as represented in Fig. I., a band of these four feet in thickness having also been thrust up five feet and a half above the general level of the rock surface.

Fig. 1.



DISLOCATIONS IN GLACIATED SLATES AT ST. EVARISTE DE FORSYTH, BEAUCE CO., QUE.

SCALE :—10 feet to 1 inch.

The main dislocated band shown in Fig. 1, was traced about 600 feet, although broken down in places. The pressure or shove which forced up this mass of slates seems to have been from the south. After the first shove there appears to have been a settling down of all the slates except the four-foot band, followed by another, or perhaps several shoves, each apparently succeeded by a slackening in the pressure. The basset edges of all the slate bands are striated by ice which moved S. 56° E. Succession of movements.

East of Jersey Mills, dislocated slates with a downthrow of about three inches on the south-east occur. Other dislocations

In Ste. Marguerite settlement, to the east of Jersey Mills, a band ot glacially striated slates from six to eight feet thick is dislocated abouf four feet. The downthrow is on the north. Other minor dislocations of three or four inches also occur in these glaciated rocks.

At the International boundary, on the old Kennebec road, the striated Cambrian slates are dislocated in a number of places from three to six inches or more. Here also the downthrow was on the north side; but the surfaces are a good deal weathered.

Near the mouth of Gilbert River, a dislocation of from twelve to fifteen inches was observed in striated slates; downthrow to the north.

At MacLeod crossing, Canadian Pacific railway, east of Scotstown, dislocations of three inches or more in glaciated surfaces were noted; downthrow to the north.

On the road leading from Sherbrooke to Stoke Centre, five or six miles from St. Francis River, dislocations from two to six inches also occur in the slates.

West of Richmond Junction, Grand Trunk railway, a dislocation of three inches was seen in slates, the basset edges of which are glaciated.

On the west side of Orford Mountain a dislocation of four or five inches in a glaciated rock occurs. The downthrow is on the side towards the mountain, that is, on the north.

These dislocations and many others of small amount tend to show the changes recently, and perhaps, still going on in the outer crust of the earth in a region where it is supposed to have attained a considerable degree of stability. The slips or displacements are quite numerous in districts occupied by the Cambro-Silurian slates.

Slips near mountains or resisting masses.

A noteworthy circumstance in regard to the local dislocations or slips is that they seem often to have occurred near some ridge or mountain, or mass of resisting rocks, the downthrow being usually on the side towards it, or rather the sliding up of the slates has taken place on the side farthest from it. Whether this has been caused by a pushing up of the beds against this resisting mass, or by a slight sinking of such mass from cooling and contraction, or whether it is due to both causes, remains to be determined. The facts serve to show the instability of the outer crust even in the latest geological period.

Pleistocene Marine Shore-lines of the St. Lawrence Valley.

Shore-lines.

Besides the local and orogenic changes of level described, other movements have taken place in the Pleistocene period affecting not only the whole North-east Appalachians, but also the St. Lawrence valley and the Laurentides, and indeed, the whole of Eastern Canada. These were of a more general character, although, perhaps in some places, differential or orogenic. Investigations regarding these general oscillations are still in progress; but enough is known to give us a fairly accurate idea of their range or extent in the St. Lawrence valley.

Height of region in the later Tertiary period.

The data at hand respecting the height of that portion of Canadian territory lying to the south of the St. Lawrence River relative to sea level during the later Tertiary, appear to demonstrate that it stood considerably higher at that time than at present.* Except in the Lake

*Annual Report, Geol. Surv. Can., vol. VII. (N.S.), pp. 22-25 M.

Champlain basin, however, no new facts have been obtained specially bearing on this question. Lake Champlain is 402 feet deep in the deepest part,* and a large part of it has an average depth of 200 feet. Its mean surface level is 98 feet above the sea.

Here, therefore, we have what was probably a river valley, or a valley of denudation in the Tertiary, the depth of which below sea-level (304 feet) may be taken as a measure of the height of the land in that period relative to its present altitude. S. Prentiss Baldwin infers that the Lake Champlain district was in pre-glacial times at least from 300 to 500 feet higher than at present.† Be that as it may, the facts are in accord with those observed around the seaboard in Eastern Quebec and New Brunswick regarding the height of the region in the Tertiary period. On the advent of the glacial period, the North-east Appalachians seem to have maintained approximately the height at which they stood in the later Tertiary until they became enveloped in ice. Succeeding this was a subsidence, at the maximum stage of which the land in some parts of the region stood from 800 to 1000 feet lower than at the present day relative to the sea. A great gulf or estuary then occupied the St. Lawrence valley, which formed shore-lines or beaches when at its extreme height, and also others during its recession as the land rose. A preliminary table of the elevations of these shore-lines on both sides of the valley is given in the Summary Report of the Geological Survey for 1897, pages 66-68, but the levellings have been made with aneroids only, based on those of the nearest railway stations. In the present report, a general statement of the altitudes merely will be offered until instrumental levellings have been made at a few, at least, of the principal points.

Height of the North-east Appalachians in the glacial period.

Heights of shore-lines.

In the investigations regarding these shore-lines, the St. Lawrence valley has been traversed on the south side, from Métis to Lake Ontario, and on the north from Cap Tourmente, or Ste. Anne de Beaupré, to Lake Nipissing. Longitudinally, this valley may be said to ascend from the estuary and Gulf of St. Lawrence, of which it forms a part, and in its westward extension the bottom or plain preserves approximately the same gradient throughout till it enters the Lake Ontario basin. The tributary valley of the Ottawa also exhibits the same contours westward to Chalk River or beyond. From this point upward, as far as Mattawa, the valley rises more rapidly. Here it bifurcates, in one valley flows the Ottawa River, in the other its tributary, the Mattawa, the latter continuous to the Nipissing Lake basin.

Slope of St. Lawrence valley longitudinally.

*Report of the U.S. Coast and Geodetic Survey for the year ending June, 1887, pp. 165-166, 172.

† American Geologist, vol. XIII. No. 3, March, 1894, pp. 170-184.

Slopes transversely.

Transversely, the St. Lawrence valley ascends also from the river northward and southward to well-defined limits, although to the eye apparently a level plain. The plain abuts against higher slopes, and its margins can be traced almost as clearly as those of the Gulf of St. Lawrence at the present day. These margins are not, however, always uniform in height; but appear to have suffered deformation in a number of places. Skirting the valley or plain on all sides are terraces, beaches and benches, composed for the most part of stratified gravel, sand and clay, although occasionally a terrace or bench cut into the boulder-clay is met with. These mark the shores of the sea which invaded this valley in the later Pleistocene. Generally speaking, they form a series of three or more, the lowest distinct and continuous, the highest often interrupted. Like the bottom of the St. Lawrence valley itself, these shore-lines have an ascending gradient westward, that is, up the valley. This gradient is rather greater than that of the bottom of the valley, or of the marine plain; but neither is exactly uniform. Local deformations, or what may be termed a 'bulging up' of the surface, occur in places. Near the border of the plain these affect the shore-lines and probably the higher grounds also. Correlative local sags or reduced uplifts may likewise be noted. From Cap Tourmente on the north and Montmagny on the south, westward to Montreal Island, or to an imaginary line drawn across the valley from St. Jerome to Danville or Richmond, the shore-lines are practically the same height on both sides, evidencing thus far the comparative uniformity of the general uplift. Along the north side of the Ottawa, their gradient increases from St. Jerome as far westward as they have been traced, although apparently with more local deformation. On the south side of the St. Lawrence, the shore-lines seem to indicate a slightly descending gradient from Danville south-westward towards the International boundary; but, owing to most of the measurements having been made with aneroid only, they probably contain small errors.

Deformations.

Method of tracing shore-lines.

The method pursued in tracing the Pleistocene marine shore-lines of the St. Lawrence basin was to proceed from the known marine fossiliferous beds outwards towards the margin of the plain, and to follow those beaches which flank the slopes and face the open valley. Along the foot of the Notre Dame Mountains they are practically continuous from the gulf as far west as Richmond or Shefford; to the west of that they are more or less interrupted, or rather they are more difficult to trace.

All the measurements of heights were made with aneroids based on the levels of the nearest railway stations, except where otherwise noted, and are referred to mean sea-level. Localities where shore-lines were levelled.

	Feet.
1. At Gaspé Bay (Annual Report, vol. VII. (N.S.) pp. 22-25 M.); height, 225 to	230
2. Near Trois Pistoles, three shore-lines at 240 feet, at 345 feet, and at	375
3. South-east of Montmagny, or St. Thomas, three shore-lines at 250 feet, at 465 feet, and at	545
4. At St. Anselme Mountain, 15 miles south-east of the city of Quebec, shore-lines at 540 feet, and by sp. level at	559
5. West of Ste. Julie in Somerset, shore-lines occur at 626 feet, at 790 to 800 feet, and at	890
6. Near Danville, shore-lines at 675 feet, at 720 to 740 feet, at 830 to 860 feet, at 875 to	895
7. At Shefford Mountain, an isolated trap hill, shore-lines and benches at 650 feet, at 725 to 735 feet, at 815 to 820 feet, and terraces and ancient dunes and spits at 865 to	885
8. North and north-west of Abbott Corner, near Pinnacle Mountain, shore-lines and terraces at 790 feet, at 835 feet, and at	885

The last-noted locality is within a mile or two of the International boundary.

The high-level terraces and shore-lines have not been definitely traced beyond the boundary line into the Lake Champlain valley. Baron Gerard de Geer, when in America in 1891, levelled the height of one of these at St. Albans, Vermont, and found it to be 658 feet,* and there seems to be one, at least, at a lower level, and possibly another higher.

On the northern slope of the Adirondacks terraces and mounds of fine sand with gravel in places, underlain with stratified clay, the whole resting on boulder clay, were observed in the vicinity of Chateauguay station and Malone Junction, (Ogdensburg and Lake Champlain railway). The sands apparently formed ancient spits and dunes along the margin of the Pleistocene waters during the period of submergence, although now at an elevation of 1000 or 1100 feet. The slope where these deposits occur faces the open St. Lawrence valley, and descends with a comparatively even surface to the bank of the St. Lawrence River. The present streams flowing down the mountain side have cut deep, narrow, trench-like channels into these beds, thus showing that they are comparatively new, and indicating Dunes and spits along northern Adirondacks.

* Proc. Boston Soc. of Natural History, vol. XXV., 1892, p. 469.

that the region has been uplifted at a recent date, geologically speaking. Much more detailed examination is necessary to trace out the shore-lines here, however, than the time at my disposal would allow.

Character of deposits on lower levels of St. Lawrence valley.

On the lower levels of the St. Lawrence valley, south-west of the International boundary and of Cornwall, it was found that the deposits on both sides of the river, as far as the Lake Ontario basin, are of the same character as those to the north-east. Northward and south ward the surface of these gradually ascends to limits which have not yet been definitely traced, but are probably coincident with the lowest of the series of shore-lines which border the great valley. The eastern portion of the Iroquois beach, where it has been levelled, seems to form one of the limits referred to. These beds evidence submergence with deposition of sediments and subsequent uplift.

Iroquois beach.

High-level shore-lines on northern slope of Adirondacks.

Although the high-level shore-lines have not yet been fixed and levelled along the northern slope of the Adirondacks to the east of Fine or Watertown, State of New York, there seems little reason to doubt that they are continuous or practically continuous with those to the north-east of the International boundary, and the inference, tentatively held, is that they all belong to the same system of shore-lines, the northern part of the Adirondacks having undergone a greater differential uplift than the region to the north-east and probably also greater than that to the south-west. A similar local uplift above the normal gradient, although much less in vertical range, occurs in the shore-lines between Ste. Julie and Richmond, Quebec.

Shore-lines on north side of St. Lawrence and Ottawa rivers.

On the north side of the St. Lawrence and Ottawa rivers the shore-lines, as already stated, were traced from Cap Tourmente or Ste. Anne de Beaupré, along the ascending grade as far as Algoma or Lake Nipissing. The upper border of the marine sediments of Pleistocene age can, in many places, be followed more closely and to better advantage on the north side of the valley than on the south side; but in other places it runs in among the Laurentian hills forming a very irregular line. Generally speaking, however, the border of the Pleistocene area is coterminous with that of the lake area of the Laurentide plateau, the marine sediments having apparently filled in all the smaller lake basins to the limit of submergence. Commencing at the above-mentioned places, the heights of some of the shore-lines at a few of the principal points, as measured by aneroid, are as follows :—

Localities where observed.

	Feet.
1. At Ste. Anne de Beaupré, terraces or shore-lines at 350 to 355 feet, and at	540
2. North-west of Quebec city, near Charlesbourg, shore-lines at 450 feet, and at........	560

Feet.

3. Near St. Raymond, on the Quebec and Lake St. John railway, terraces and shore-lines at 635 feet, and at............ 660
   Pleistocene marine shells were found in this vicinity at a height of 515 feet *above high tide level*, by Mr. A. P. Low, of this Survey.*
4. At St. Jerome, on the west side of Rivière du Nord, shore-lines at 620 to 625 feet, at 730 feet, at 765 feet, and at 895 to 900
5. North of Lachute, shore-lines at 600 to 625 feet, at 740 to 745 feet, at 845 feet, at 885 to 900 feet, and at.................. 975
6. At Kingsmere Mountain, north of the city of Ottawa, terraces and shore-lines occur at different levels, viz. : at 480 feet, 705 feet (de Geer), at 800 feet, 925 feet, and a doubtful one, not properly levelled, at................................. 965

Probable irregularity of upheaval north of the Ottawa.

Between forty-five and fifty miles of the Ottawa River, namely, from Allumette Rapids to Rapides des Joachim is lake-like and in places reported to be 200 feet deep, or more. If the depth stated is correct, the bottom of the channel there lies as low or lower than at the Chaudière Falls immediately above Ottawa City, 138 miles further down. This fact with the general features of the valley as far up as Rapides des Joachim, indicates that there may have been a local sag or reduced uplift here. Between Rapides des Joachim and Lake Nipissing, however, the Pleistocene upheaval seems to have been greater than to the eastward. On the north side of the Ottawa within this distance, terraces and other evidences of submergence are rare; but on the south we find heavy beds of fine stratified sand, with stratified clay beneath, the whole resting on boulder clay, which occasionally rises to the surface through the overlying series. Deposits of this kind are abundant at various places from Madawaska River westward to Klocks Mills or beyond, and are often deeply denuded on the higher grounds; but on the lower contain marine shells of Pleistocene age. They are especially noteworthy on the Ottawa, Arnprior and Parry Sound railway between Douglas and Barrys Bay stations, the latter 942 feet high. The summits of the sand-hills rise 100 to 150 feet above the railway track, and face the Ottawa valley at an elevation of 1000 feet or more. The same series of beds is extensively developed at Deux Rivières where they rise to about the same elevation.† They appear to be a great development of Saxicava sands marking the upper limit of the Pleistocene submergence in this part of the country.

Saxicava sands.

High-level beaches at North Bay, Ont.

High-level beaches, 1100 to 1200 feet occur north of North Bay, first observed by Mr. F. B. Taylor.‡ Whether these beaches are

* Annual Report, Geol. Surv. Can., vol. V., N.S., p. 55 L.

† Am. Geologist, vol. XVIII., p. 114. Paper by F. B. Taylor.

‡ Bull. Geol. So. Am., vol. V., 1893. Am. Geologist, vols. XIV. and XVIII.

marine, as first supposed by him, or due to the interruption of drainage by glacier-dams, has not yet been determined. Extensive deposits of sands and silts, implying submergence are spread over this part of the country up to a height even greater than that of the beaches referred to, which have been described in early reports of this Survey as Algoma sands. These await detailed investigation and study.

Beaches north of the Great Lakes.

In that part of the province of Ontario lying between the Ottawa and Mattawa rivers and the Great Lakes to the south, the evidences of submergence have been only cursorily examined by me. Elevated sand, gravel and clay beds resting on boulder-clay occur in numerous places, and beaches regarded as lacustrine by some and marine by others, have been traced by Spencer, Lawson, Taylor and other geologists along the north and north-east sides of the great lakes, Ontario, Erie, Huron and Superior. The question of the origin of some, if not all of these, is still under discussion; but on any hypothesis we must postulate a considerable upheaval of the region, although, so far as observations have extended, one which can be closely correlated with that of the Great St. Lawrence valley to the east of the Thousand Islands and Rapides des Joachim in the Ottawa valley.

Conclusions respecting uplift raising the beaches.

The conclusions which may be tentatively drawn from the foregoing facts, with reference to the Pleistocene uplift, are that the general elevation of the St. Lawrence basin, in the later Pleistocene, was unequal or differential throughout, increasing to the westward as far as the watershed to the north and north-east of the Great Lakes; but that some portions of the country were raised higher than others, the uplift being unequal locally as well as generally. And the hypothesis held by Spencer and Taylor, that the upheaval which raised the marine plain of the St. Lawrence valley and the shore-lines bordering it, was the same as that which elevated the beaches around the Great Lakes, seems to be supported by the evidence at hand. In the latter region, the uplifting force has probably acted along several axes not always parallel to each other, but conforming perhaps more or less to the longitudinal direction of the basins of these bodies of water. The period of these crustal movements appears to have been that of the deposition of the Saxicava sands, or rather that of its closing stage. Much faulting and displacement occurred, and there were doubtless upward and downward complementary oscillations of greater or less amount and complexity, the upheaval of so considerable a portion of the region near the Great Lakes presumably implying a corresponding downward movement in the basins occupied by these It is not at all improbable, therefore, that it was at this stage of the

Pleistocene that the lake basins attained in part their present form and dimensions, and sank so far below the level of the surrounding country.

In the "Eastern Townships" of Quebec, and along both slopes of the St. Lawrence valley, evidences of changes of level of another and more local kind came under observation. These are best shown in the dislocations of river-valleys, and in the changes produced in river-courses, causing waterfalls and rapids, and in some cases a total diversion of a river from its old channel. Crustal movements of this kind may have been partially effected in the Pleistocene period; but there are reasons for believing that they are also of much older date, extending as far back as Mesozoic, and probably Palæozoic times.

Other changes of level in "Eastern Townships."

A description of the changes which have taken place in the contours of the region, as evidenced by the erosion and base-levelling of rivers, necessarily involves a discussion of the origin of river-valleys and lake-basins. Those of the district specially under review will now be briefly referred to.

Rivers and Lakes of South-eastern Quebec.

Abundant evidence has been obtained to show that the rivers and lakes of the region are of great age, geologically speaking, some of them having registered the changes of level, orogenic or destructive to which it has been subjected ever since Palæozoic times. The Chaudière and St. Francis, the two largest rivers, flow transversely to the general trend of the mountain ranges and intervening valleys, and have cut channels through the range nearest the St. Lawrence River down nearly to the base-level of erosion. That the courses and valleys of some of the rivers, notably the St. Francis, have been affected by orogenic movements is certain. Lake St. Francis occupies part of the valley of an ancient river which trenched the Cambro-Silurian and Cambrian rocks. It seems also possible that Lake Megantic lies in another part of the same ancient valley. This river-valley has been dislocated by orogenic movements which occurred in the crystalline range nearest the St. Lawrence and possibly also in that along the International boundary. Whether Trout Lake, Williams and St. Joseph lakes likewise occupy dislocated portions of the old river-valley mentioned has not been determined for lack of time to make a complete examination, but it seems probable.

Changes of level evidenced by drainage.

St. Francis River.

The drainage of the area around Lake St. Francis now finds outlet by the St. Francis River, the upper part of which trends at right angles to the course of the ancient river, and to the lower part of the present river,—a change produced by the dislocation of the ancient valley due to the differential uplift of the belt of Cambrian and pre-Cambrian rocks to the north-west, as stated. Different portions of the St. Francis River valley appear to be of different ages. The Coaticooke and Massawippi rivers seem to have been originally the chief upper portions of the present St. Francis River, although that portion between Sherbrooke and its source in St. Francis Lake is doubtless also of a very ancient date.

Massawippi River.

The old valley now occupied by Massawippi River and lake appears likewise to have suffered dislocation, although extending parallel to the trend of the geological formations instead of transversely, as St. Francis Lake does. Massawippi Lake has been thus produced. Little Magog Lake, lying parallel thereto along the western border of the Cambrian belt, occupies a dislocated portion of another ancient river-valley, the extent of which cannot now very well be traced, though apparently effected also by the vertical movements of the pre-Cambrian and Cambrian rocks to the south-east.

Memphremagog Lake.

In the basin of Lake Memphremagog, however, we find important evidence of the differential or orogenic movements which have taken place in the region. This lake also occupies a portion of an ancient river-valley, extending from the rivershed to the south of the International boundary, in the State of Vermont, northward by way of Fraser and Brampton lakes; thence by Salmon River to the St. Francis valley. This old valley is traceable at the present day across the valley of the St. Francis between Windsor Mills and Richmond Junction, passing to the north of Shipton Pinnacle, and reaching the great St. Lawrence plain at Danville. It can thus be followed for upwards of 85 miles, and is probably older, geologically speaking, than the valley of St. Francis River, which has intersected it transversely at a wide angle, apparently at a later date. Silurian limestones occupy a portion of the Lake Memphremagog basin, showing its pre-Silurian age.

The dislocation of this ancient Memphremagog valley has also been caused by a differential uplift, or series of uplifts, of the pre-Cambrian and Cambrian belt which crosses it. The first of these movements probably took place in early Palæozoic time; but there were doubtless others at later periods. The very latest is probably related to the igneous eruptions of the region, and may have been partly produced by them. That there have been more than one of these eruptive periods is assumed by Ells,* and seems probable as far as regards the diorites and

* Annual Report, Geol. Surv. Can., vol. VII. (N.S.), p. 77 J. *Ibid.*, vol. II. (N.S.), p. 41 I.

diabases. Correlatively with the uplifts there seem to have been dislocations and subsidences, as evidenced by the ancient lake-basins referred to.

Chaudière valley.

The Chaudière valley is, apparently, an exception to the rule, but a detailed examination shows that it also has sustained a dislocation and differential uplift in one part, with a corresponding sag or subsidence in the part of its course crossed by the Cambro-Silurian rocks above the Devils Rapids. The axis of the uplift, apparent even at the present day, occurs in a district of intrusive rocks. At the Devils Rapids, where these eruptives have produced the dislocation referred to, the waters now flow over bed-rock, and there is no appearance of an old filled-in passage of the river on either side. Above that point, as far as the mouth of Rivière du Loup, the bed-rock in the bottom of the Chaudière valley seems to lie lower than it does at the rapids referred to. Mr. W. P. Lockwood informs me that in a flat just above the last-mentioned point, on the east side of the Chaudière River, he sank a shaft 70 feet deep without reaching bed-rock. Opposite Jersey Mills, on the west side of the Chaudière River, a shaft, the mouth of which is about twenty feet higher than the level of the river at the nearest point, was sunk a few years ago to a depth of 77½ feet wholly in boulder-clay without reaching the bottom of this deposit. The difference in level between the Chaudière River at the Devils Rapids and at the point nearest the shaft mentioned, is, approximately, forty feet by aneroid, so that it appears this shaft has penetrated the boulder-clay to a depth nearly twenty feet lower than the present level of the river at the Devils Rapids without reaching the bed-rock.

Shafts sunk in Chaudière valley.

Mr. Lockwood also informs me that another shaft was sunk near the mouth of the Gilbert River, on the east side of the Chaudière, to a depth of sixty feet, but rock was not reached. Sections of the deposits passed through in the two shafts referred to sunk under his direction, are given on a later page.

Synclinal basin in Chaudière valley.

From the evidence afforded by these three shafts, it would seem that a great basin, or a sag corresponding with that observed at Lake St. Francis and to the south-westward, also occurs here. That the part of the Chaudière valley from the Devils Rapids as far up as Big Falls is not now occupied with a lake corresponding to St. Francis, Massawippi and Memphremagog lakes, is most likely because a much larger volume of water seeks outlet by this river, and consequently the barrier at the Devils Rapids has been worn down, though not as yet to the base-level of erosion. But it is pretty certain that a lake once existed here in pre-glacial time, and another in the Pleistocene period. The great quantities of sand and clay beneath the boulder-clay evidence a long period of slack drainage in this part of the Chaudière valley before the advent of the ice age, while terraces and benches of stratified materials overlying the boulder-clay would seem to favour the conclusion that a post-glacial lake also was held in here by a barrier at the Devils Rapids, which was subsequently drained out to the present level by the partial erosion of this barrier.

Depth of material in the basin.

The depth of boulder-clay and of other overlying stratified beds in the valley of the Chaudière between the Devils Rapids and the mouth of the Rivière du Loup shows the amount of material which has been thrown into this basin by glacial action and by that of the drainage-waters of the country, fluviatile and lacustrine. It is probable also that the sea invaded this portion of the Chaudière valley during the Pleistocene submergence of the St. Lawrence valley, and that the deposits may be partly estuarine.

Long north-and-south lakes.

The foregoing facts and inferences are offered with the view of explaining the origin of the long, narrow north-and-south lake basins of the region, and of the present rivers and lakes. The great age and persistency of these ancient drainage systems is a noteworthy feature.

Why their basins have not been filled up.

In regard to these long north-and-south lake-basins, the question arises why if they are pre-Pleistocene, have they not been filled in and obliterated during the glacial period and subsequently by sedimentation. There is no doubt that portions of the original valleys have thus been filled in and levelled off, so that it is difficult, if not impossible, now to locate their position continuously; but other parts have from certain causes not been filled up in this manner, and it is these which now hold the lakes referred to. The correlative subsidence or sag of the wide belt of country lying between the ranges traversing the "Eastern Townships" of Quebec during the orogenic movements already referred to, also aided in the formation of these lake basins. That their bottoms have been partially filled up during the Pleistocene period there seems no reason to doubt. The present condition of the Chaudière valley between the mouth of Rivière du Loup and the Devils Rapids proves this; but owing to the scooping or erosive action both of the northward and southward moving ice-masses, as well as to the fact that portions of them never seem to have been altogether filled with drift even during the glacial period, they exist as we now find them,—receptacles for the drainage waters of the surrounding country.

DENUDATION OF THE REGION.

Since this region rose above the sea in Silurian or Devonian time, it has been the theatre of a vast amount of denudation and base-levelling from subaerial, fluviatile and lacustrine agencies, as well as from that due to glacial and marine action. This denudation is well exhibited in the interior valley lying between the range along the International boundary and Sutton Mountain and its prolongation north-eastward, and is especially noticeable in the great St. Lawrence valley. It is observable indeed, in every part of the region under review. The bottom of the St. Lawrence valley is an extensive, denuded or base-levelled plain, this and the Carboniferous area of New Brunswick being the largest of the plains which have been reduced nearly to a uniformly level surface in Eastern Canada. The former has doubtless undergone repeated oscillations of level and deformations, both regional and local, accompanied by more or less faulting and dislocation since its latest rocks were formed; nevertheless these have in most parts preserved their original position and horizontality in a remarkable degree. Into the history of the causes which produced the denudation and uniform levelling of the bottom of this valley, we do not propose here to enter, leaving this for a succeeding report, but will pass on to the consideration of the agencies which have produced the present condition of the surface on the south side of the valley, especially in their bearing on the distribution of the auriferous drift.

Denudation of the region, how caused.

It has been shown on a previous page that the rocks of the "Eastern Townships" extend in parallel bands in a north-east and south-west direction, and consist of three series, each of which is characterized by a different degree of hardness or capacity for resisting erosion, hence the old gneisses and schists now occupy the more elevated portions of the country, while the belts underlain by slates and limestones have suffered the most wear and denudation. In areas of Cambro-Silurian rocks, although the strata are everywhere tilted at a high angle, they are, nevertheless, worn down nearly to a uniform surface, which in some places is so level as to resemble a marine plain. This is especially the case on the divide between the Chaudière and St. Francis waters, also westward towards Lake Megantic, and about the source of Ditton River. Comparatively level tracts were also observed on both sides of Coaticook River, and in a number of other places. Crustal movements have doubtless taken place at repeated intervals here throughout the geological history of the region, producing deformations; but notwithstanding these the agencies of erosion have unceasingly continued their work of reducing it to a base-levelled

Base-levelling.

surface. Taken as a whole it now presents, therefore, different physiographic features from what it did originally, or indeed, at any intermediate stage of its geological history.

Conditions affectingriver-valleys.

The ancient river-valleys, dislocated portions of which now only remain, would, however, seem to show that the wide interior valley above referred to, occupied by Cambro-Silurian rocks, must have assumed nearly its present relations in early Palæozoic ages, as the rivers have followed a considerable gradient for a long time, geologically speaking, until their channels became interrupted by the orogenic uplifts shown on a previous page. The denudation and general lowering of the surface has been greatest in the drainage basins of the St. Francis and Chaudière rivers, these having sufficient erosive power to cut passages for themselves through the range of mountains nearest the St. Lawrence (the Sutton Mountains) and wear their channels down nearly to the base-level of erosion. The other rivers flowing in this interior basin, not having such power of erosion, had to seek outlets by the Chaudière and St. Francis, being unable to cut channels for themselves directly across the range referred to. Between the erosion of these latter rivers and the orogenic forces which raised the Sutton Mountain range there would seem to have been a long struggle for the mastery, hence we find the old channels of these still traceable across the uplifted belts or mountain ranges with more or less distinctness. But the orogenic forces seem ultimately to have gained the ascendancy and the dislocated portions of the ancient river-valleys in the synclinal basins became receptacles for the drainage waters, and thus formed the long narrow north-and-south lakes already described. The lakes seem to have stood at considerably higher levels at one time than they do now, before wearing down their present outlets. All the ancient rivers of the region have thus been forced to cut out new channels for themselves by the orogenic upheaval referred to, except the Chaudière and the lower part of the St. Francis.

How the long north-and-south lakes were formed.

Transportation of material.

The transportation of material by the Chaudière and St. Francis rivers from their upper drainage basins towards the St. Lawrence plain throughout their long existence must have been enormous. Notwithstanding the large amount of eroded material thus swept away, and the consequent reduction of the land surface within the drainage basins of these two large rivers to a lower level than in other parts of the interior valley occupied by Cambro-Silurian sediments, yet thick sheets of superficial deposits mantle and conceal the rocks from view everywhere within this valley. The hill and mountain ranges present their denuded summits, often of bare rock, above the valleys while intrusive masses, such as Owls Head, Orford, Big and Little Ham mountains loom up above the whole surrounding country, imposing in their isolation.

The deposits now occupying the surface of the region, being largely boulder-clay, have a preservative effect upon the rocks, and therefore, except on summits bared by ice-action, and along river-valleys, there must be less subaerial or atmospheric disintegration going on than in pre-glacial ages. The glacial period itself was, however, one of great denudation, and had a wonderful levelling effect, sweeping the material off the higher ground and filling the valleys. This agency and its effects upon the distribution of the deposits of the region may now be considered. Protective effect of deposits.

GLACIATION.

The glaciation of the St. Lawrence valley presents many remarkable and complex features. Three or more systems of land-ice and at least one system of floating ice are indicated by the facts collected in the field. First, there seems to have gathered upon the North-east Appalachians a glacier or system of glaciers in the early Pleistocene, independent of any other ice-sheet. This ice flowed outward from one or more central gathering-grounds in radial lines, northward, eastward and southward. The main *névé* appears to have been in northern New Hampshire and in the "Eastern Townships" of Quebec. This is the ice which produced the principal striation of the province of Quebec east of the Chaudière River and head of the St. John waters, also the striation of New Brunswick and the New England States. The striæ of the Appalachian glacier have been traced on the south slope of the St. Lawrence valley nearly from the International boundary down to the foot-hills and in some places to the bottom of the marine plain. Glaciation of the region. Appalachian glaciers.

Succeeding this was the invasion of ice from the north and north-west,—the Laurentide or Labradorian glacier of Dr. G. M. Dawson and Mr. A. P. Low,—the southern and south-eastern limits of which will be defined in the sequel. Below the city of Quebec no evidences of this ice having crossed the St. Lawrence River were found. Laurentide glacier.

A second glacier or system of glaciers flowed off the Laurentian plateau in a south-westerly direction, the striation produced by it having been observed principally upon the southern slope of the plateau and in the bottom to the St. Lawrence valley. This striation is later than the south to south-east striation and is superposed on it.

Local glaciers. Towards the close of the glacial period, during the melting or retiring stage of the glacier systems referred to, a number of local glaciers crept down the slopes in various directions as they were influenced by the topographical features.

Floating ice. The lower slopes and the rock surfaces in the great marine plain of the St. Lawrence valley, have been striated by ice which appears to have been sea-borne and to have been carried westward, or up the valley. This implies a submergence of several hundred feet below the present level.

In the following list of striæ each of the three or four systems will be separately grouped in what seems to be their chronological order. The data upon which they have been separated are the courses of the striæ, with the stoss side noted wherever observed; the weathered condition of the rock surfaces glaciated by the earliest ice as compared with that of those striated by the latest ice; the superposition of one set of striæ upon another on the same exposures, the character of the boulder-clay produced by each, etc.

The striæ are all referred to the true meridian, and the elevations to mean sea-level.

Stoss side. To avoid repetition, the word "stoss side," though not used, is to be understood with a reverse bearing after each recorded observation of the courses of striæ. Where the "stoss side" is not known, or is uncertain, the fact will be stated.

Striæ produced by the Appalachian System of Glaciers.

Striæ of Appalachian ice.

No.

1. At Ste. Flavie, N.
2. Near Bic station, Intercolonial railway, N. 20° W. and N. 30° W.
3. At Trois Pistoles station, Intercolonial railway, N., N. 2° E., N. 5° E., N. 20° E., N. 24° E., N. 35° E., N. 40° E., N. 45° E., N. 50° E., N. 55° E., N. 58° E., N. 64° E., and N. 74° E.; also N. 4° W., N. 5° W., N. 10° W., N. 12° W., N. 14° W., N. 20° W., N. 26° W., N. 32° W., N. 34° W., N. 36° W., N. 40° W. The dominant course is N. 2° E.
4. In the second concession behind Trois Pistoles, N. 20° W. Height 435 feet.
5. In the third concession, N. 40° W., and N. 50° W.
6. At Rivière du Loup, in the second concession, N. 18° W., N. 25° E., etc.
7. On the Temiscouata road, near St. Honoré, N. 40° W.
8. Near Montmagny station, Intercolonial railway, N. 62° E., N. 67° E., and N. 72° E.
9. South-east of Montmagny station, N. 22° E., N. 52° E., N. 62° E., N. 72° E.; also N. 8° W., and N. 18° W. Height 465 feet.
10. Ten or twelve miles south-east of Montmagny station, N. 8° W., N. 32° E., and N. 42° E. Height 1,400 feet.
11. A mile or more south of St. Gervais village on the road to St. Lazare, N. 38° E., and N. 52° W.

Striæ of Appalachian ice—*Cont.*

12. Further south on the same road, N. 43° E.
13. Half way between St. Gervais and St. Lazare villages, on great bosses, N. 33° E.
14. At St. Lazare, N. 33° E., N. 43° E., and N. 7° W.
15. On the road from St. Lazare to St. Clare, N. 7° W. (See No. 328).
16. West of last observation, N. 2° W.
17. Two concessions west of St. Lazare, on St. Clare road, N. 61° W. (Later, S. 87° E.)
18. East side of St. Clare village, N. 7° W., N. 17° W.
19. West of St. Clare, on St. Anselme road, N. 22° W., and N. 25° W.
20. At northern base of St. Anselme mountain, 15 miles south-east of Lévis, N. 43° E. Height 555 feet.
21. On top of St. Anselme mountain, N. 47° E., and N. 62° E. Height 630 feet.
22. At Ste. Marguerite, N. 7° W. Height 1,120 feet.
23. In another place at Ste. Marguerite, N. 42° W.
24. On road from Bisson to Sts. Anges, N. 44° E. Height, 850 feet.
25. Three miles west of West Frampton, N. 27° E., and N. 61° E. Height, 1,460 feet.
26. To the south-west of West Frampton, N. 42° W.
27. Further to the south-west, on the same road on which No. 26 striæ were seen N 7° W.
28. Some rods further to the south-west, N. 1° E. Well defined.
29. On the southern brow of the same ridge, N. 17° W., and N. 3° E.
30. South-west of St. Odilon, N. 6° W., and N. 4° E.
31. Between Colway and Des Plantes rivers, N. 6° W., N. 4° E. etc.
32. On road on south side of Rivière des Plantes, N. 19° E., N. 24° E. Height, 775 feet.
33. Half a mile east of Ste. Rose church, N. 9° E. Height, 1,485 feet.
34. On road from Etchemin Lake to Culdaff P.O., N., 9° E.
35. On the same road nearer Culdaff P.O., N. 16° W.
36. South-east of Culdaff P.O., N. 16° W., and N. 1° W. Doubtful whether these are earliest or latest.
37. About two miles east of limits of Rigaud Vaudreuil seigniory, N. 16° W. Similar courses occur to the west within three miles of St. François village.
38. East of Jersey Mills P.O., N. 15° W., N. 20° W., N. 22° W., and N. 2° W. The last may belong to the latest glaciation.
39. On hill slope between St. François and Gilbert River, N. 17° W. Height, 800 feet.
40. South-east of St. Francis station, Quebec Central railway, N. 62° E.
41. In another place near above course, N. 4° E.
42. At Marlow, P.O., N. 26° W., N. 36° W., and N. 46° W.
43. On Lot 30, Linière, N. 46° W.
44. East of road between St. Henri and St. David concessions, Aubert Gallion, N. 5° W. Height, 920 feet.
45. West of Chaudière River at St. François, Beauce, N. 6° W.
46. Along second concession road W. of St. François, N. 14° E., N. 24° E. Height 1,120 feet.
47. On same road further north, N. 6° W.
48. South of Bras River, west of Chaudière, N. 4° E. Height about 860 feet.
49. On road going from Ste. Marie to St. Sylvester, near Rivière Beaurivage, N. 4° E.
50. East of St. Victor de Tring, N. 12° E. Height, 1,225 feet.
51. In another place nearer St. Victor de Tring, N. 10° E.
52. West of same place, N. 16° E., N. 20° E.
53. Further west of St. Ephrem de Tring, N. 14° E. (*See* No. 272.)
54. Near St. Ephrem on hill summit, N. 2° E.
55. North of St. Ephrem, on road to Broughton, N. 12° E., and N. 18° E. Height 1,250 feet.

Striæ of Appalachian ice—*Cont.*

56. Six or seven miles from Broughton, on same road, N. 2° E. with a S. 66° E. set superposed on it. Also N. 36° W. Height, 1,250 feet.
57. About five miles south of Broughton station, Quebec Central railway, N. 2° E. with S. 66° E., striæ also.
58. Near Broughton station, N. 6° W., N. 12° W., and N. 14° W.
59. On road from Broughton to Leeds and Inverness, N. 9° E.
60. Near Leeds on northern slope of range, N. 24° E. Height, 1,360 feet. This course occurs on several exposures here.
61. Between Leeds and Inverness, N. 12° E., N. 16° E.
62. Near brow of mountain before descending on marine plain of St. Lawrence Valley, N. 14° E. Height, 895 feet.
63. South of Ste. Julie, near Bate, N. 52° E., and N. 64° E. Height, 1,000 feet.
64. South-east of Wolfestown, N. 1° W. Height about 1,250 feet.
65. On same road, near Nicolet Lake, N. 2° W., crossed by a later S. E. course (No. 246.)
66. Still nearer Nicolet Lake, N. 16° W., N. 14° W. Height about 1,000 feet. Also crossed by a S. E. course.
67. North of South Ham, N. 20° E. Height, 960 feet.
68. At South Ham, N. 5° W., N. 15° W., and N. 25° W. Crossed by S. E. striæ, (No. 241.)
69. Between South Ham and Marbleton, N. 10° W., and N. 15° W. Numerous.
70. At limekilns, Marbleton, N. 25° W., and N. 30° W.
71. West of St. Romaine, N. 5° W., N. 10° W. Height about 1,400 feet.
72. Two miles east of Forsyth. (Also No. 275.)
73. Half way between Forsyth and St. Ephrem, N.
74. Three miles from East Angus, on road to Cookshire, N. 35° E.
75. About a mile from Cookshire, on same road, N. 25° E., and N. 30° E.
76. Two or three miles south-east of Scotstown, near Canadian Pacific railway, N. 35° W., N. 45° W., and N. 63° W. Height about 1,200 feet.
77. Near MacLeod crossing, N. 56° W., in several places.
78. North of Nadeau crossing, Canadian Pacific railway, and east of Lake Megantic, N. 46° W., and N. 66° W., besides (No. 189).
79. On Stoke Centre road, north of St. Francis River, N. 55° E. Height, 680 feet.
80. On the same road, five miles from St. Francis River, due W.
81. Further to north-east, N. 45° W. Height, 865 feet.
82. At slate quarry near Danville, N. 18° W.
83. West of Danville, N. W. Height, 750 feet.
84. At Stoke Lake, N. 55° W. Height, 800 feet.
85. South of Stoke Lake, N. 55° W. Numerous.
86. Seven or eight miles east of Windsor Mills, N. 85° W. Height, 850 feet.
87. About two miles east of Windsor Mills, S. 85° W. Height, 600 feet.
88. One mile east of Windsor Mills, N. 75° W., N. 83° W., and S. 85° W. Height, 600 feet.
89. West side of St. Francis River, opposite Windsor Mills, N. 85° W. At Kingsbury, N. 85° W. Height, 590 feet.
90. On the east side of Shefford Mountain, N. 45° W.
91. On road from Knowlton to Sweetsburg, N. 20° W. In another place further north, N. 5° E.
92. Three or four miles from Sweetsburg, on same road, N. 83° W., crossed by a southerly trending set, (No. 150.)
93. Another exposure shows N. 83° W., crossed by a later set S. 57° W.
94. Two miles from Sweetsburg, N. 87° W., varying to S. 57° W., crossed by a later set, (No. 150.)

95. South-west of "Pinnacle," Sutton Mountain on road from Abbott corner to Richford, Vermont. N. 62° W., and S. 88° W. Numerous. In other places in this locality N. 42° W., N. 52° W., etc. (See No. 138.) Striæ of Appalachian ice—*Cont.*
96. South of Phillipsburg, Missisquoi Bay, N. 38° W. Imperfect.

Striation produced by the earlier Laurentide Glacier.

97. At St. Eustache, north of Portneuf, Canadian Pacific railway, S. 12° E., S. 45° E. Height, 375 feet. Striæ of earlier Laurentide glacier.
98. Near Belair station, Canadian Pacific railway, S. 84° E. (This ice moved down the valley of Rivière du Cap Rouge.)
99. At Grand' Mère, St. Maurice River, S. 25° E. Height, 675 feet.
100. South of Maskinonge Lake, S. 28° E., and S. 33° E. Height, 675 feet.
101. In another place near Canadian Pacific railway track, S. 18° E. Height, 650 feet.
102. Further south, S. 13° E. and S. 9° E. Height, 640 feet.
103. At St. Jerome, S. 32° E., S. 30° E., S. 8° E., S. 3° E., S. 3° W., and S. 16° W. Height, 320 feet.
104. On a boss on bank of North River, at St. Jerome, S. 12° E. and S. 50° E.
105. At iron mines, west of St. Jerome, S. 5° W.
106. North of St. Jerome, S. 22° E. and S. 40° E. Height, 735 feet.
107. At Ste. Camille, S. 12° E.
108. On the road from Lachute to Dunany, S. 12° E. Height, 475 feet.
109. North of Lachute, S. 12° E. and S. 32° E.
110. North-east of Calumet, S. 18° W. and S. 28° W. Height, 530 feet.
111. On the road going north from Calumet station, Canadian Pacific railway, S. 2° E. and S. 12° E. Height, 635 feet.
112. Along Rouge River valley, one mile north of the Canadian Pacific railway station, at Calumet, S. 2° E. Height, 400 feet. Further up river, S. 17° E., in two places. Height also 400 feet.
113. North of Papineauville, S. 9° W.
114. North of Buckingham, near Mayo, two courses, S. 31° E. and S. 9° W. to S. 14° W. On weathered exposures.
115. Near last mentioned locality, viz., at Emerald mine, S. 11° E.
116. West of Buckingham, glaciated bosses with two stoss sides occur, one to the north, another to the east; but no distinct striæ were detected.
117. Near Old Chelsea, in Gatineau Valley, S. 10° E. to S. 20° E.
118. In Chichester, opposite Pembroke, S. 29° E. Heavy. Height, 625 feet.
119. At Chippewa Creek, two or three miles north of North Bay, S. 14° W.
120. On ledges north of North Bay, S. 4° W. and S. 9° W. Height, 660 to 670 feet.
121. At Klock's Mills both the southward and south-westward sets of striæ were observed.
122. At Madawaska station (Ottawa, Arnprior and Parry Sound railway), southward striation was observed.
123. Half a mile south of Perth, two or three courses of striæ occur, often in the same surface, the oldest being S. 28° E. Height, 435 feet.
124. About two miles south of Perth, older striæ, S. 28° E. and S. 33° E. These are nearly effaced by a later south-west set. Height, 435 feet.
125. West of Bathurst, Canadian Pacific railway, striæ were observed with courses trending from north to south, and another set from north-east to south-west.
126. At Tweed station, Canadian Pacific railway, S. 14° E., S. 16° E., S. 46° E., and S. 1° W.
127. About three miles north of Smiths Falls, S. 1° W., in several places, also S. 3° W.

Striæ of earlier Laurentide glacier—*Cont.*

128. South of Smiths Falls, S. 4° E., S. 1° W., and S. 6° W.
129. On Wolfe Island, foot of Lake Ontario, S. 21° W., S. 31° W., S. 31° E., etc. Height, 250 feet.
130. At Clayton, N.Y., S. 21° E., S. 11° E., and S. 6° E.
131. At Morristown, N.Y., S. 25° E., and S. 40° E. On another exposure, S. 7° E. On the higher grounds south of Morristown, S. 8° W.
132. At Nevin's quarry, west of Ogdensburg, N.Y., S. 5° E., S. 18° E., S. 23° E. and S. 22° W. The S. 5° E. striæ are the heaviest. Superposed on these are south-west striæ which may be due to floating ice.
133. About four miles south of Ogdensburg, S. 10° E., in several places. Light.
134. At Prescott, Ont., S. 15° E, and S. 18° E. Another finer set (No. 351.) superposed on these.
134½. Near St. Albans, Vt., S. 12° E.
135. On the south-east side of a ridge behind St. Albans, Vt., S. 14° W. and S. 18° W.
136. South of Phillipsburg, Que., S.
137. On the ridge just west of St. Armand station, S. 38° W., and S. 33° W.
138. On the road from Abbott Corner to Richford, Vt., S. 52° E., and S. 42° E., crossing N.W. striæ.
139. At foot hills north-east of "Pinnacle," S. 42° E. and S. 27° E. Height, 960 feet.
140. South-east of "Pinnacle," Sutton Mountain, S. 32° E.
141. On the west side of Pigeon Hill, S. 22° E.
142. Two miles south of St. Armand, at International boundary, S. 18° W.
143. A mile east of St. Armand, S. 46° E.
144. At Frelighsburg, S. 27° E. Height, 500 feet.
145. South-east of Dunham, west of Sweetsburg, S. 40° E.
146. On the road going south from East Dunham, S. 60° E. and S. 65° E; well marked.
147. In another place near by, S. 34° E.
148. On north-west slope of ridge, three miles west of Sweetsburg, S. 72° E. and S. 52° E.
149. In another place on same slope, facing St. Lawrence plain, S. 28° E.
150. On hill south of Sweetsburg, S. 54° E.; another common course here is S. 62° E.
151. At Knowlton village, S. 12° E.
152. On summit of Shefford Mountain, in a hollow, S. 55° E.
153. On south-west side of Shefford Mountain, S. 62° E.
154. East of West Shefford, S. 37° E.
155. Near Iron Hill, Brome Mountain, S. 52° E.
156. In Bolton, near Grass Pond, S. 32° E., S. 12° E.
157. Near Foster junction, and at South Stukely, Canadian Pacific railway, S. 12° E.
158. At Eastman station, Canadian Pacific railway, S. 32° E. and S. 12° E.
159. On slope of Orford Mountain, S. 53° E. Height, 1,400 to 1,500 feet.
160. On same slope of Orford Mountain, at elevation of 1,800 feet, glaciated surfaces were noted, but without distinct striæ or grooves. Above this to summit, 2,860 feet, no glaciation was observed.
161. Near the foot of Orford Mountain, S. 23° E., S. 33° E.
162. South of Orford Mountain, S. 63° E., or N. 63° W., stoss side indistinct.
163. Along the Canadian Pacific railway, north-west of Lake Memphremagog, S. 23° E. and S. 33° E.
164. Between Memphremagog and Magog lakes, in several places, S. 13° E., to S. 9° W.
165. North of Lake Memphremagog towards Cherry and Fraser lakes, in several places, S. 14° E. Height, 800 to 915 feet.
166. West of Lake Memphremagog towards Orford Lake, S. 2° W.
167. Two miles south of Georgeville, S. 28° W., S. 8° W. Height, 800 feet.

Striæ of earlier Laurentide glacier—*Cont.*

168. On west side of Lake Memphremagog, three miles from north end, S. 4° E. Height, about 1,000 feet.
169. On east side of this lake, near Oliver, P. O., S. 12° W. Height, 1,000 feet.
170. At cross roads, south end of Little Magog Lake, S. 9° E. Height, 715 feet.
171. Near cotton mill, Magog village, S. 8° W. Height, 700 feet.
172. Near same place on east side of Magog River, S. 14° W. and S. 26° W.
173. On east side of Lake Memphremagog, above Magog village, S. 24° W. and S. 10° W. Height about 820 feet.
174. On road from Magog to Katevale, S. 8° W. Height, 900 feet.
175. West of Katevale, S. 20° W. and S. 14° W. Height, 1,090 feet.
176. At Katevale, S. 10° W. Height, 845 feet.
177. South-east of Massawippi River, S. 35° E. Height, 520 feet.
178. At International boundary, Maine Central railway, S. 35° E., and S. 25° E. Height, 1,118 feet.
179. At St. Malo station, same railway, S. 45° E.
180. West of Sawyerville, S. 60° E. and S. 50 E.
181. About a mile south of Dixville station, Grand Trunk railway, S. 30° E. Height 1,130 feet.
182. On granite hills further south, S. 80° E. Height, 1,950 feet.
183. On road from Norton Mills to Barnston, not far from International boundary, S. 57° E. Height 1,650 feet.
184. Further west, nearer Barnston, S. 33° E. Height, 1,345 feet.
185. On road from Coaticook to Barnston, S. 30° E and S, 25° E. Height, 1,265 feet.
186. South of Chartierville, at foot-hills, S. 55° E. and S. 35° E. Height, 1,750 feet to 1,800 feet.
187. On road from Ditton to Scotstown, S. 80° E. and S. 60° E. And on another ledge nearer Scotstown, S. 60° E. and S. 50° E. Height about 1,350 feet.
188. On easternmost road leading from Megantic to Spider lake, S. 86° E., S. 76° E. and S. 62° E. Near Spider Lake, S. 76° E.
189. On second short road crossing Canadian Pacific railway, east of Megantic, S. 86° E.
190. East of Agnes P.O., or Megantic, on south side of Chaudière River, S. 86° E. (numerous), S. 66° E., etc.
191. In another locality, east of Megantic, to south of last, S. 82° E. and S. 66° E. Height, 1,540 feet.
192. At north end of Lake Megantic, S. 66° E. and S. 56° E.
193. Along the road from Megantic to Ste. Cécile, four or five miles from lake, S. 66° E. and S. 61° E.
194. Near Lowelltown, Me., along Canadian Pacific railway, S. 86° E., S. 80° E., S. 73° E, S. 69° E. and S. 65° E.
195. At Hampden Settlement, Que. S. 45° E. Height, 1,565 feet.
196. Further east on same road, near cross roads, S. 60° E., and S. 15° E. Height, 1,770 feet.
197. Near McLeod crossing, Canadian Pacific railway, S. 85° E. and S. 52° E. In another place near last, S. 45° E.
198. At Scotstown, several sets, the most distinct being S. 65° E.
199. On the Macnamee road, west of Scotstown, S. 60° E. and S. 55° E. Light. Height, about 1,330 feet.
200. Four miles west of Scotstown, S. 75° E.
201. At Compton village, S. 55° E. and S. 45° E.
202. At Cookshire, S. 58° E. and S. 48° E.
203. On second cross-road west of Sherbrooke, on north side of Magog River, S. 13° E. Height, 800 feet.
204. At Sherbrooke, S. 54° E., S. 52° E., and S. 48° E.

Striæ of earlier Laurentide glacier—*Cont.*

205. Three miles north of Sherbrooke along Grand Trunk railway, S. 35 E. Height 480 feet.
206. From one to two miles east of Sherbrooke, S. 15° E., S. 1° W., and S. 5° W. Height, about 600 feet.
207. Half a mile further east on north side of St. Francis River, S. 40° E., S. 35° E. and S. 30° E.
208. Near Ascot station, Quebec Central railway, S. 81° E. and S. 53° E. Height, 640 feet,
209. At junction of two roads leading from Sherbrooke to Ascot, S. 55° E. Height 990 feet.
210. From one to two miles west of Ascot, S. 56° E. Height, 850 to 875 feet.
211. East of St. Francis River, on east road leading to Stoke Centre, S. 44° E. and S. 30° E. Height, 550 feet.
212. At junction of two roads leading to Stoke Centre, S. 46° E. Height, 950 feet.
213. Near Brompton Falls, St. Francis River, S. 40° E, Height about 500 feet.
214. Further down river, at the same place, S. 36° E. and S. 20° E. Height, 470 feet.
215. About a mile east of Windsor Mills, S. 35° E. Height, 600 feet. (See No. 88.)
216. Two miles east of Windsor Mills, S. 55° E. Height about the same as last.
217. At Kingsbury, S. 47° E. Height 590 feet. (See No. 89.)
218. On road leading direct from Kingsbury to Richmond Junction, north of first bend, S. 55° E. Light.
219. At Melbourne, south-west of Richmond Junction, S. 50° E. Height, 685 feet.
220. Seven or eight miles from Windsor Mills, on road to Wattopekah Lake, S. 41° E. Height, 850 feet.
221. South of Stoke Centre, on west road leading to Sherbrooke, S. 76° E., S. 65° E., and S. 56° E.
222. On the same road, north side of large brook, S. 61° E. Height, 850 feet.
223. South of same brook, S. 56° E. and S. 46° E.
224. South-west of Richmond Junction, Grand Trunk railway, S. 50° E. Height, 700 feet.
225. On a northern slope further west, S. 46° W.
226. Further west, on Montreal road, S. 56° E. Height, 720 feet.
227. Near Lisgar station, Grand Trunk railway, west side, S. 56° E. and S. 46° E.
228. On a boss west of Danville, S. 51° E.
229. Half way between Shipton Hills and Danville, S. 46° E. Height, 740 feet.
230. East side of Shipton Hills, S. 22° E., S. 20° E.
231. At slate quarry, south of Danville, S. 74° W. and S. 44° W.
232. South of Danville village, S. 22° E. and S. 20° E. Height, 550 feet,
233. On hill slope south of Danville, S. 36° E. and S. 26° E. Height, 895 feet.
234. On hill facing the St. Lawrence valley at Warwick, Grand Trunk railway, S. 74° E., S. 64° E., etc. Height, 860 feet.
235. Two miles west of Arthabaskaville, on hill slope facing St. Lawrence, S. 46° E. Height about 870 feet.
236. At Arthabaskaville, on similar hill slope, S. 8° E.
237. Three miles south of Angus station, Quebec Central railway, S. 40° E. and S. 35° E.
238. On the road from Angus station to Cookshire, near latter place, S. 40° E.
239. On road from Dudswell station, Quebec Central railway, to Marbleton, east of lake, S. 32° E.
240. Near Marbleton, on road to South Ham, S. 66° E. and S. 56° E.
241. At South Ham, S. 62° E. and S. 46° E.
242. Within a mile or two of Nicolet Lake, on road to Wolfestown, S. 86° E.
243. North of Nicolet Lake, on same road, S. 56° E. and S. 36° E.
244. Two or three miles north of Nicolet Lake, S. 86° E., also N. 75° E. Light striæ.

Striæ of earlier Laurentide glacier—*Cont.*

245. Further to the north-east, S. 84° E. Light: numerous.
246. Still further to the north-east, S. 68° E. (See No. 65.)
247. Five or six miles south-west of Wolfestown, S. 70° E.
248. Between St. Pierre Baptiste and Ste. Julie, about a mile from brow of mountain, S. 71° E.
249. Near brow of mountain, on same road, S. 86° E. Height, 950 to 1,000 feet.
250. Two or three miles west of Ste. Julie, along foot-hills, S. 54° E. Stoss side indistinct. Height, 700 feet.
251. At base of mountains south of Ste. Julie, on road to St. Pierre Baptiste, S. 22° E. Height, 680 feet. The same course occurs in other places on this road.
253. South of Ste. Julie village, S. 54° E.
254. South-west of Ste. Julie, among foot-hills, S. 76° E. and S. 62° E.
255. On road from Ste. Julie to Inverness, at foot-hills, S. 56° E. Height, 750 feet.
256. On brow of slope, going south on same road, S. 56° E. Height, 895 feet.
257. Still further south on slope, S. 46° E., in several places.
258. Just east of cross roads between Inverness and Leeds, S. 26° E.
259. Further south on road to Leeds, S. 46° E. and S. 36° E.
260. North of Leeds, S. 56° E., S. 46° E., etc. (*See* No. 60.)
261. South of Leeds near Harvey Hill, on road to Broughton station, Quebec Central railway, S. 86° E. Height, 1,150 feet.
262. At Broughton station, Quebec Central railway, S. 82° E.
263. At Weedon station, Quebec Central railway, 52° E. Height, 1,170 feet.
264. At west end of Lake Aylmer, S. 76° E. Height, 1,075 feet.
265. Near Stratford P.O., S. 66° E. and S, 52° E. Height, 1,175 feet.
266. Between Stratford and Stornoway, S. 56° E.
267. East of Stornoway, in a valley, S. 60° E.
268. At St. Romain church, S. 86° E. and S. 66° E. Height, 1,400 feet.
269. On road from Broughton to St. Ephrem de Tring, six or seven miles from Broughton, S. 66° E. (See No. 56.)
270. On same road north of Bras River, S. 66° E.
271. East of St. Ephrem on road to St. Victor de Tring, S. 86° E. and S. 66° E.
272. Half a mile or more to the east of last, S. 34° E. (See No. 53.)
273. At St. Victor de Tring, S. 50° E. to S. 60° E.
274. Halfway between St. Ephrem de Tring and Forsyth, S. 56° E.
275. About two miles east of Forsyth, S. 66° E. (*See* No. 72.) Height about 1,300 feet.
276. At Forsyth (St. Evariste de Forsyth), S. 64° E. on several exposures.
277. Behind R.C. church where dislocated slates occur S. 56° E.
278. On the west side of River Tierney, S. 56° E. and S. 46° E.
279. About a mile east of Lambton, S. 56° E. Height, 1,300 to 1,400 feet.
280. At the south end of St. Francis Lake, S. 66° E. to S. 70° E.
281. Near St. Elzéar in two places, S. 56° E. and S. 26° E. Light.
282. Further south going up hill, S. 32° E. Fine striæ. Height, 1,050 feet.
283. At St. Elzéar, S. 36° E., or the reverse. Stoss side indistinct. Height, 915 feet.
284. On road from St. Elzear to Ste. Marie, S. 52° E.
285. North-west of Millstream, near St. François, Beauce county, at rear of first concession, S. 86° E., S. 66° E., and S. 56° E. Height, 850 to 900 feet.
286. On west side of Chaudière River, south-west of the Devils Rapids, in the second concession, S. 76° E. Height about 960 feet.
Other striæ in rear of first concession near here, S. 66° E.
287. At east end of road between St. Henri and St. David concessions, S. 47° E. Height, 920 feet.
288. In the southern part of Aubert Gallion, S. 53° E. Numerous.

Striæ of earlier Laurentide glacier—*Cont.*

289. About a mile above mouth of Rivière du Loup on east side of Chaudière River, S. 47° W.
290. At Jersey Mills, S. 70° E., S. 64° E., S. 56° E., and S. 48° E.
Same place at bank of Chaudière River, S. 52° E. and S. 40° E.
291. At Ste. Marguerite, east of Jersey Mills, S. 32° E. Height, 1,170.
292. One or two miles above Jersey Mills, on east side of Rivière du Loup, S. 62° E., S. 46° E. and S. 27° E.
293. About four miles from Jersey Mills, on old Kennebec road, S. 77° E. and S. 72° E.
294. Seven miles above Jersey Mills on same road, S. 67° E. Height, about 840 feet.
295. At St. Come, S. 68° E., S. 37° E., and S. 20° E. Height, 935 feet.
296. In second concession east of St. Come, S. 47° E. Height, 1,100 feet.
297. Near Langevin road, in several places, S. 47° E. and S. 37° E.
298. At Marlow, P.O., N. 88° E., S. 80° E. and S. 62° E. Height, about 960 feet.
299. Further south-west on Kennebec road at school house, S. 52° E., S. 42° E., and S. 36° E. Height, 1,050 feet.
300. On Lot 30, Linière, S. 46° E. and S. 32° E. Height, 1,530 feet.
On another exposure here, S. 27° E.
301. At Monument stream, S. 46° E., S. 42° E. and, S. 36° E. The S. 46° E. striæ may be N. 46° W. as there is no distinct stossing.
302. At International boundary, east of Line House, Kennebec road, S. 57° E. or N. 57° W., stoss side doubtful. Height, 1,950 feet.
303. Along Kennebec road south of boundary line, S. 57° E. or N. 57° W.
304. Two miles south of boundary, on same road, S. 82° E., S. 72° E., and S. 66° E.
About three miles south-west of boundary, same road, S. 72° E., S. 66° E., S. 62° E., S. 56° E., S. 52° E., and S. 46° E. Last two of these courses light.
305. Along Langevin road going from St. Come, and before reaching head-waters of Abenaquis River, S. 75° E. and S. 45° E. Height, 1,245 feet.
306. South of Abenaquis River, on same road, S. 67° E., S. 47° E., and S. 37° E. Height, 1,275 feet.
307. North of Abenaquis River on this road, S. 66° E., S. 56° E., and S. 46° E.
308. North of St. Francis station, Quebec Central railway, in the Chaudière valley, S. 42° E., S. 37° E.; also S. 17° E.
309. Still further north along Quebec Central railway track, S. 72° E., S. 66° E., S. 62° E., and S. 56° E.
310. On south side of Famine River, two miles from the Chaudière, S. 36° E. Height about 1,000 feet. In another place further east, S. 46° E.
311. On the road from St. Francis to Gilbert River gold mines, S. 62° E., and due E.
312. Between Famine River and Lake Etchemin, S. 76° E. Height, 900 feet.
313. South of Lake Etchemin, S. 76° E. and S. 82° E.
314. Between Gilbert and Famine Rivers, in Fief Cumberland, S. 67° E.
315. Two miles east of St. Francis, Beauce, S. 47° E.
316. Between this and Chaudière River, S. 75° E. and S. 50° E. Numerous.
317. Four or five miles west of St. Odilon, S. 87° E. Height, 1,250 feet.
318. At mouth of Colway River, S. 76° E. and S. 72° E.
319. On eastern slope of Chaudière, between St. Joseph and Colway River, S. 67° E. Height, 535 feet.
320. East of St. Joseph, two or three miles, S. 82° E.
321. On road from Bisson to Frampton, second concession, S. 76° E. Height, 1,020 feet.
322. At Ste. Marie, S. 50° E.
323. About a mile east of Ste. Marie, S. 45° E. Height, 890 feet.
324. Between Ste. Marie and Ste. Marguerite to east of first concession, S. 72° E. and S. 62° E. Height, 1,080 feet. In another place near by, S. 72° E. Height, 725 feet.

325. West of St. Marguerite, S. 88° E. Height, 925 feet. Striæ of earlier Laurentide glacier—*Cont.*
326. On hill at Ste. Marguerite, facing St. Lawrence River, S. 80° E. In another place, S. 83° E. Height, 1,120 feet.
327. Two concessions west of St. Lazare, S. 88° E.
328. At St. Clare and on road towards St. Lazare, S. 78° E.

Striation produced by the Second or Later Laurentide Glacier flowing south-westward, or, perhaps, partly by Floating Ice.

In the list of striæ given in Mr. A. P. Low's report on the Geology and Economic Minerals of the district in the vicinity of Quebec,* a number of courses with a south-west trend are recorded from Bonhomme Mountain, Fossambault, Bourg Louis, Ste. Anne River, etc. Some of these were noted by the writer during the summer of 1897. Others further west were observed as in the following list:— Striæ of later Laurentide glacier.

329. At St. Jerome, N. 73° W., N. 66° W., N. 87° W., S. 57° W., S. 63° W., S. 72° W., and S. 50° W. Height, 320 feet.
330. On a boss on the bank of North River, at St. Jerome, N. 82° W. and S. 72° W.
331. On the road from St. Jerome to Ste. Camille, N. 82° W. Height, 440 feet.
332. Along the road from Lachute to Dunany, N. 72° W. and N. 82° W. Height 475 feet.
333. North-east of Calumet, S. 33° W. Height 530 feet.
334. Two or three miles north of Calumet, S. 78° W. Height, 450 feet.
335. On the south-east brow of Mount Royal, Montreal, S. 57° W.
336. On the north-east brow, imperfect grooves and striæ, S. 32° W., S. 27° W., and S. 22° W.
337. South-west of Ste. Julie, on road to Lake Williams, on mountain slope facing St. Lawrence Valley, S. 45° W., S. 15° W., etc. Height, 765 feet. (See No. 240.)
338. Higher up on slope, S. 55° W. and S. 30° W. Height, 900 to 1,000 feet.
339. West of Warwick station, Grand Trunk railway, on brow of hill facing St. Lawrence Valley, S 74° W. and S. 64° W. Height, 860 feet.
340 On north-east side of Shipton Pinnacle, N. 85° W., S. 85° W., and S. 75° W. Height, 800 to 1,000 feet.
341. On direct road from Richmond Junction to Kingsbury, due W.
342. On the south-east side of Shefford Mountain, S. 60° W.
343. On the north-west slope of Shefford Mountain, N. 75° W. Height, 550 feet.
344. On the summit of the same mountain, near the western slope, S. 75° W.
345. On the east side of Brome Lake, S. 75° W. At Knowlton village, S. 75° W.
346. East of Pigeon Hill, Missisquoi county, S. 78° W.
347. At east end of Beauharnois canal, S. 38° W., S. 33° W. and S. 28° W. Extensive ledges striated. Height, from 50 to 75 feet above the level of the St. Lawrence near by. On the shore of the river interrupted striæ and grooves occur trending, N. 82° W. The ledges grooved in the direction of S. 38° W. have a N. 87° W. course superposed on them, and although no north-to-south striation was seen yet some of the bosses are stossed on the north side.
348. Between two and three miles west of Valleyfield, on the bank of the St. Lawrence, S. 45° W., S. 51° W., and S. 34° W. These striæ occur on three exposures and have several intermediate courses. Boulder-clay, three or four feet deep rests on the surface of the ledges. One of the bosses shows a stoss side to the north or north-west with older glaciation than the south-west set. The south-west striæ trend parallel to the St. Lawrence River.

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* Annual Report, Geol. Surv. Can., vol. V. (N. S.), pp. 48-52 L.

Striæ of later Laurentide glacier—*Cont.*

349. At the Soulanges canal, S. 50° W., S. 40° W., and S. 30° W., with a great number of intermediate courses. From the character of the striation upon the rocks here it appears to have been produced by floating ice. The boulder-clay is in no respect different from that due to land ice.
350. From three to four miles north of Prescott, N. 70° W., and N. 80° W.
351. Just above Prescott, on the bank of the St. Lawrence, a fine set superposed on those of No. 134, S. 50° W., S. 22° W., and S. 10° W.
352. About a mile north of Smiths Falls, S. 46° W.
353. At and near Lansdowne station, Grand Trunk railway, S. 55° W., S. 52° W., S. 40° W., and S. 30° W.
354. About five miles west of Lansdowne, S. 50° W.
355. At Nevin's quarry, near Ogdensburg, N.Y., S. 80° W., N. 78° W., and on another exposure S. 76° W., and S. 62° W. These are superposed on No. 132 and are the latest. Some of them may be be due to floating ice.
356. At DeKalb Junction, New York Central railway, and between that and Philadelphia Junction to the west, the north-east to south-west striation is dominant. This course is also well exhibited on numerous ledges along the St. Lawrence River between Ogdensburg and Morristown, N.Y., and westward.
357. On the higher grounds south of Morristown, N.Y., fine striæ occur, S. 85° W.
358. At Clayton, N.Y., S. 53° W., S. 52° W. and S. 50° W. On another exposure S. 58° W., S. 45° W. and S. 25° W.; and on a third ledge, S. 55° W., and S. 45° W. Striation heavy, especially the S. 55° W. and S. 45° W. courses.
359. On Washington Island, at Clayton, S. 55° W., S. 45° W., and S. 35° W. The two first common and well defined. In many places these striæ cross the hollows in the rock surface, the ice apparently not having accommodated itself to the inequalities thereof, and their trend is closely parallel to the course of the St. Lawrence River.
360. Three or four miles east of Gananoque station, Grand Trunk railway, S. 36° W.
361. Five miles north of Gananoque, on the road to Seelys Bay, S. 41° W. in several places.
362. Between the last mentioned point and Seelys Bay, S. 45° W. and S. 42° W. A kame or gravel ridge occurs here parallel to the striation.
363. Between Gananoque village and the Grand Trunk railway station, S. 42° W. Common. Also S. 66° W.
364. On a boss near the Grand Trunk railway station, Gananoque, S. 56° W. and S. 42° W. The last, most common.
365. A mile or more to the north-east of Gananoque station, Grand Trunk railway, S. 76° W., S. 56° W., etc.
366. West of the last point, towards Willetsholme and Pitts Ferry, S. 56° W. and S. 42° W.
367. Nine or ten miles east of Kingston, along the road nearest the St. Lawrence, S. 37° W.; and at the junction of two roads about half-way between Kingston and Gananoque, S. 62° W. and S. 54° W. Nearer Kingston the courses have more westing.
368. On the west side of Wolfe Island, S. 52° W., S. 47° W., and S. 42° W. Superposed on these are striæ trending S. 76° W. and S. 62 W. Curving striæ also occur here S. 12° W. to S. 4° E. within the space of six feet square. These are clearly superposed on all the other striæ and may be due to recent lake ice. The straightness and parallelism of the deep grooves and striæ of the S. 52° W. set indicate rather the action of land than of floating ice.
369. In the suburbs of Kingston, S. 48° W., superposed on which is another set trending N. 82° W.
370. At Grove Inn quarry, Kingston, the same two sets occur. Here the N. 82° W. striæ are clearly seen to be the latest. In another place, near by, this latest course diverges slightly more to the north, being N. 73° W. and N. 68° W.

371. Half a mile south of Perth, superposed on older striation, S. 87° W. and S. 52° W. Striæ of later Laurentide glacier—*Cont.*
372. Four miles to the south or south-west of Perth, S. 42° W.
373. About two miles south of Perth, S. 47° W. (See No. 124.)
374. Near Beckwith Lake, south of Carleton Junction, south-west striæ were noted.
375. Between Maberly and Sharbot Lake stations, Canadian Pacific railway, the northern as well as the north-east and east sides of the bosses are stossed.
376. At Tweed station, Canadian Pacific railway, faint striæ, S. 54° W. and S. 47° W. Poorly preserved.
377. In the region around Peterborough there are boulder-clay ridges (drumlins or drumlike forms of drift) trending S. 60° W. to S. 45° W., apparently parallel to the striation, although no distinct striæ were observed.
378. Along the Canadian Pacific railway between Pembroke and Klock the north-east and east stossing was also noted.

On the south of the Ottawa River, near Mattawa, S. 62° W. and S. 52° W. In a third locality, near by, S. 42° W.

The older striation here is about south, especially as seen on the higher grounds. The south-west striæ are the latest. This is a common course to the north-east and north of the great lakes.

Striation produced by Glaciers of a still more Local Character at or near the close of the Glacial Period.

379. At Trois Pistoles, Intercolonial railway, N. 75° W., N. 60° W., N. 31° W., N. 25° W., N. 15° W., N. 11° W., N. 3° W., and N. 1° W. West of the railway station, N. 41° E., N. 39° E., N. 21° E., N. 17° E., and N. 13° E. Striæ of local glaciers.
380. South-east of Montmagny station, Intercolonial railway, seven or eight miles, S. 78° E. and S. 88° E. Height, 850 feet.
381. Ten or twelve miles south-west of same station, on road to St. Paul, N. 58° W., and still further south, S. 78° E.
382. Two or three miles south of Ste. Henedine, Quebec Central railway, on road to Ste. Marguerite, N. 72° E. and N. 62° E.
383. North of St. Lazare, on road to St. Gervais, N. 72° E. and N. 62° E. Height, 895 feet.
384. At St. Lazare, N. 86° E. and N. 62° E.
385. From one to two miles west of St, Lazare, S. 88° E.
386. West of St. Clare village, N. 72° E. (See Nos. 27 and 327.)
387. Further down Etchemin River, one or two miles below St. Clare, N. 72° E.
388. Half a mile south-east of Lake Etchemin, S. 48° W.
389. West of St. Odilon, four or five miles, N. 2° E., defacing south-east striæ in places.
390. In Watford on south-east side of Famine River, S. 8° E. and S. 2° W. Height, 1,050 feet.
391. In St. Thomas, between Des Plantes and Colway rivers, S. 38° E.
392. On road between St. Thomas and St. Jean, north of Colway River, N. 56° W.
393. At St. Odilon, N. 26° W. Height, 1,300 feet.
394. South-east of Culdaff P.O., N. 1° W. May be earliest striæ. Doubtful.
395. At Culdaff P.O., Cranbourne, N. 74° E.
396. On the road between the Townships of Ware and Watford, on the north side o Famine River, S. 12° W. and S. 7° W. Height, 1,600 feet.
97. Between Gilbert River gold mines and St. François, on hill slope, N. 27° W. and N. 10° W. Height, 800 feet.
398. North-west of Gilbert River gold mines, on east and west road, N. 27° W. and N. 17° W.

Striæ of local glaciers—*Con.*

399. East of Gilbert River, P.O., on hill slope facing Chaudière River, N. 17° W. and N. 12° W. Height, 800 feet.
400. Just south of Famine River, on road going east, S. 7° W.
401. Farther east, S. 8° E. and S. 5° E. Height about 1,500 feet.
402. Near St. Joseph, Beauce, N. 6° W.
403. Between St. Joseph and Colway River, in Chaudière valley, N. 16° W. and N. 2° W. These are superposed on the S. E. course.
404. At mouth of Colway River, N. 6° W. (*See* No. 318.)
405. On Kennebec road, four miles above Jersey Mills, N. 50° W. Height, 685 feet.
406. West side of Chaudière valley, above Devil Rapids, and at rear of first concession, N. 11° W.
407. On east side of Chaudière River, half a mile above Great Falls, N. 85° E. Imperfect.
408. On road between St. Henri and St. David concessions, Aubert Gallion, N. 3° E., or the reverse.
409. West of St. François, Beauce, N. 11° W., N. 6° W. and N. 1° W. Height, 800 or 900 feet.
410. East of Lambton, N. 14° E. Height, 1,400 feet.
411. East side of River Tierney, N. 6° W. Distinctly later than S.E. striation.
412. At south end of St. Francis Lake, N. 16° W.
413. At St. Romain church, N. 84° E.
414. North of Lake Weedon, nearly due W.
415. At Weedon village, N. 75° W. Height, 1,170 feet.
416. Near Broughton station, Quebec Central railway, N. 13° W., N. 2° E., and N. 11° E. Height, 1,110 feet.
417. In Ste. Marie, on road between St. Thomas and St. Jacques concessions, N. 32° E. Height, 1,220 feet.
418. On road from St. Sylvester to Ste. Marguerite, N. 47° E. Height, 1,300 feet.
419. At north end of Lake Williams, S. 76° W. and N. 84° W.
420. South-west of Ste. Julie, on road to Williams Lake, S. 63° E. Height, 950 to 1,000 feet. (*See* Nos. 63 and 64, also 248, 249 and 251.)
421. Still further south-west, N. 16° W. Light, numerous. Height, 1,100 feet.
422. From two to three miles west of St. Julie, along foothills, N. 21° W., N. 14° W., etc. Height, 700 feet.
423. On a large boss at the foot-hills, on road mentioned in No. 420, due N. to N. 25° W.
424. Five or six miles south-west of Wolfestown, N. 3° W. and due N. Height, 900 to 1,000 feet.
425. Another boss near the last shows the due N. course; also a S. 85° E. course.
426. Five or six miles south of South Ham, N. 70° E. and N. 65° E. Height about 925 feet.
427. North of Nicolet Lake, N. 75° E., S. 85° E. and N. 85° E.
428. Between South Ham and Marbleton, near the last place, N. 75° E. and S. 65° E. Numerous.
429. At Coaticook, on bank of river, N. 25° E.
430. Seven or eight miles east of Windsor Mills, on road to Wattopekah Lake, S. 15° W. and S. 5° W.
431. South-west of Shefford Mountain, two miles from West Shefford, S. 76° W.
432. East of St. Albans, Vermont, behind first ridge, S. 78° W. and S. 57° W.
433. Along Canadian Pacific railway, on second cross road east of Lake Megantic, N. 76° W.

Striæ supposed to have been caused by Floating or Sea-borne Ice at the close of the Glacial Period.

434. West of Bic, S. 50° W. Striæ of floating, or sea-borne ice.
435. Near Trois Pistoles station, Intercolonial railway, S. 63° W. (short and apparently gouged out), S. 70° W., S. 84° W., N. 75° W., and E. to W., or the reverse. Height 100 to 110 feet.
436. Near Lévis, S. 65° W. Height (corrected) about 165 feet.
437. Near Mount Royal, Montreal, S. 68° W. and S. 60° W., etc., by Sir J. W. Dawson.
438. At St. Jerome, S. 82° W., S. 60° W., etc.
439. North of Lachute, E. and W. to N. 85° W.
440. At Soulanges canal, S. 50° W., and S. 40° W.
441. On shore of St. Lawrence at east end of Beauharnois canal, irregular curving or gouged striæ and grooves. E. to W., nearly.
442. On bank of St. Lawrence west of Valleyfield, S. 50° W. to S. 55° W.
443. Near Prescott, S. 50° W.
444. At Lansdowne, S. 55° W. and S. 52° W.
445. At Nevin's quarry, near Ogdensburg, N.Y., irregular light striæ, S. 76° W. and S. 65° W. These superposed on all the other striæ.
446. At Gananoque, S. 76° W., S. 56° W., etc.
447. West side of Wolfe Island, opposite Kingston, S. 76° W. and S. 60° W.
448. Near Perth, S. 87° W. to S. 52° W.

In addition to the above, numerous striæ, tentatively attributed to the agency of floating ice, have been observed in the bottom of the St. Lawrence valley between Métis and Lake Ontario. Usually their trend is closely parallel to that of the St. Lawrence River, although occasionally they diverge at a small angle from it. Whether all are due to ice of this kind alone has not yet been satisfactorily determined. Some of them may have been produced by land ice, *i.e.*, by the later Laurentide glacier.

A considerable number of striæ in the region under review are recorded in the Geology of Canada, 1863. In the Eastern Townships of Quebec, Dr. R. W. Ells made a large number of observations on striæ, lists of which are given in his reports on the geology of that region.* Former lists of striæ.

The Appalachian Glacier, or System of Glaciers.

The oldest striation recorded in the foregoing list has been produced, as already stated, by ice which accumulated independently upon the North-east Appalachians in the early Pleistocene. As has been shown on a previous page the portion of Canadian territory lying to the south of the St. Lawrence River was at a higher level in the later Tertiary period than at present. At what height the Laurentian plateau then stood we have no data at hand to show. There are, however, some Observations respecting the Appalachian system of glaciers.

* Annual Report, Geol. Surv. Can., vol. II. (N.S.), pp. 46-48 J. *Ibid.*, vol. III., 1887, p. 99 K.

considerations which tend to support the view that in the early Pleistocene this plateau was at least no higher than now, and may have been somewhat lower relative to the Appalachians. But whatever their elevation then was it seems pretty certain that the North-east Appalachians maintained approximately the same altitude in the early Pleistocene which they had in the later Tertiary. With this elevation the region was, therefore, very favourably situated, geographically and meteorologically, on the advent of glacial conditions, for the production of glaciers. The greater amount of precipitation there compared with that of the region to the north of the St. Lawrence, and its position with respect to the Atlantic Ocean, combined to render it as suitable a gathering-ground for ice as Greenland is at the present day. It is not unreasonable to assume, therefore, that ice began to form there independently, at an early stage of the Pleistocene period, probably before it gathered upon the Laurentian plateau. At all events the first Pleistocene ice does not appear to have advanced over Eastern Canada as a great flowing sheet from the north ; but doubtless formed originally at certain centres above the line of perpetual snow, and, spreading from these higher *névé* grounds was governed in its movements by the topographical features of the country. One of these centres was the North-east Appalachians, as already stated, and it would seem as if the ice had accumulated on these in sufficient thickness and extent to enable it to move down to the bottom of the St. Lawrence valley northward, eastward and southward, as well as in other directions, unchecked by ice from the Laurentides. Indeed, it is not at all unlikely, though the data are not yet at hand in full detail, that an interglacial period, *i.e.*, a period of ice-recession, supervened after the maximum extension of the Appalachian ice was reached and before the invasion of the Laurentide glacier took place, as evidenced by the weathering which the older striæ suffered before those of the Laurentide ice were superposed upon them, as well as by certain stratified interglacial deposits met with in a number of localities in the " Eastern Townships " of Quebec.

Difference in elevation.

Probable interglacial period.

But whether there was an interglacial period or not, if the relative altitudes of the North-east Appalachians and of the Laurentian plateau were even approximately the same as at the present day when glacial conditions came on in the early Pleistocene, ice would accumulate in a similar manner to that which has been supposed. Glaciers would gather first upon the Appalachians, accompanied or followed by a lesser and slower accumulation upon the southern and eastern Laurentides, and the ice of the latter would be long in attaining sufficient thickness to enable it to flow beyond the limits of the plateau.

The ice which generated on the North-east Appalachians had, as already stated, a radial flow from the central and higher portions of this mountain system northward, eastward and southward, and to all intermediate points of the compass. It was to this ice that the glaciation of that part of the province of Quebec lying to the east of the Etchemin River and the head-waters of the St. John is wholly due. The glaciation of New Brunswick and of the principal portion of New England at least, has also been largely effected by it, as was described in my last report.* It is to this ice-sheet or combination of ice-sheets that the writer gave the name of the *Appalachian glacier*, or *Appalachian system of glaciers.* † Movements of Appalachian ice.

In the "Eastern Townships" of Quebec, to the east of the Chaudière valley, the movements of the Appalachian ice are shown by heavy and distinct striation, especially on the south sides of ridges and bosses, the courses varying from north to east, though in a few places where it was influenced by the local topography the ice swung round and flowed to the west of north. On the watershed between the Chaudière and the head-waters of the St. Francis and Becancour rivers, the courses were, generally speaking, north to north twenty degrees east. In the district west of this watershed, however, the movements had a considerable westerly trend. The Appalachian ice in the valley of Wattopekah River flowed nearly westward, crossing the St. Francis River, and the striæ are traceable into Melbourne and beyond. Similar courses were observed in the vicinity of Scotstown and near Lake Megantic. Near the International boundary, to the south and south-west of this lake, the striæ produced by this ice seem to have been largely effaced by later ice, but the courses, generally, wherever observed, show a westerly trend. Further north, a westerly or north-westerly trend is especially noticeable at Shefford and Brome mountains, near Knowlton and Sweetsburg, and in other places on the north-west side of Sutton Mountain. On many of the exposures in the two ranges of mountains nearest the St. Lawrence, the (Sutton

* Annual Report, Geol. Surv. Can., vol. VII., (N.S.) part M.

† American Geologist, vol. VI., Nov. 1890, p. 324.

NOTE.—The latter name seems preferable, from the fact that the ice referred to cannot have formed one continuous sheet throughout Eastern Quebec, New Brunswick and the New England States. Although presumably originating in all these places at the same period, there were doubtless numerous local centres upon which it would first gather and from which it would spread until the maximum stage of accumulation was reached, much of the ice from these centres probably coalescing before then. Hence the name "Appalachian System of Glaciers" seems more applicable to the earlier Pleistocene ice of this region, when speaking of it as a whole.

and the Stoke Mountains,) evidences of the Appalachian ice having flowed across them and down upon the St. Lawrence plain were observed.

Probable thickness of Appalachian ice.

The striation produced by this system of glaciers in the "Eastern Townships" does not appear to have been as heavy, as a rule, as that produced by the ice which afterwards came from the Laurentian plateau. What its maximum thickness was on this slope we have no data at hand to show. On the south side of Cranbourne Mountain it must, however, have reached a thickness of from four to six hundred feet at least, to override the known glaciated portion of the summit. The apparent lightness of this striation is often the result of the weathering of the rock surface which took place since it was produced, and to its partial effacement by the later ice.

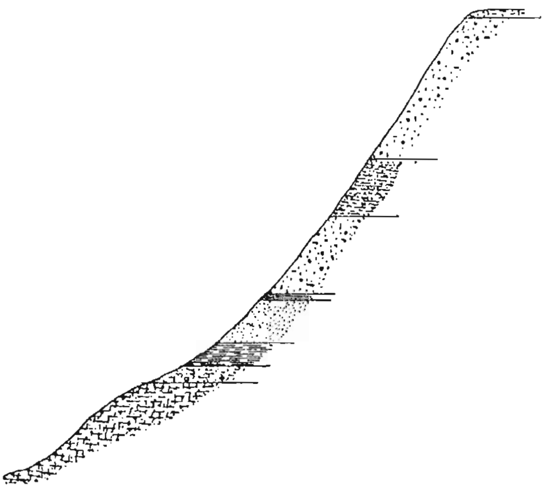
The Laurentide or Labradorian Ice.

Laurentide ice, how originating and moving.

After the Appalachian ice had reached its maximum extension, and on the northern slope, had flowed down to the bottom of the St. Lawrence valley unchecked by contrary ice movements, a withdrawal or amelioration of glacial conditions seems to have supervened. What length of time elapsed then before the Laurentide ice advanced up the slope on the south-east side of the St. Lawrence River into the "Eastern Townships" region, or whether or not there was a coalescence of the two ice sheets, we are as yet unable definitely to decide. Although the St. Lawrence plain has been examined with some care from the lower end of the Island of Orleans to Lake Ontario, no glacial products containing interstratified beds have, so far, been found there. And from the fact that the Appalachian ice seems to have moved freely and without hindrance over the region striated by it, together with the fact that the Laurentide ice, when it subsequently advanced over the "Eastern Townships" region, moved southward and south-eastward, in a great number of places at least, as if it had received no check to its onward progress, it seems probable that the earlier ice had departed before the oncoming of that from the Laurentides. As already stated, the earlier or Appalachian striation is found in a number of places to have been weathered before that of the Laurentide ice was superposed on it. Further, the boulder-clay in a bipartite division occurs in certain localities in the "Eastern Townships" of Quebec. These facts seem to favour the view of an interglacial period between the two glaciations referred to. But the partial examination of the St. Lawrence valley and Laurentide slope carried out during the season of 1897, has not thrown any light on the question, and further observations are required. The facts respecting the two-fold division of the boulder-clay are here presented:

Boulder-clay, with an intercalated bed, was observed in Riviére du Loup valley, a quarter of a mile above its junction with the Chaudière in Humphrey Pit, No. 2. Twofold division of boulder-clay.

Fig. 2.



SECTION NEAR MOUTH OF RIVIÈRE DU LOUP.

SCALE:—50 feet to 1 inch.

The series here shows, in descending order: (1) unstratified boulder-clay containing transported boulders, 37 to 38 feet; (2) an irregular stratified deposit, apparently lenticular, 15 feet, and (3) unstratified boulder-clay, more compact than the upper division, boulders not nearly so large, and as far as could be seen, chiefly from local sources, 20 feet.

At Le Rocher, in the Chaudière valley, the series seems to be as follows: (1) gray boulder-clay, unstratified: (2) a stratified band; (3) dark or bluish-gray boulder-clay of unknown thickness. Owing to the sliding down of the beds here exact measurements could not be made. Chaudière.

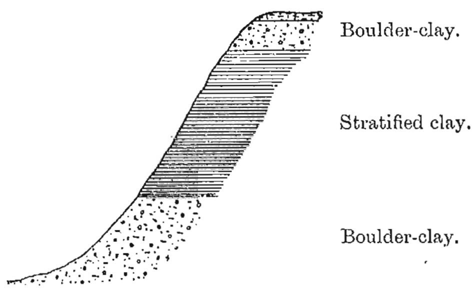
In a tunnel opened by Messrs. J. E. Hardman and Geo. Macduff, at St. George, Beauce county, the boulder-clay, which is here fifty or sixty feet in thickness, occurs also in a two-fold division, with an intercalated, stratified, band intervening. The precise thickness of the constituent parts was not ascertained here either.

St. Francis.

In the St. Francis River valley, three miles east of Angus station, Quebec Central railway, in a gravel cutting, a section of the boulder-clay likewise shows in descending series: (1) boulder-clay, unstratified, containing glaciated boulders, 12 to 15 feet; (2) stratified clay containing the same glaciated boulders as in the lower division, 3 to 5 feet, and (3) boulder-clay, unstratified, 20 feet or more exposed in the bank, but the bottom was not seen.

A quarter of a mile further east in another railway cutting, the following series occurs (descending order): (1) gravelly boulder-clay, containing glaciated boulders, 3 to 5 feet; (2) fine, unctuous, gray clay, distinctly stratified horizontally, 12 to 15 feet, and (3) boulder-clay, unstratified, thickness unknown.

Fig. 3.



SECTION SHOWING INTERSTRATIFIED CLAY IN BOULDER-CLAY, IN ST. FRANCIS RIVER VALLEY, 3 MILES EAST OF ANGUS STATION; QUEBEC CENTRAL RAILWAY.

SCALE :—20 feet 1 inch.

None but local boulders were observed in the boulder-clay and interstratified beds here. The Dudswell Mountains to the north-west seem to have shed off the Laurentide ice from this particular district, or checked the passage of Laurentian boulders into this valley.

Along the Clifton River, a branch of Eaton River, two or three miles south of Sawyerville, boulder-clay with a seam of stratified clay interbedded, was seen in two or three places.

The lower boulder-clay in the foregoing sections, so far as it has been possible to examine it, consists mainly of local materials, while the upper often contains Laurentian and other transported boulders from the north.

The Laurentide glacier having two extensions, an earlier and a later.

The Laurentide ice, the movements and striation of which have been traced in considerable detail in the provinces of Quebec and Ontario, seems to have consisted of two divisions or extensions, one earlier than the other. The first is named, provisionally, the *older Laurentide glacier*, the second the *later Laurentide glacier*. The older Laurentide glacier, the striæ of which have been observed throughout the St. Lawrence valley from the city of Quebec westward, and on the north side below that, had a general southward to south-eastward flow; the later Laurentide glacier flowed nearly at right angles to this or approximately south-westward. In many parts of the region, however, the older striæ have been much defaced, in some places entirely obliterated, by weathering and the action of the later ice, but wherever the two courses referred to are seen together, they can be distinguished.

Limits.

The eastern and south-eastern limits of the older Laurentide ice have been traced approximately and determined by the following criteria: (1) the striation and stossing on the north and north-west sides of the bosses, and (2) by the distribution of Laurentian boulders upon the region. Only in a few places does this ice seem to have crossed the International boundary. Near its eastern and south-eastern border it has had a tendency to spread out in places into separate tongues or lobes, extending in this way along valleys or upon the lower grounds. One of these lobes flowed along the valley of St. Charles River, north of the city of Quebec, partly following the depression between the Island of Orleans and the north bank of the St. Lawrence, overriding the eastern part of that island obliquely, the western and southern parts of which are unglaciated. Another tongue of this ice moved up the Chaudière valley and spread over and deployed upon the district to the east. Many of the peculiar easterly courses of striæ here, and to the east of the Etchemin River, are due to this swerving ice-flow. To the south of Cranbourne Mountain, a wide lobe or tongue of ice, apparently an extension of the Laurentide glacier, flowed across the divide between the Chaudière and St. John waters, 1200 or 1300 feet high, in an easterly direction for a considerable distance, but how far has not yet been definitely ascertained. From the fact that boulders, resembling Laurentian granite and gneiss, have been found in the St. John valley in northern Maine and north-western New Brunswick, however, it seems not improbable that the lobe referred to may have extended that far. Prof. C. H. Hitchcock records striæ on the upper St. John, either following the valley, or caused by local glaciers flowing into it from either side, some of which probably, belong to the closing stage of the glacial period.* Other lobes or tongues of the early Laurentide glacier entered New England by the valleys and passes along the International boundary, especially at Norton Mills, Halls Stream, Lake Memphremagog and Lake Champlain. The striæ of the older Laurentide glacier are distinct on the latter basin, and as shown by the list of striæ on previous pages, were also observed in the vicinity of Ogdensburg and at other places in northern New York.

Movements of earlier Laurentide glacier.

The trend of movement of the early Laurentide ice is tolerably regular and direct from the mountains north of the St. Lawrence valley to the nearest range of mountains on the south-east side. Beyond this the movements were more or less affected by the topographical features, especially in the eastern portion of the "Eastern Townships" region. The range of mountains referred to, sometimes called the Sutton Mountain range presents a stoss side to the north-west almost continuously from the Chaudière valley, south-west to the Vermont boundary. In many places this Laurentide ice deployed on the slope, surged against the sides of the higher summits, and swung round sometimes to the north-east, and in other cases to the south-west, as it was affected by the contour of the surface. Some of the higher parts of the range have not been overridden by this ice, and on these we have a means of measuring its thickness or height above sea-level in this part of the region. Near Sts. Anges, or the north flank of the range to the east of the Chaudière valley, we have what appears to be the limit of the Laurentide ice in this direction at a height of 1025 feet. West of the Chaudière, on the north slope of this range, faint striæ due to this ice were observed at a height of 1050 to 1100 feet. Beyond this, towards St. Severin, they were not observed at 1325 feet.

Its thickness.

To the south-west, however, as stated, this Laurentide ice must have been thicker. Orford Mountain, at the north end of Lake Memphremagog, was found to be glaciated to a height of 1800 feet. The summit, 2,860 feet high, is bare rock, but no ice-action was observed upon it. Owls Head, on the west side of Lake Memphremagog, 2400 feet high, has not, according to Dr. Ells, been glaciated on the summit either. These and a number of other peaks in this range must have stood up above the surface of this ice-sheet as "nunataks" even during its maximum development.

*Agriculture and Geology of Maine, Second series, Sixth Annual Report, 1861 pp. 268-270.

Besides the easterly trend of the striæ of the early Laurentide ice observed near the city of Quebec and on the east side of the Chaudière valley, an easterly ice-flow is seen to be the prevailing one also on both sides of the International boundary as far west as the high grounds about the head-waters of Halls Stream and northern New Hampshire. These courses are especially noticeable about Lake Megantic and at Lowelltown, Maine, also to the north-east, where the old Kennebec road, which follows the south-east side of Rivière du Loup, crosses the International line. The source or centre from which this easterly-flowing ice received its momentum was probably in the elevated region between Lake Megantic and Norton Mills station, Grand Trunk railway. It may, indeed, have generated there independently. Striæ with eastward trend.

A considerable area south-east of the Sutton Mountain axis on the watershed between the Chaudière and St. Francis waters, although glaciated by south-eastern flowing ice, the striæ of which are superposed on those of the Appalachian glacier, is without Laurentian boulders. This second striation may also have been caused by ice which gathered upon the axis referred to on the higher grounds of Wolfestown, Ireland, etc., during the period of invasion of the older Laurentide glacier.

Below the city of Quebec, or Lévis, the slopes on the south side of the St. Lawrence River present abrupt faces to the north, often with talus at the base. No Laurentian ice crossed this part of the valley.

In studying the relations of the Appalachian and Laurentide glaciers, the question arises whether the altitudes of the mountains upon which they gathered changed during the time they were occupied with ice. It has been shown that the Appalachians stood from three to five hundred feet higher in the later Tertiary, and probably also in the early Pleistocene, than at present, while it was supposed that the Laurentides were approximately at their present level. After the Appalachian glaciers reached their maximum thickness and extent did a subsidence of the region occupied by them set in? This seems probable. The greater elevation of these mountains, compared with that of the Laurentidan plateau, may have been one reason why the ice of the latter did not reach its maximum stage as early as that of the north-east Appalachians. If a subsidence of the Appalachians began in the early Pleistocene, it was possibly accompanied by a correlative uplift of the ancient Laurentides. This subsidence would not only check the accumulation of ice upon the Appalachians, but would probably permit more moisture to reach the south-eastern and southern slopes Relations of Appalachian and Laurentian ice.

of the Laurentides. And this together with their supposed increasing altitude would be proximate causes for the increasing thickness of ice upon them, and for its spreading further southward and south-eastward than at the previous stage.

Probable thickness of early Laurentide glacier in the St. Lawrence valley.

If the early Laurentide glacier passed over those portions of the International boundary, which are upwards of 1800 or 2000 feet in height, this might be supposed to show that the divide was lower at that stage of the glacial period relative to the range nearest the St. Lawrence than at the present day. But no striæ strictly attributable to the Laurentide ice, nor any Laurentian boulders have yet been found at greater elevations near the boundary line than 1800 or 2000 feet. The occurrence of such a subsidence along the Appalachians followed by an uplift, would throw light on the origin of the high-level terraces and other stratified Pleistocene deposits occurring in the basins of St. Francis River and Lake Memphremagog.

From the foregoing facts and inferences it seems probable that the maximum stage of ice accumulation upon the Laurentides was later than that of the Appalachians, with perhaps as already inferred, an interglacial epoch intervening. But if this greater accumulation of ice upon the Laurentides was caused, either partially or wholly, by an increased recurrence of glacial conditions, following an interglacial epoch, such conditions would also affect the north-east Appalachians to some extent, and there would thus be another increase in the thickness of the ice upon the higher portions of these mountains at least. All that can be said at present is that this hypothesis is not incompatible with the facts as observed in the "Eastern Townships" and along the International boundary, but no positive evidence has been obtained on this point.

The Later Laurentide Glacier.

Movements of later Laurentide glacier.

Succeeding the older system of Laurentide ice-movements described, was the second or later Laurentide ice-flow, which has left the most distinct striation met with in this region, especially on the north side of the St. Lawrence River and of the Great Lakes. Whether this was wholly a system of land ice, or partly land ice and partly floating ice, is an open question. Within the limits of the St. Lawrence valley its trend was largely accordant with the direction of that valley, as will be seen from an examination of the list of striæ on a previous page. The striæ produced by it have been found superposed upon those of the earlier Laurentide glacier in a number of places, and are fresher and heavier. This would seem, in some instances, at least, to be the result of weathering of the exposures after the first glaciation, and before the second was imposed on them. The later Laurentide striation has been found as far east as the hilly district to the west of the city of Quebec, and is traceable thence westward throughout the whole of the St. Lawrence valley into the Lake Ontario basin and beyond that. It has also been traced along the Ottawa valley to Mattawa, and seems from the observations of others to be common on the north-east side of Georgian Bay and Lake Huron. Evidences of this ice-flow are not, however, confined to the lower grounds, but have been observed on the more elevated tracts as well. From the fact therefore that it occurs over such a large area and with such a persistent trend, it would seem that it must have been produced by a separate body of ice from the older Laurentide glacier. Many of the bosses are stossed on both the north and east sides, and wherever this occurs the latter appears to have suffered most erosion. Other exposures exhibit light scratching, especially those met with in the lower parts of the St. Lawrence valley, as if effected by some body grating the more prominent parts of the surface only, and not by one moving slowly and accommodating itself to all the inequalities of the rock surface. Both land and floating ice seem, therefore, to have been concerned in the production of this system of striation.

Interglacial period.

In the study of the Laurentian glaciation two questions already referred to have arisen, namely: (1) whether there was a withdrawal of ice at the close of the earlier advance from the Laurentides into the St. Lawrence basin and an interglacial period between this and the advent of the later ice; and (2) whether a change of level occurred in the region during the interval between the maximum extension of the earlier and of the later Laurentide glaciers, and if so, how did it take place?

As regards the first of these questions we find that some of the bosses exhibit weathered surfaces after the earlier Laurentide glacier passed over them and before the second ice-flow occurred. No interglacial deposits have yet been discovered on the slope of the Laurentides, nor in the bottom of the St. Lawrence valley; but investigations are still in progress and final results have not been reached.

The second question may be answered in the affirmative. On a former page it has been stated that a correlative rise of the southern and south-eastern part of the Laurentian plateau possibly took place after the withdrawal of the Appalachian ice and simultaneously with the advance of the early Laurentide glacier. This movement, if it occurred, seems to have been general north-east

How changes of level occurred.

of the Great Lakes. For, in this region, wherever striæ produced by the older glacier have been observed, their trend is approximately the same, namely, southward. After this ice had advanced to its southern and south-eastern limits, there would appear to have been a withdrawal or amelioration of extreme glacial conditions, whether resulting in a complete departure of this ice from this region or not remains to be determined. A change of level, or tilting of the land, seems to have occurred about this time also, accompanied by a recrudescence of glacial conditions. The changed attitude of the region then brought about the south-west ice-flow so general in the St. Lawrence valley and to the north of the Great Lakes. Whether this tilting was due to a subsidence of the upper St. Lawrence basin only, or to a rise of the region towards the gulf, or to a correlative movement including both, cannot be fully determined. One thing seems to be certain, namely, that this subsidence attained regional dimensions towards the close of the glacial period, and continued until it reached that stage indicated by the highest shore-lines found on both sides of the St. Lawrence gulf and river, from Gaspé to the Great Lakes, as recorded on previous pages. Before the last withdrawal of ice from the region the whole St. Lawrence basin must have been at a low level relative to the sea; and whether the theory of land-ice or floating-ice, or both, be adopted to explain the phenomena, there appears to have been sufficient slope south-westward to cause a flow in that direction, as no flowage could take place with existing levels.

Extent of subsidence in St. Lawrence Valley.

The closing stages of the glacial period, therefore, found the St. Lawrence valley from the gulf to the Great Lakes, altogether below sea-level, to a depth of several hundred feet. A great south-westward driftage of floating ice appears to have marked the final episode of glacial conditions, during which the fossiliferous boulder-clay and the lower portion of the Leda clay were laid down. This is proved by the occurrence and character of marine fossils, and by the stoss side of ridges and hills, especially of the isolated trap hills in the St. Lawrence valley, *e. g.* Mount Royal, Montarville or Belœil Mountain, Mount St. Hilaire, Montagne de Rougemont, Yamaska, Johnson, Shefford and Brome mountains which are all abrupt on the north-east sides and slope gradually to the south-west, with terraces, ancient dunes and spits as high often as the limits of submergence, namely from 875 to 895 feet. The facts seem to point to strong currents flowing up the valley, doubtless heavily ice-laden during the winters, and impinging against these hills. The submergence continued until the Leda clay and Saxicava sands were deposited.

Towards the close of the deposition of the Saxicava sands, the grea differential upheaval was inaugurated, evidences of which are everywhere observable in the St. Lawrence basin and around the coasts of Eastern Canada. This rising of the land was apparently greatest towards the region of the Great Lakes; but was characterized by several inequalities or reductions in the uplift, these reduced uplifts being more pronounced in the districts where the greatest changes of level occurred, as has been shown on previous pages in discussing the evidence respecting the Pleistocene marine shore-lines, pp. 12-19.

Local Glaciers and Floating Ice.

The striæ supposed to have been produced by local glaciers and by floating or sea-borne ice in the St. Lawrence valley have been studied in some detail during the seasons of 1895–96–97, although much more has yet to be learned concerning them. The striation attributed to local glaciers is distinguished from that due to the Appalachian and Laurentide glaciers: (1) by its superposition on these, (2) by its more recent appearance, and (3) by its very irregular courses. As will be seen by an examination of the list of striæ, (pp. 26-39) they trend in all directions, the movements depending wholly upon the local topography. In a number of instances it is impossible to differentiate these from the irregular, veering striæ of the older sets, especially near their margins. In the "Eastern Townships" of Quebec the plateau-like character of the region, and the fact that the mountains and valleys lie transversely to the direction in which the Appalachian and early Laurentide glaciers flowed, show that these limited glaciers could only have a very local movement and would often be compelled to follow these valleys and pursue other erratic and apparently unaccountable courses.

Movements of local glaciers and floating ice.

The striation attributable to floating ice has been traced from the lower St. Lawrence, at Bic, to Lake Ontario. It is usually confined to the valley proper, and is distinguishable from that produced by land ice by the manner in which the rock surfaces have been impressed by it. Where these are uneven, only the higher and more prominent portions have been scratched and worn, while the smaller hollows and inequalities have not been touched by the abrading agent. Bosses and short ridges extending parallel to the St. Lawrence River, of which there are many on the south side from Métis westward, have been much eroded and polished, and occasionally retain striæ produced by floating ice. The direction of movement was usually closely parallel to that of the valley. The striæ, although light, are in many places distinct, and are often found superposed on all other striæ, showing

Character of floating-ice striæ.

Where noted.

them to be the latest. They have been noted at Bic, Trois Pistoles, Cacouna, Lévis, Ste. Julie, St. Jerome, Mount Royal, Soulanges canal, Valleyfield, Prescott, Gananoque, the Thousand Islands, Kingston, Perth, and other places.

There is no escape from the conclusion, therefore, that this latest striation is due to floating or sea-borne ice, and that the estuary or gulf which then occupied the valley must have found outlet somewhere to the south-west or west.

It is proper here to state that similar conclusions to these were long ago reached by Sir J. Wm. Dawson from his examination of the St. Lawrence valley.*

Summary of facts respecting glaciation.

Synoptic statement respecting glaciation of region.

Summing up the data in regard to the glacial geology of the St. Lawrence valley, we find that on the advent of the ice age in Eastern Canada the more favourable geographical and meteorological conditions for the development of glaciers in the Appalachian region compared with those which existed in the Laurentides, brought on a more rapid accumulation of ice upon the former. Contrary to the view held by many glacialists, the ice did not first gather upon the Laurentian plateau and then advance as a great wave-like sheet southward. It seems more reasonable to suppose that it would first accumulate upon certain centres above the line of perpetual snow as the climate became colder. The North-east Appalachians having been from three to five hundred feet higher in the early Pleistocene than at present, and receiving, evidently, a larger amount of precipitation than the Laurentides, would necessarily generate glaciers more rapidly than the latter. These flowed from the higher centre or centres in northern New England and south-eastern Quebec radially towards the periphery of the region lying to the south-east of the St. Lawrence river and gulf. On the northern slope this ice seems, in some places at least, to have reached the bottom of the St. Lawrence valley, apparently unchecked by ice coming from the Laurentides. Whether an interglacial warm period supervened at this stage is a question which cannot be answered. In the "Eastern Townships" of Quebec boulder-clay occurs in a two-fold division, denoting two separate ice movements. On a number of glaciated bosses here also, the striæ produced by the earlier or Appalachian ice have been weathered before those of the later Laurentide ice were superposed on them. Further observations are

* The Post-Pliocene Geology of Canada, Can. Nat., 1872.

required on the slope of the Laurentides and in the intervening valley, however, before this question can be settled.

Subsequent to the maximum stage of extension of the Appalachian ice, there would seem to have been changes of level in the Appalachian region, whether affecting the ancient Laurentides or not is problematical. The change was in the nature of a subsidence of the former, which possibly may have been accompanied by a correlative elevatory movement of the region to the north of the St. Lawrence River. Whether this last movement took place or not, the ice from the Laurentian plateau then advanced into the St. Lawrence valley west of Quebec, and up the slope on the south-east to, or nearly to the International boundary and crossing it in some places, *e.g.*, in the Lake Champlain valley, at Lake Memphremagog, Hall Stream, etc. The earlier Laurentide glacier was thicker here than to the north-east. At the Chaudière River, on the northern slope of the range nearest the St. Lawrence, evidence respecting its upper limit was found at a height of 1000 or 1050 feet above the sea, while on the slopes of Orford Mountain and Owls Head, at Lake Memphremagog, striation was observed up to an elevation of 1800 or 2000 feet. These and a number of other peaks in the range referred to, must have stood up as "nunataks," even at the maximum extension of this glacier. If, therefore, evidence can be found of this ice having overridden portions of the range along the International boundary, above 1800 to 2000 feet in height, the fact would tend to show that this range stood relatively lower during the invasion of the Laurentide glacier than at the present day. This view assists in explaining certain high-level terraces met with near the International boundary described on a later page, and also the deformation or rise of the gravel beds from north to south observed in the basins of Lake Memphremagog and along the Coaticook, Salmon, and other rivers.

Thickness of early Laurentide glacier.

After the early Laurentide glacier had partially or wholly retired from the region, and especially from the St. Lawrence valley, succeeding which there was probably an interglacial epoch, a re-advance of ice from the Laurentides again occurred. The changed attitude of the St. Lawrence basin, which had taken place meantime, however, caused the later ice to flow south-westward, instead of southward or south-eastward, following the general course of the valley towards the Great Lakes. The progressive differential subsidence of the region then begun appears to have continued until the ice had wholly disappeared from the region, and for some time afterwards, during the deposition of the Leda clay and Saxicava sands. The closing stage of the later

Later Laurentide glacier.

Laurentide glacier was that which witnessed great numbers of local glaciers on both slopes of the St. Lawrence valley, and floating or sea-borne ice drifted south-westward. The deposition of the Saxicava sands brought the period of subsidence to a close, and the great Pleistocene upheaval followed.

Floating ice.

SUPERFICIAL DEPOSITS OF THE ST. LAWRENCE VALLEY, AND ESPECIALLY OF SOUTH-EASTERN QUEBEC.

Classification of superficial deposits.

The superficial deposits of the St. Lawrence valley may be closely paralleled with those of the Maritime Provinces, described in previous reports of the Geological Survey. The main divisions are Post-Tertiary and Tertiary (or Pre-glacial), the former being subdivided into the Recent and the Pleistocene. These are represented here both by marine and fresh-water beds. The Pleistocene is divisible into an earlier and later series of formations, to the latter of which belong the Saxicava sands and Leda clay and the deposits constituting the marine shore-lines and beaches of the St. Lawrence valley. This series also embraces the stratified sands, gravels and clays forming terraces in river-valleys, etc., and found overlying the boulder-clay. In south-eastern Quebec, in the auriferous districts these often contain gold. The earlier Pleistocene includes the boulder-clay or till, with moraines, eskers,* etc. It is slightly auriferous in some parts of the Chaudière valley.

Pre-glacial or Tertiary beds.

The Pre-glacial or Tertiary beds everywhere underlie the boulder-clay and other glacial products, and consist of (1) sedentary decayed rock-material, altogether in its original position, and (2) transported stratified deposits derived from this, in the form of coarse oxidized gravels, sands and clays which have been removed from their original position and worn by fluvial agencies. These are the true gold-bearing deposits of south-eastern Quebec.

Pre-glacial Decayed Rock-material, Sedentary and Transported.

Decay of rocks of the region.

The facts relating to the base-levelling and the denudation of the region have been given on previous pages of this report. The most potent cause of the general wearing down or reduction of the surface in pre-glacial ages was the subaerial decay of the rocks. Although it is not the purpose of the writer to enter into details regarding this in

*Eskers are long ridges of gravel and sand, sometimes with boulder-clay beneath. They are often called åsar, or osars, and formerly horse-backs, boar's backs or kames.

the present report, it may be stated that under the climatic conditions of this country the most important of the processes which bring about rock decay are: (1) the precipitation, and (2) the action of the carbonic acid of the atmosphere and of decaying vegetable matter. The changes of temperature which have such a wide range in these latitudes must also have exercised a direct influence in producing expansion and contraction of the rocks, producing joints, cracks, and crevices and opening them to the disintegrating agents referred to. The ever-recurring climatic oscillations of summer and winter have doubtless subjected the rock-surfaces to very great wear and waste. This erosion or decay resulted in the production of extensive sheets of decomposed rock in Eastern Canada in pre-glacial ages, and these and other waste products of rock decay must have accumulated to a great depth in the long time during which the surface was exposed to this process, so much so that they doubtless formed an almost universal mantle overspreading the country. Upon the elevations it would be more or less denuded even before the advent of the ice age. The removal of the decomposed materials from the higher grounds would tend to give the disintegrating forces renewed power from time to time to act directly upon the rocks, and consequently these higher grounds would suffer the most erosion and waste. Some of the products of rock decay in this region must be of an early date, geologically speaking. They have, however, been so shifted about, and have undergone so many changes, that they have probably altogether lost their original character. Those met with on the surface of the rocks, now beneath the boulder-clay, are most likely all of Tertiary age. No great quantities of sedentary material are found in any one place. In valleys and on declivities these materials have been acted upon by the usual atmospheric agencies before the glacial period, and in large part have undergone more or less transportation, and assortment and re-assortment, being laid down in stratified sand, gravel or clay beds, as the case may be, such as are now met with beneath the boulder-clay. The materials of the boulder-clay itself, and of the later stratified deposits overlying it, are derived from them.

Distribution of derived materials.

In the sections of the stratified, pre-glacial beds, given in the following pages, it will be observed that those in the bottom, whether lying upon the sedentary decomposed material or upon eroded rock-surfaces, are usually the coarsest. They consist of well water-worn gravels and sands which have probably undergone repeated removals and transportation by the rivers and streams, the finer earth and sand having apparently been carried further down stream from time to time. As might naturally be expected from this continual shifting in pre-glacial

Lower deposits containing gold.

time (and in certain local instances in the post-glacial period also), the materials now consist mainly of gravel and boulders, and in auriferous districts contain gold in the bottom. The loose alluvial gold of the Chaudière and Du Loup valleys, also of the Ditton and Dudswell districts of the "Eastern Townships" of Quebec, occurs in these gravels and sands. In the sedentary beds it is met with in a very scattered condition; but in the concentration which these underwent in the bottoms of river-valleys the loose nuggets and particles of gold have been brought together, and are now found on what formed reefs and shoals of these ancient river-courses. The gold generally lies on the rock-surface, or in the gravel next to it. Often it has worked its way down into the crevices, cracks and openings below that, especially in shaly or slaty strata with a high dip. The ancient, coarse, auriferous bottom gravels have either been laid down in portions of river-valleys which had a steep gradient, or else in comparatively shallow waters, or, perhaps, under both conditions—the finer material originally intermixed with them having been carried down to still lower levels.

Probable age of the pre-glacial beds.

The precise age of these pre-glacial auriferous deposits has not been determined, no fossils having yet been found in them; nevertheless, as stated, they appear to be largely Tertiary, and were possibly contemporaneous with the deposits found further west, on the north side of the Green Mountain range, at Brandon, Vermont, many years ago, which Lesquereux, on the evidence of fossil plants and leaves, referred to the Miocene.*

Changes of level.

Succeeding the deposition of the yellow, coarse, auriferous gravels above described, considerable changes of level seem to have taken place which affected the region in a remarkable degree, causing a change in the character of the beds subsequently deposited before the glacial period set in. The range of mountains known as the Sutton Mountain axis and its extension north-eastward, and also the parallel range of the Stoke mountains, seem to have sustained a greater differential uplift relative to other parts of the region, while the wide parallel basin between these and the range along the International line probably suffered a sag or correlative subsidence. In consequence of these movements the two westerly ranges (the Sutton and the Stoke mountains) must have again been vigorously attacked by denuding agencies, while the depression to the south-east became the receptacle of a large amount of sediment transported thither from the north-west, and also from the axial divide of the International boundary. Along with this transported material con-

* Geology of Canada, 1863, p. 929.

siderable quantities of alluvial gold were carried thither from the old pre-Cambrian ranges on either side, much of it in a very finely divided condition. From the varying character of the sediments deposited in some of the river-valleys at this stage, it is evident that the changes of level have been slow and of long duration. The beds graduate upwards from the gravels in the bottom to clay, then to sand, which is overlain by the boulder-clay. This seems to be the general succession of the pre-glacial beds throughout the region. The clay and sand deposits denote lacustrine conditions, or more probably quiet lake-like river expanses; but these have doubtless been merely local in certain parts of river-valleys. The materials of these gravels, clays and sands have been originally derived from the sedentary beds of decayed rock, or from portions of these which had undergone a previous assortment or shifting down stream. As regards the origin of these stratified, pre-glacial sediments, there seems to have been no general law, the character of the material as now observed depending upon the force of the currents, the volume of the rivers, etc. The coarse beds would probably be deposited in those portions of the river-channels where the currents were strongest, while in the deeper parts and where there were slack currents, the fine sand and clay would be laid down. From the fact that these fine sand and clay beds are well developed and widespread in the valleys of the Chaudière and Du Loup rivers, and occur at a nearly uniform level from the Devils Rapids in the former to the vicinity of St. Come, in the latter, it would appear that lacustrine conditions existed there for a considerable time in the later Tertiary, just previous to the advent of the ice age. Whether these conditions were due to a change in the climate caused by the approach of the glacial period is not known, but it seems probable. The gradual increase in thickness of the ice upon the North-east Appalachians would give a greater volume to the rivers during the summers while this ice was spreading from the higher grounds and before it reached the lower slopes and valleys. There would then be the waters from precipitation, plus those from the melting snow and ice of the mountain districts, throughout the summer months each season. For these reasons the rivers were probably larger than at present for a great part of the year. Hence the greater erosion and deposition of sediments, coarse and fine, during the later Tertiary or early Pleistocene, that is, if we draw the dividing line between those two periods at the stage when ice first began to gather upon the mountains, and before it descended into the valleys.

Character of sediments

How deposited.

Greater volume of rivers.

The causes of the great accumulation of beds of stratified gravel, clay and sand resting on the inferior auriferous deposits are, there-

Summary of conditions.

fore : (1) the differential movements which occurred in the region, producing lakes or lake-like expanses in the river-valleys in which the finer sediments were deposited ; (2) the greater volume of the rivers from the approach of glacial conditions, and (3) the greater quantities of material at hand in the sedentary and stratified fluviatile beds of an earlier date.

Deposits of the glacial period.

Before giving a detailed description of the pre-glacial auriferous deposits and the mode of occurrence of the gold in them, it seems desirable to present the facts regarding the boulder-clay, and later formations, well developed in many of the river-valleys, after which the origin and distribution of the gold found in the alluviums can be more intelligently discussed.

Boulder-clay, Moraines, Boulders, etc.

Boulder-clay.

Generally speaking, it may be stated that the boulder-clay forms a mantle, of greater or less thickness, covering the rock surfaces and decayed rock-materials throughout the whole St. Lawrence valley, including the region here under description. Although, often irregular as to thickness, and thrown into mounds and short ridges, which may occasionally be classed as drumlins or drum-like hills,* it presents few structural peculiarities, and no true moraines or eskers have yet come under observation. The boulder-clay of the region was described many years ago by Logan and his officers †, and by Sir J. Wm. Dawson. ‡ For the most part it seems to have been the product of land-ice ; but in the bottom of the St. Lawrence valley, especially at Rivière du Loup and below that, it has been found to contain arctic marine shells of Pleistocene age, and is apparently due to the action of floating, or sea-borne ice. Local glaciers both from the north and from the south have, however, debouched into the valley, to which portions of the boulder-clay found here are likewise to be attributed.

Drumlins.

Marine boulder-clay.

Except as regards the presence of marine shells in some of the deposits of boulder-clay met with in the St. Lawrence valley it exhibits no characters by which the marine can be distinguished from the land-ice product.

*Drumlins are long oval-shaped ridges or mounds of boulder-clay, their longitudinal trend being usually parallel to the striation of the district in which they occur. They differ from moraines, inasmuch as they are not marginal formations ; but are supposed to have accumulated beneath the ice.

† Geology of Canada, 1863, pp. 893-896. ‡ Notes on the Post-Pliocene Geology of Canada, pp. 6-16. The Ice Age in Canada, pp. 37-52.

Within this valley the boulder-clay has been subject to very great denudation by subaerial agencies, by the rivers, and by the sea during the submergence of the later Pleistocene.

As has been shown on previous pages the boulder-clay has a bi-partite division in the "Eastern Townships" of Quebec; but this has not been observed as yet in the bottom of the valley, nor on the Laurentide slope, although intercalated beds have been found in it at Toronto by Prof. A. P. Coleman.* Bi-partite division of boulder-clay.

Very little gold has been met with in the boulder-clays of the auriferous districts of south-eastern Quebec. The reason of this seems to be that but little of the pre-glacial assorted gravels from the river-valleys have entered into their composition, the materials composing them having been gathered mainly from the higher grounds. It is, nevertheless, made up largely of decayed rock-material.

Although no moraines nor eskers have been found in the St. Lawrence plain; yet, on the slopes, short broken ridges composed of boulder-clay, or partly of boulder-clay and partly of coarse stratified and worn deposits, have been met with. Such of these as are distinguishable from drumlins and kames may be classed as moraines of recession.

Kames or kame-like deposits† have been noted, some appearently of constructive origin, others due to denudational. The greater number belong to the Saxicava sand period, and are usually composed of stratified materials, although exhibiting hummocks, ridges, kettle-holes, etc. Kames.

The principal source of the boulders met with throughout the St. Lawrence valley has been the Laurentian plateau, but a number belong to the Appalachians and to the eruptive crystalline rocks of the region. The wide distribution of Laurentian boulders has been effected by several agencies, some of which are still in operation. The first dispersion of Laurentian boulders took place during the extension and southward movement of the early Laurentide glacier, the powerful action of which transported them across the St. Lawrence valley and to an elevation of 1800 or 2000 feet up the southern slope. Following this was the south-west ice-flow, or later Laurentide ice-movement, which likewise effected a great transportation of boulders towards the region of the Great Lakes, and across the International boundary. Sources of boulders. Dispersion.

*American Gelogist, vol. XIII., 1894, p. 85.

†Kames are short, irregular ridges or hummocks of gravel, sand, etc., the materials being much the same as those of eskers, or osars, Their mode of formation is, however, supposed to be different, but has not yet been clearly defined.

Agencies of dispersion.

And during the subsequent submergence of the St. Lawrence valley beneath the sea, floating ice played an important part in their distribution—a work which is still in progress in the estuary of the St. Lawrence and around the shores of Eastern Canada. Boulder pavements can be seen in the littoral similar to that illustrated by Sir J. Wm. Dawson, (frontispiece of *The Ice Age in Canada*). These are due to recent floating and coast ice. But the most unequivocal proofs of the carriage of boulders by floating ice were seen in certain non-glaciated areas, for example, on Orleans Island below the city of Quebec, where large angular boulders were found lying scattered about singly upon the surface of the Saxicava sands, evidently having been dropped there during the great submergence.

Transportation by rivers.

The agency of rivers, especially during floods, and also that of river-ice, in transporting and distributing boulders within the St. Lawrence basin, have likewise been very great. Remarkable examples of this can be seen along the tributaries flowing into the St. Lawrence from the Laurentian plateau. It is quite evident from the immense numbers of boulders derived from the Laurentides, which now cumber the valleys and strew the inner border of the plain, that other agencies besides that of Pleistocene land-ice have been influential in their production, and one of these seems to have been subaerial denudation, large quantities of decayed rock-material, including boulders, having been met with along the slopes and foot-hills of the Laurentian highlands. The Ottawa valley, for example, appears to have received an immense amount of this material, a portion of which, however, was doubtless accumulated during the invasion of the sea which followed the glacial period. Subsequently, as the region rose and emerged from beneath the gulf waters, denudation in the littoral and also in the river-valleys, attacked the deposits referred to, and great quantities of sand, gravel and clay must have been swept away and transported to lower levels, leaving the boulders exposed on the surface.

Boulders in the Ottawa valley.

Accumulation at Rigaud Mountain.

In large valleys, such as the Ottawa, Mattawa, etc., great accumulations of boulders occur at certain places. At Rigaud Mountain, on the south side of the Ottawa River, not far from its confluence with the St. Lawrence, we find remarkable boulder deposits. These were first described in the Geology of Canada (1863, page 896) where it is stated that "there is a series of plains destitute of vegetation and covered with boulders." One of these boulder plains on the north-west side of the mountain was examined. It is situated on a sloping terrace, about 300 yards long from south-west to north-east, which descends in overlapping or imbricated parts about 65 feet in that distance. Transversely it is nearly horizontal and about 140 yards wide.

The height above sea-level, at the upper part, is 550 feet. The terrace on which these boulders lie, extends along the base of a low escarpment to the south-east, and the boulders are entirely local, belonging to Rigaud Mountain. Not a single boulder from the Laurentian hills, directly opposite, was seen. The depth of the boulder-bed is not known, but holes from five to ten feet deep do not show the bottom. It is evidently deepest in the centre however, thinning out towards the margin where it becomes covered with a growth of bushes. Nearly all the boulders are less than a foot in diameter, only an occasional one reaching two or three feet. They are without any appearance of ice action, though well-rounded probably from attrition.

These boulders are evidently the result of the subaerial wear and waste of Rigaud Mountain in pre-glacial times; but how they escaped the denudation of the Laurentian ice is an unsolved problem. During the marine invasion they must have been entirely submerged, and probably buried in superficial deposits. On the emergence of the land which followed, the finer and lighter materials seem to have been entirely swept away, leaving not a vestige of anything but the boulders. The imbricated or overlapping condition denotes powerful currents and perhaps the action of floating ice from the west. They had apparently reached their present stable situation just as this mountain was deserted by the later Pleistocene sea. How produced.

At Hull, north of the city of Ottawa, another singular boulder-bed, or series of boulder-beds, came under observation. These occupy short ridges trending east and west, or to points between north-east and south-west. Some of the ridges are wide or flat-topped, and show two kinds of boulders on them, one series exhibiting a majority of Laurentian boulders and another of limestone slabs. The boulders in the first are probably secondary from moraines, as a number of them show signs of effaced glaciation. The ridges appear to have been formed at the meeting of the Gatineau and Ottawa waters. Those ridges containing most limestone boulders have probably been produced by the Ottawa River, and are partly due to accumulation and partly to subsequent denudation. A section of the deposits in one of these, in descending order exhibits the following:—(1) Sand and gravel, packed with boulders or limestone slabs, of all sizes, from five feet in diameter downwards. Most of these belong to the underlying Cambro-Silurian rocks, but some have been brought down the Ottawa apparently from outliers of these along the valley. Very few Laurentian boulders occur in these ridges. The limestone slabs lie mostly in an imbricated manner, as if acted upon by some powerful current or impact of floating Boulder-beds at Hull. Section at Hull.

ice from the west. None of these slabs are glaciated. The thickness of this bed is from 5 to 10 feet. (2) Dark gray clay, (Leda clay), containing fragments of marine shells of Pleistocene age, resting on boulder-clay. Thickness from 12 to 15 inches. (3). Boulder-clay from 1 to 2 feet or more in thickness, lying apparently on the rock-surface.

Origin of the boulder ridges.

The ridges in which boulders of limestone predominate are on the south side, and those with the greater proportion of boulders of Laurentian origin lie on the north, or nearest the Gatineau River. But why there should be such a difference in the distribution of the boulders on ridges so near each other, for they are not more than from a hundred yards to a quarter of a mile apart, is not apparent. The rivers and river-ice may have been instrumental in this regard during the period of deundation or emergence of the valley from beneath the Pleistocene sea. The trend of the ridges is not in the direction of movement of the ice from the Laurentian highlands—in fact seems to be entirely independent of it. There is little doubt that many of the boulders in this locality have been brought thither by floating ice, both sea-borne and river ice, during the great submergence.

Boulder-bed at Mattawa.

But Rigaud Mountain and Hull are not the only places along the Ottawa valley where boulders occur in great abundance, indeed, they are common everywhere throughout its whole extent. Ascending the valley we find them plentiful at Deux Rivières, also at Klock, and thence to Mattawa, at the latter place the village being really built on a bed of boulders. A great accumulation of sand and gravel containing worn Laurentian boulders appears to have taken place at the junction of the Mattawa and Ottawa rivers, which has since been much denuded, leaving the boulders exposed on the surface. The succession of the Pleistocene deposits here, so far as observed, is as follows in descending order:—(1) Sand and gravel with great numbers of worn boulders, a few of which still show traces of glaciation; (2) a clay and silt bed, calcareous, fine-grained, stratified, bluish in colour, and without sand or gravel, 16 feet. The underlying deposit was not reached, but it is probably boulder-clay.

Between Mattawa and Lake Nipissing, the valley is plentifully strewn with boulders and occupied for the most part with water-laid deposits.

Conditions in Ottawa valley.

The boulders of the Ottawa valley seem, therefore, to have been brought to the surface by the denudation of the beds of which they formed a part, as the valley emerged from beneath the Pleistocene sea during the closing stage of the Saxicava sand period and these beds became subjected to erosion by the Ottawa River and its tributaries

The upper portion of the series now occupying this valley may, therefore, be partly marine and partly fluviatile. Whether or not the upper Great Lakes once found outlet by the Mattawa-Ottawa valley is a question which appears to the writer to require further detailed investigation.

Although glaciated boulders occur in the Leda clay and Saxicava sand, this must not be taken as necessarily evincing the action of glaciers at the time. Glaciated boulders are to be found in all the formations above the boulder-clay, even in the recent river alluviums and marine-beach sands. These have merely been transferred from one deposit to another by the existing agencies of transportation, and have all been derived originally from the boulder-clay.

Inland Gravel, Sand, Clay, River-beds and Lake-beds, stratified and often terraced.

The stratified deposits thus classified are those found on both slopes of the St. Lawrence valley above the level of the shore-lines described on former pages of this report. They consist of sand, gravel and clay, usually in the same succession as the known marine deposits, and rest upon the boulder-clay; but thus far no fossils have been detected in them. In the "Eastern Townships" of Quebec they are well developed in the wide interior valley between the north-east prolongation of the Sutton Mountain range and the International boundary. Commencing in the south-western part of this valley, we find, in the basin of Lake Memphremagog, thick deposits of stratified gravel, sand and clay. At the northern end these are terraced at an elevation of from 865 feet to 875 feet above the sea, or 180 feet above the lake surface. Near Georgeville, on the east side of the lake, ten miles from the north end, the height is from 915 to 920 feet. Further south, near Magoon Point, terraces and benches occur at about 950 feet above the sea-level. At Newport, Vermont, near the southern end of the lake, similar denuded terraces rise to an elevation of 990 feet, or about 295 feet above the lake surface. Whether these deposits rise in still higher terraces and banks along the Memphremagog basin to the south of Newport, has not been ascertained, but the facts, so far as observations have extended, show their gradual rise from north to south.

High-level, stratified deposits.

Lake Memphremagog.

In the valleys of the Massawippi River and its tributary the Coaticook, a similar rise from north to south, was observed in the terraces. At Sherbrooke and Lennoxville they occur at heights of 875 feet. Ascending the Coaticook River, terraces were noted at Coaticook station, Grand Trunk railway, on both sides of the valley at an eleva-

Massawippi and Coaticook rivers.

tion of 1235 feet. These are formed of stratified materials, underlain by boulder-clay. No barrier exists between these high-level terraces and the great St. Lawrence plain capable of holding in a body of water at that elevation. At Norton Mills, further up the Coaticook valley, terraces occur at about the same height as the railway station there, viz., 1361 feet; but as these are somewhat uneven, and are almost wholly surrounded by hills, they may be lacustrine or fluviatile.

St. Francis River.

Proceeding eastward from Sherbrooke and Lennoxville along the main valley of the St. Francis River, terraces were also found to ascend as far as the divide between these waters and those of the Chaudière River. In the vicinity of Sherbrooke they are, as stated above, about 875 feet high, while at Lake Aylmer they occur at an elevation of from 1050 to 1075 feet.

Chaudière River.

In the valley of the Chaudière River, terraces have been formed along both slopes of the valley, apparently under similar conditions to those of the terraces described above. The height of the upper terraces in the lower part of this valley, corresponds with that of the marine shore-lines observed on both sides of the mouth of the Chaudière River, namely, 750 or 760 feet. As we ascend the valley of this river and that of its principal tributary the Du Loup, the terraces also ascend and have been traced up to a height of 875 or 900 feet. But as the latter are in basins lying within the boundaries of the river-valleys, the conditions of their formation seem to have been such that they may be of either fluviatile, lacustrine or marine origin.

Sutton and Stoke mountains.

In the Sutton Mountain range and its extension north-eastward, also in the Stoke Mountains, valleys and depressions occur occupied with stratified gravel, sand and clay, usually terraced, at about the same elevation as the marine shore-lines on the north-west slope of the mountain. Examples of these can be seen in the Wattopekah valley, and between that and Danville, at Dudswell, etc.; and west of the St. Francis River in the direction of Kingsbury, and many other places.

General view of these deposits.

Taking a general view of the facts in connection with these stratified and terraced deposits it appears that those found in the mountains referred to and near the south-eastern side of the Stoke Mountains are practically at the same elevation as the marine shore-lines of the St. Lawrence valley at the nearest point. From the base of the Stoke Mountains and their continuation north-eastward, however, these stratified beds rise, in the drainage basin of the St. Francis River, towards the south, south-east, and east till they approach the base of the range along the International boundary. Were these beds laid down originally in a horizontal attitude, and subsequently eroded or deformed? Are they fresh water or marine? No fossils have yet been found in them except near Little Magog Lake, lot 6, range 14 of Ascot, where Mr. A. Michel found "fragments of shells many years ago, too imperfect to be preserved, but from a drawing made on the spot" were supposed by Dr. T. Sterry Hunt, who records their occurrence, to be a species of Mya.* The height of the bed from which the shells were taken is about 690 feet.

Question of original attitudes.

As regards the question of the original attitude of these deposits the facts would seem to favour the view of a differential elevation, the axial divide of the International boundary having apparently undergone a greater uplift than the district nearer the St. Lawrence, as held by Prof. J. W. Spencer.† Whether this hypothesis has any foundation in fact, or not, it explains the deformed attitude of these stratified deposits. Moreover, it seems to receive support from the local conditions which affected the glaciation of the region, especially by the manner in which the early Laurentide glacier moved. This ice flowed apparently with tolerable regularity over what is now a surface with a considerable gradient, the slope being opposite to the direction of ice movement. It appears also, in a few instances at least, to have reached levels higher than its source, *i. e.*, allowing that the relative heights of the Laurentides and of the north-east Appalachians were even approximately the same in the glacial period as at present. Whether during this period the relative altitudes of the two principal mountain ranges, viz., the Sutton Mountain axis and its extension north-eastward, and the axial divide along the International boundary, were different from what they are at present, cannot be determined; but it seems possible the latter was lower for some time.

Mode of origin of these stratified deposits.

In reference to the origin of the deposits under discussion several hypotheses may be advanced.—(1) They may be marine; (2) they may have been deposited in so-called glacial lakes; (3) they may be of fluviatile and lacustrine origin; or (4) they may be partly due to subaerial base-levelling. Indeed, it is possible that two or more, perhaps, all these causes combined have contributed to bring about the present condition of things as regards these deposits. If existing levels obtained during the period of their deposition, the third hypothesis may be eliminated, except as regards terraces in river-valleys, as no barriers of sufficient height to hold in bodies of water at the level of the higher terraces lying outside of the river-valleys exist at the present day in the region between these and the St. Lawrence plain. But if the

*Report of Progress, Geol. Surv. Can., 1863-66, p. 87.

† Bull. Geol. Soc. Am., vol. VI., pp. 460-461.

region along the axis of the Nôtre Dame Mountains were lower relatively at that stage than at present, rivers and lakes may have been largely instrumental in their formation.

Hypothesis of glacially dammed waters.

The second hypothesis, namely, that of glacial dams and glacial lakes, does not seem capable of explaining the facts; indeed serious difficulties present themselves when an attempt is made to elucidate the phenomena by its aid, except as regards some local beds. Only a very brief statement concerning these objections can, however, be given here. In order that these terraced gravels, sands, etc., could be deposited in waters held in by an ice-dam, we must postulate the existence of a mass of ice occupying the bottom of the St. Lawrence valley, and covering the first range of hills to the south-east (the Sutton mountain range) at that stage of the Pleistocene, while the principal portion of the region to the south-east of the range, especially the wide valley in which the deposits referred to mainly lie, was free from it. It is at once evident that this hypothesis is not in accordance with the physical conditions governing the existence of glaciers. For is it not a matter of observation as well as of theory that glacier-ice first melts and disappears from the lower grounds and clings latest to the slopes and valleys among the hills and mountain ranges? It may be maintained, however, that ice would occupy the Sutton and Stoke mountain ranges after its disappearance from the St. Lawrence valley and from the interior valley between the ranges referred to. But even if this were the case, it does not seem probable that a barrier of ice on these mountains would hold in water for a sufficient length of time to allow the deposition of sediments in a supposed glacial lake or series of lakes, to a thickness or vertical range of two to four hundred feet. Such a barrier, if it ever existed could only have been of the most temporary character. The nature of the deposits, their similarity to the terraced beds on both sides of the Sutton Mountain range, and also to those in the central parts of that range, where an ice barrier on the theory of glacier-dams may be supposed to have existed, their comparatively uniform height from the marine shore-lines south-eastward through the mountains and into the portions of the interior valley nearest thereto, etc., preclude the theory of a continuous ice-dam occupying the Sutton and Stoke Mountain ranges and holding in a glacial lake to the south-east. Moreover, it appears doubtful whether deposits of the character met with here would be thrown down in hypothetical glacial lakes of the kind, in the sequence usually occurring in the terraces found in the region inside the Sutton Mountain range.

Probably of marine origin.

For these and other reasons which cannot be given in detail here, the marine hypothesis would seem to afford a more satisfactory explanation than any other of all the stratified and terraced deposits met with up to a height equal to that of the marine shore-lines on the north and north-west side of the Sutton Mountain range, which varies from 750 feet near the mouth of the Chaudière River to 875 to 900 feet near the International boundary. And in regard to the stratified beds found at a higher level, the question of their origin will for the present be left open.

High-level stratified beds on north side of the St. Lawrence.

On the north side of the St. Lawrence River, similar beds occur in certain localities above the level of the marine shore-lines, but they are more uneven and detached than in the "Eastern Townships." They are generally found among the Laurentide hills, and are at different levels, and in many of the valleys they cannot be separated from those of fluviatile and lacustrine origin. The thick beds of stratified sand, in terraces, noted in many of these valleys necessarily suggest the question as to their source. The existing rocks of the region do not seem capable of furnishing such quantities of sand, and it would seem as if these beds must be due to Palæozoic strata of an arenaceous nature largely or wholly denuded.

Gold.

The deposits under discussion yield gold in the Chaudière and Rivière du Loup valleys, also at Dudswell, Ditton, etc. The gold is very fine, however, and very much scattered. Its occurrence in these gravels and sands is due to the assortment and re-assortment which the valley drift underwent since the glacial period. The rivers have cut down into the pre-glacial auriferous gravels and their superincumbent boulder-clay beds, transporting the whole to lower levels to form post-glacial terraces, etc. In this way the gold has been re-distributed in these post-glacial deposits. Some of these terraces and valley drifts have again been eroded, and undergone renewed transportation. Doubtless some of the fine gold found in the present river-beds is from these sources.

Leda Clay, Saxicava Sand and Marine Shore-lines of the St. Lawrence Valley.

Leda clay and Saxicava sands.

The Leda clay and Saxicava sands of the St. Lawrence valley were first described in a general way by Logan and his colleagues,* and the nomenclature now in use regarding them was then employed for the first time by Sir J. William Dawson. Since that early date the last-mentioned author has more fully worked out the Pleistocene geology

* Geology of Canada, 1863, pp. 915-928.

of the region, and published detailed results, with extensive lists of fossils, etc.* The extent and character of these deposits are now pretty well known, both on the north-west and south-east sides of the St. Lawrence valley, where they are delimited by the marine shore-lines described in former pages of this report; but to the south-west their limits have not been traced, and whether they reach as far inland as the valleys of the Great Lakes or not is a debatable question.

Character of materials.

The materials constituting the Leda clay and Saxicava sands are fully described in the publications referred to above. The former not infrequently consists of coarse clay with pebbles and some boulders in the bottom, graduating into a dark or blue clay near the summit, usually containing marine shells. The Saxicava sands are generally composed of fine, stratified—in some places blown—sands, of variable amount, sometimes reaching a thickness of one or two hundred feet. Occasionally they contain gravel towards the summit. In many places they are found resting directly upon the Leda clay, but elsewhere on boulder-clay or upon the rock surface. They are very seldom fossiliferous except at the base, or at their contact with the underlying Leda clay, and contain only shallow-water species.

Irregular surfaces.

The surface of the Saxicava sand beds is not always flat, being occasionally hummocky, or formed into kame-like ridges and mounds, with hollows intervening which may be called kettle-holes. The latter often contain ponds or lakelets. These topographical features appear to be the result of two causes, first, that which may be termed constructive—and which may have imposed certain forms upon them during the deposition of the materials; and secondly, destructive, that is, due to subsequent erosion. Examples of this kind of surface are more frequent near the borders of the marine area, but were also noted at lower levels.

Materials of shore-lines.

The materials of the Pleistocene marine shore-lines of the St. Lawrence valley seem to be chiefly Saxicava sands; but gravel, and occasionally bands of clay enter into their composition. Most of the shore-lines are formed of built terraces. In a few places, however, they have been produced by wave-cutting in boulder-clay. The stratified clay in these shore-lines appears to be the equivalent of the Leda clay, although hitherto no fossils have been found in it. Ancient beaches of gravel and sand, behind which a lagoon or shallow channel lay have also been met with. These do not at all places indicate high-water mark, however, being found at different levels.

*Notes on the Post-Pliocene Geology of Canada, 1872; The Ice Age of Canada, 1893.

The heights at which Pleistocene marine fossils have been found in the St. Lawrence valley may be here noted. The data are mainly compiled from the publications of Sir J. Wm. Dawson and from the reports of the Geological Survey.

Elevations at which marine fossils occur.

Between Kenogami and Belle Rivière, near Saguenay, 400 feet. (Dawson.)

At Murray Bay and Les Eboulements, 600 feet. (Dawson.)

North of St. Ambroise station on the old line of the Quebec and Lake St. John railway, 575 feet, with terraces of Saxicava sand, 600 to 615 feet high. (Low).

At Mount Royal, Montreal, 560 feet, with distinct beach at 625 feet. (Dawson, Adams, de Geer).

At Magog Lake, 690 feet? (*supra*).

Near Smiths Falls, remains of a whale, 440 feet. (Dawson and others).

In Lake Champlain valley, 400 feet, with marine terraces up to 480 feet. (Baldwin).

At Fort Coulonge Lake, 365 feet.

Throughout the counties of Renfrew, Lanark, Carleton and Leeds, Ontario, 425 feet.

The above are the highest known fossiliferous beds; but lower beds are numerous throughout the St. Lawrence valley, and occur at various altitudes.

Formations of the Recent Period.

The peat beds and other formations belonging to this period are well developed in some parts of the St. Lawrence valley; but only those of fluviatile origin can be noted here. These consist of sand, gravels and clay along the river-valleys, the two first forming "bars," which in auriferous districts contain "colours" of gold. The gold found in the river bottom at the Devils Rapids, on the Chaudière and at Great Falls, also that met with in the present channel of Riviere du Loup near its mouth, appears to have been brought thither in the recent period.

Beds of the recent period.

Extensive boulder-beds which belong to this period, occur in the littoral along the lower St. Lawrence below Quebec having been formed by river and coast ice. They have been described by Sir J. Wm. Dawson. *

*See frontispiece in The Ice Age in Canada.

THE GOLD-BEARING REGION OF SOUTH-EASTERN QUEBEC.

Gold-bearing region of south-eastern Quebec.

The gold-bearing region proper of south-eastern Quebec, as at present known, extends from Memphremagog Lake on the west, to the Etchemin River and Township of Ware on the north-east, and from the crystalline range of mountains nearest the St. Lawrence (the Sutton Mountain anticline) south-eastward to the International boundary. In an early report of the Geological Survey * the region was estimated to comprise from three to four thousand square miles; but in a considerable part of this area gold does not actually occur, while in several places within these limits it is in such an exceedingly fine state of division and is so sparsely discriminated as to be of little or no economic importance. The non-auriferous districts are principally in the Cambro-Silurian basins lying between the ranges of mountains above referred to.

Original source of the gold.

The topographical features of the region, as outlined on a preceding page, seem to have had an important influence on the distribution of the gold. The examinations here reported on show that the original source of the precious metal was in the oldest rocks of the "Eastern Townships," namely the pre-Cambrian or Huronian (?) of the three mountain ranges which traverse it. The Cambrian and Cambro-Silurian rocks are probably composed largely of materials derived from the pre-Cambrian in their disintegration and waste, and the gold they contain, as well as that met with in the alluviums derived from them probably owes its origin likewise to the same source. Concentrating processes have been in operation ever since. During the formation of the Cambrian and Cambro-Silurian rocks there may have been some mechanical concentration of the gold in these, as the sediments which were derived from the pre-Cambrian in Cambrian and Cambro-Silurian times would naturally contain it in a fine state of division. It is difficult except on this supposition to account for its presence in some areas and its scarcity or absence in others. But the chief concentration seems to have been in some of the quartz veins at a later stage in areas of eruptive diorites and other intrusive rocks, and still later in the alluviums of the river-valleys during the wear and waste of the land surface.

Literature pertaining to gold-mining in south-eastern Quebec.

In the following account of gold mining operations in the "Eastern Townships" and adjacent portions of the province of Quebec, free use has been made of all previous publications relating to the subject. The literature pertaining to it is somewhat voluminous and extends

* Report of Progress, Geol. Surv. Can., 1850-51, p. 6.

over a period of more than sixty years, but much of it is now out of print and inaccessible to the public, hence quotations and references are frequently given. Considerable new material, is however, added, for which I am indebted to a number of gentlemen whose names are given below. The reports and publications which have principally been made use of are as follows :—

Sir W. E. Logan and Dr. T. Sterry Hunt, 1851-52.—Report of Progress, Geol. Surv. Can.

F. T. Judah, Clerk of Crown Lands, 1863.—Report of the Quebec Government, on the Gold Mines of the Chaudière.

Sir W. E. Logan, Geology of Canada, 1863.

Report of the Select Committee appointed by the Quebec Government to ascertain the value of the Chaudière gold areas, 1865.

Sir W. E. Logan and Dr. T. Sterry Hunt, 1865-66,—Report of Progress, Geol. Surv. Can.

Mr. A. Michel, 1865-66.—Report on the Gold Region of Lower Canada, in Report of Progress, Geol. Surv. Can., 1865-66.

Dr. A. R. C. Selwyn, C.M.G., 1870-71.—Notes and Observations on the Gold Fields of Quebec and Nova Scotia ; Report of Progress, Geol. Surv. Can., 1870-71.

Mr. W. Chapman, 1881.—Gold Mines of Beauce.

Dr. A. R. C. Selwyn, C.M.G., (Mr. A. Webster) 1880-81-82.—Notes on the Geology of the South-eastern Portion of the Province of Quebec. Report of Progress, 1880-81-82.

Prof. E. J. Chapman, 1886.—Report on the property of the St. Onge Gold Mining Company.

Dr. R. W. Ells, 1887.—Report on the Geology of a Portion of the Eastern Townships. Annual Report, Geol. Surv. Can., 1886. Part I.

Dr. R. W. Ells, 1888.—Second Report on the Geology of a Portion of the Province of Quebec. Annual Report, Geol. Surv. Can., 1888. Part K.

Dr. R. W. Ells, 1888-90.—Report on the Mineral Resources of the province of Quebec. Annual Report, Geol. Surv. Can., Vol. VI., 1888-89. Part K.

Prof. H. Y. Hind.—Unpublished reports on the auriferous deposits, etc., of the Chaudière and Du Loup valleys.

Mr. J. Obalski, Inspector of Mines for the province of Quebec. Reports of the Commissioner of Crown Lands, and Reports of the Commissioner of Colonization and Mines for the province.

Besides the information derived from the above-mentioned sources, the writer begs to acknowledge his indebtedness to a number of miners

Other sources of information.

and others who have wrought in the gold mines referred to or been connected therewith. Mr. Wm. P. Lockwood of Montreal furnished Mr. E. D. Ingall of the Division of Mineral Statistics and Mines of this Survey and the writer with a large amount of valuable data, accumulated during his extended operations in the Gilbert River valley and freely placed his notes, maps and plans at our disposal. Tracings of the surveys of the Gilbert valley made by his son, Mr. Arthur Lockwood and of the elevation and gradient of the valley referred to as levelled by him have also been obtained. These data together with the position and depth of a number of shafts sunk by Mr. Lockwood, have enabled us to determine the site of the old pre-glacial river and ascertain its gradient in the auriferous district approximately at least.

The gentlemen named below have likewise kindly supplied me with valuable information respecting gold mining operations in the particular districts in which they have worked.

Mr. Samuel Byrne of the American Gold Mining Company has given me an account of the operations carried on in the Gilbert River valley by him. Mr. Louis Gendreau, whose extensive knowledge of gold mining matters in south-eastern Quebec has afforded me with a large number of facts collected during his lengthened experience in Beauce, Ditton, etc. To the following gentlemen I am also under obligations for assistance courteously given and for various acts of kindness:—J. E. Hardman, Capt. Geo. Macduff, Peter Brown of McArthur Bros. (Ltd.), P. Angers, Notary, St. François, Beauce, H. C. Donnell, Chas. Rodrigue and T. C. Osgood of the Rodrigue Mining Company, Dudswell; F. E. Harrison of Harrison Brook, John Blue, Eustis Copper Mines, E. B. Haycock, Ottawa, Dr. R. W. Heneker, Sherbrooke and others.

History of Gold Mining in South-eastern Quebec.

Gilbert River.

History of gold mining in the Gilbert River valley.

Gold is reported to have been first discovered about the year 1823 or 1824, by a woman near the mouth of the Touffe des Pins, or Gilbert River, an affluent of the Chaudière. This statement was presented in a paper read before the Literary and Historical Society of Quebec, in 1863, by the Rev. James Douglas, entitled, "On the Gold Fields of Canada," but little or no attention was paid to it. In 1834, a young girl named Clothilde Gilbert, who afterwards became the wife of Oliver Morin, of St. George, Beauce, "taking a horse to water near the same spot, perceived as she supposed, a stone glittering in the bed of the river, and thinking it curious enough to preserve, took it home with her." This was the discovery reported by Gen. Baddeley in 1835.* The piece he described was said to weigh 10·63 grains; but he was unaware that this piece had been cut off a larger nugget, the weight of which was 1056 grains. Mr. Leger Gilbert, father of the girl who found the nugget, sold it for $40, a sum apparently much below its value. Encouraged by this discovery he made further search, and on several occasions found more gold, but not of any considerable amount. The DeLery family, owners of the seigniory of Rigaud-Vaudreuil, in consequence of these discoveries and of the indications of gold which the district afforded, applied for and obtained letters patent from the Crown, dated September 18th, 1846, giving them exclusive mining privileges for the precious metals *for ever*, within the limits of the seigniory in question, subject to certain conditions, among others the payment of a royalty of ten per cent on the gross produce after melting (smelting) of the ores in furnaces, which conditions it appears were never complied with. No royalty was paid to the Government, as no gold was produced in this way. The seigniory comprises an extent of three leagues (9 miles) along the Chaudière River, and a depth of two leagues (6 miles) on each side. Explorations were carried on by Mr. C. DeLery, and an examination and report on the value of the property made by J. P. Cunningham. In 1847, the Chaudière Mining Company was formed, to which Mr. DeLery leased all his rights in consideration of receiving an improved royalty, amounting for the first portion of the leasehold term to twenty-five per cent, and for the latter portion to thirty-three and a half per cent, but this arrangement not being found satisfactory, the improved royalty was bought up for a fixed sum. This company also acquired the right of working in the fief La Barbe, through which the Famine River flows. Rigaud Vaudreuil seigniory.

The Chaudière Mining Company began operations on the Touffe des Pins, or Gilbert River, at a point about one mile from its mouth, where they worked for several years, but in such a reckless and unscientific way that expenses were not met. They also operated on the Des Plantes River in 1847, and several rich deposits were struck. At one of these, just above the first fall, from three to ten ounces of gold were obtained daily for several weeks. Dry digging from the gravel hills was also tried, but though gold was found in considerable quantity the appliances for washing and collecting were so poor that the attempt was abandoned. Early operations.

Of the two reports written by Mr. Cunningham, the first, in 1847, was addressed to the proprietors of the seigniory of Rigaud-Vau- Mr. Cunningham's reports.

*Am. Journ. Sci. (1st Ser.), vol. XXVIII., p. 112.

dreuil, Messrs. Charles and Alexander DeLery, and related chiefly to the character of the rocks as compared with that of the mining areas of Carolina and Virginia, U.S. He, however, refers to the finding of nuggets of gold weighing from thirty to fifty pennyweights, which had their angles rounded, but which he concluded had their source in close proximity to the spot in which they were found.

Chaudière Mining Company.

The second report was addressed to the Chaudière Mining Company, in 1850, in which the results of two experiments in working the gravels of the Gilbert are given. The first of these extended from the 24th of June to the 6th of August. The work consisted in digging several pits or trenches, the largest of which was 150 feet in length with an average width of twelve feet. In these, the gravel directly overlying the slates was found to be auriferous, while an overlying stratum, directly beneath the soil, was also found to carry gold in places. Much difficulty was experienced from the water, and the work was at last abandoned for another portion of the deposit. The amount of gold obtained from the first trial is said to have been one hundred pennyweights.

The second trial lasted from the 8th of August to the 20th of September. The course of the stream was changed for a short distance, and the gold was collected from the old bed, amounting in all to 940 pennyweights, which, it is stated, was the result of about two men's labour for that time. Further explorations of a similar character were made subsequently, and good results obtained, the examination of a quartz vein at this place, which was stripped for 150 feet, showing several fine pieces, one of which weighed twenty-five pennyweights. In the construction of a canal and dam for the purpose of working a second portion of the river-channel, one man is reported, in the six weeks in which the work continued, to have taken out, by panning, 380 pennyweights of gold. Fine pieces of gold are reported to have been taken at this place along the course of a fissure caused by the decomposition of a vein of quartz, while the loose gravel lying upon the slates yielded, upon several trials, more than three grains of gold per bushel of 100 lbs.

Dr. Douglas's operations.

In 1851 Messrs. DeLery leased, subject to a percentage, their mining rights over the whole seigniory to Dr. James Douglas and others of Quebec. Dr. Douglas eventually became solely interested in this lease, and under it mining operations were carried on by him and others, under sub-leases, at different times and at different places. Dr. Douglas's lease expired on September 1st, 1864, and was transferred, in consideration of the sum of $3,000, in July of that year to Messrs.

Hans Hagan & Company, who began mining operations on the Gilbert. This company likewise obtained from the Messrs. DeLery a further similar lease of fifteen years, for which they agreed to pay $8,000, $2,000 of which were given in cash. Both of these leases were given by the DeLerys expressly without any guarantee on their part.

Operations of Poulin Bros.

The success which attended gold mining operations on the Gilbert River at this time commenced in the autumn of 1863. It appears that one of three brothers named Poulin, who had been mining with more or less success for some time, discovered rich gravels on lots 19, 20, 21 and 22, DeLery concession, Gilbert River, and being joined by the brothers and others they commenced operations and a large amount of gold was taken out. The north branch of the Gilbert was therefore set apart as a mining district for a distance of a mile above the forks and a rush of miners set in for that locality. Two spots were selected for work—the upper, on land owned by a man named Viellieux, lot 20, DeLery concession, the other about half a mile further down on this branch on the southern half of lot 19, owned by Rodrigue. Upon these claims, but more especially on the upper, a considerable number of people wrought in 1863 and obtained in the aggregate, a large quantity of gold. The largest piece reported, and sold for $22, was said to have been found by a woman named Parie. Among other instances regarding the discovery of gold given by Dr. Douglas was that of a party of six, including two of the Poulins, who acknowledged to finding fifteen ounces in three days, and another party of the same number found six ounces and a half in two days. These miners were all working without licenses, and upon the facts being reported to Mr. DeLery, bailiffs were sent and the crowd of workers driven off. On Rodrigue's property, lot 19 DeLery, according to affidavit given in Mr. Chapman's pamphlet, by the Poulin brothers before Mr. Belanger, N.P., of St. François, in 1880, three of them with Rodrigue washed in tin pans, from the alluviums in one day, seventy-two ounces of gold. This party is said to have admitted finding ten pounds of gold in eleven days' work with tin pans only. The largest piece found at this place during the season was sold for $200. The beds on Rodrigue's lot were as follows, descending order,—vegetable mould and earth, two or three feet; gravel and sand; and lastly a thickness of two or three feet of rock surface? (rotten rock) consisting of slate down to the bed-rock, which is found at about eight or ten feet from the surface. It was in the gravel and sand and embedded in the slate that the gold was found in small pieces and nuggets. After exhausting the bed of the stream they washed the gravel from the banks in a sluice, and are reported to have obtained

Rodrigue's property.

a pound of gold one day, and ten ounces another. Rodrigue, working with one man only, is said to have panned out in one day two ounces, two pennyweights and eight grains, valued at thirty-eight dollars. The earnings of this party for twenty days in each month for four months of the summer, averaged sixteen dollars a day per man. This success was not general, however, and many only cleared their expenses. The bed of the stream, at this place, is composed of a dark fissile slate, and the banks are made up of alternations of sand and gravel.

DeLery Gold Mining Company.

In 1864, the DeLery Gold Mining Company was formed to work the quartz veins as well as the alluviums in Rigaud-Vaudreuil, under a lease of thirty years from the DeLery family, who granted the new company all the rights originally possessed by the owners of the seigniory. This company erected extensive works, comprising a crusher, at the place known as the Devils Rapids on the Chaudière River, a short distance below the mouth of the Gilbert; and the claims and operations of the company prevented the explorations of private individuals over the seigniory or tract covered by their letters patent for some years. Quartz veins were found at the Devils Rapids, and in the Gilbert valley, some of which were reported to have yielded gold on assay. The crusher, however, proved to be an entire failure. In 1865 an American company called "The Reciprocity" organized by Col. Rankin leased from the DeLery Gold Mining Company the mining rights over several lots along the Gilbert. A wooden flume 1800 feet long with a dam at its head, was constructed to supply water for washing the gravels on the North Branch. This, although supposed to be well and strongly built, was not able to withstand the heavy freshets which occur in these streams, and the greater part of it was swept away before it was in use long, and consequently it became a total loss. This company, after the destruction of their flume, washed in a trench dug along the river bed from which the water had been diverted, and took out some $2,500 in gold, the whole expenses, including the dam and flume being from twelve to fifteen thousand dollars. The DeLery Gold Mining Company then granted permits to a few miners to work on the celebrated lots, 16, 17, 18, 19, 20, 21 and 22, DeLery concession, North Branch Gilbert River, and during the summer of 1866 Mr. Henry Powers, with several miners, drove a tunnel across lots 15, 16 and 17. A large amount of gold is reported to have been obtained along this tunnel, for the use of which each company that operated there paid to Mr. Powers two dollars per day. In the official documents of the time it is stated that gold to the value of $142,581 was realised, and that two nuggets, one found by

Mr. Kilgour on lot 17 weighed 52 ounces 11 dwts. 6 grains, and the other by Mr. Arch. McDonald, was worth $821.56. In the following summer Mr. John McRae on a claim of seventy-five square feet on lot 15, DeLery concession, is said to have realized the sum of $17,000. The Kilgour and other nuggets.

From 1863 to 1866, Mr. A. Michel, who had previously managed the practical working of gold mines in South America, was employed by Sir W. E. Logan, Director of the Geological Survey of Canada, to study the auriferous region in question, relative to the distribution of gold in the gravels and clays, to examine such gold-bearing quartz veins as had been opened up by mining excavations, to collect specimens of the same for analysis, and to give such an account of the gold mining operations of the preceding two or three years as his opportunities might enable him to furnish. Mr. Michel submitted his report in 1866. Examination and report of A. Michel.

As regards the alluvial gold, Mr. Michel prepared a detailed statement of the workings on Gilbert River, St. Francois, Beauce, where a small area of considerable richness was found, but at that time limited on all sides by much poorer alluviums. Numerous exploratory pits were sunk by him in the vicinity of these rich workings, with the view of determining their extent, and similar trials were made by him in the other more western districts, namely, at Lambton, near Lake St. Francis, at Ascot, Orford, etc. A fact of geological significance established by these various examinations, was that the rich auriferous gravels found reposing on the bed-rock, were covered in many places by a coarse clay corresponding to the unstratified boulder-clay of the St. Lawrence valley. This clay, as appeared from the testimony of the miners, and also from experiments made by washing considerable quantities of it in the three areas examined by Mr. Michel, is destitute of gold, but is in some parts overlain by a stratum of auriferous gravel, less rich, however, than that below. This boulder-clay was observed resting on auriferous gravel on the Gilbert, and likewise on lots 2 and 3, range 13 of Ascot. In many places, however, it reposes directly on the bed-rock with an intervening stratum of auriferous gravel, while in some places, as at Lambton, near Lake St. Francis, pits were sunk 30 feet in the boulder-clay without reaching its base. These facts were taken as showing that the original gold-bearing drift was of considerable antiquity, and that both it and the overlying boulder-clay had suffered local denudation which not improbably gave rise to the auriferous gravels found in some places overlying the latter. In one locality, lot 6, range 14, of Ascot, what was supposed to be the shell of a species of *Mya* was found in the boulder-clay. Conditions of gold occurrence. Age of auriferous drifts.

Mr. Michel further states: "Up to the present time the Gilbert River has been the scene of the most important workings, and has Gilbert River.

yielded the largest amount of gold; I therefore made it the subject of a special examination. In ascending the course of this stream, which is a torrent at certain seasons, but easily examined during the dry weather of summer, we find upon lot 75 of range 1, North-east, the remains of workings undertaken sixteen years since by Dr. James Douglas, which then furnished considerable quantities of gold, and would not, I am assured, have been abandoned but for the want of skilful management. A company of miners took up this old working last summer, but their explorations conducted without energy, were not long continued, notwithstanding certain satisfactory results, among which may be mentioned a nugget of gold of six ounces weight. In following the course of the stream across the concession St. Charles, I observed on both banks, and in the bed of the stream, the traces of numerous explorations.

Explorations of Mr. Michel in Gilbert valley.

"In entering the concession De Lery, we approach the rich deposit of alluvial gold which has been recently wrought. As it was important to determine the limits of this deposit, I commenced my exploration on lot 14 of this concession. I here made an opening on the right side of the stream, at a distance of about six yards from low water, and on a bank about two yards above its level. The excavation was rectangular in form, eight by twelve feet, and was carried to the bed-rock, a depth of seven feet. Three distinct layers were met with in this opening; first, a foot of sandy vegetable soil; second, a yellowish sand with pebbles; and third, a clayey gravel containing gold—the latter layers having each a thickness of three feet. The washing by means of a rocker, of one hundred cubic feet of this gravel, gave only seventeen grains weight of gold, the greater part of which was extracted from the fissures of the sandstone which formed the bed. On the same lot, about forty fathoms further up the stream, the company which has purchased the mining rights of the seigniory of Vaudreuil, [The De Lery Gold Mining Company], undertook in July and August last, [1865], certain explorations, partly in the bed of the stream, and partly on the right bank. The expenses of the explorations, which employed six workmen, were $300, and but two ounces of gold were obtained. I have these details from the agent of this company, who assured me that he saw a company of four miners extract three ounces of gold in a week, from an excavation not twenty-five feet to the right of the spot where he had wrought with so much success.

"Both sides of the stream on lot 15 are full of excavations, and I was assured that several among them had given profitable results. The two branches of the Gilbert meet on lot 16 [De Lery concession] which, like the preceding is marked all over its surface by pits and excavations from which the auriferous gravel has been extracted. The distribution of gold was found to be very irregular, and the gravel generally poor. I saw upon this lot an excavation then in progress by the Reciprocity Company ; it was a rectangular pit twenty-five feet by twelve, opposite the junction of the two branches of the stream, and on the right bank. The sides of the excavation offered the following section in descending order :—1. Three feet of sandy vegetable soil. 2. Three feet of sandy gravel. 3. Two feet of yellowish clay without boulders. 4. Two to three feet of a yellowish clay with boulders. 5. A bluish clay. This excavation was, I believe, abandoned a few days after my visit."

Section of beds on lot 16.

"Before following the Gilbert across the lots rich in gold, I resolved to examine the branch coming from the north-east. It crosses the two concessions, De Lery and Chaussegros, upon lot 16 and has been wrought with success on the first-named concession, as I was assured, and as seems to be attested by the numerous workings which I observed alike in the bed of the river and on the two sides. These workings diminished in number and in importance in approaching the concession Chaussegross, where none of them are seen. The case is similar on lot 17 of the concession of St. Gustave where exploring pits were found only here and there. The beds observed in many of the excavations in this vicinity are similar to those which I shall have to describe farther on in giving an account of my explorations on the other branch of the Gilbert above the rich lots ; but I may here notice the existence of a very thin layer of sandy gravel resting upon the blue clay, and covered by another stratum of clay. I was informed that this thin layer contained gold enough to pay the expenses of the excavations, and had been followed as far as possible.

"The rich alluvions of the Gilbert, which were wrought in 1863 and 1864 with considerable success (although the results were exaggerated by the spirit of speculation), are now considered to be exhausted. [This is scarcely correct as it is known that between the drifts in the ancient channel of the Gilbert traversing some of these lots, partings exist which have not been wrought]. They were found on the lots 16, 17, 18, 19 and 20 of the concession De Lery. To form a notion of this area, we may regard the deposit as enclosed in a rectangle having for its length the breadth of the four lots just mentioned, and for its breadth a measure of 180 feet, including the width of the river and a distance of eighty feet on either side. Let us farther imagine this area divided like a chess-board into squares, each of which is occupied by a

Alluvions on lots 18, 19 and 20.

working. Many of these squares have been wrought with profit, and some have given results of exceptional richness, while the yield in the adjacent squares has been much less, many not having paid the expenses of excavation. We thus obtain, at the same time, a notion both of the irregularity of the working and the irregular distribution of the gold over the area.

First visit to Gilbert River.

"When in October, 1863, I visited the Gilbert River for the first time, I found upon the lots 18, 19, and 20, from 100 to 120 gold miners divided into companies of from four to ten. Their workings consisted of a series of open excavations ten or fifteen feet deep, and of dimensions varying according to the number of workers. These open pits were sunk side by side, without method or regularity. While it is certain that large quantities of gold were extracted from these excavations, it is equally certain that a great quantity has been lost and left behind. The walls, often of considerable thickness, which separated the different pits, constitute in themselves a considerable volume of alluvion as yet untouched; and if we add to this the gold which was certainly lost by imperfect washings, it is safe to suppose, that a regular and methodic re-working of the deposit, including both the portions of undisturbed gravel and the refuse of the previous washings, would be profitable to whoever would undertake the operation.

Work of Reciprocity Company.

The Reciprocity Company in fact planned a work of this kind, and made costly preparations. At a second visit to this place which I made in May, 1865, the construction by them of a wooden flume, 1800 feet long, four feet wide and three deep, was already far advanced. It was supported on tressels of great strength at distances of three feet, with a surrounding frame-work. The object of this construction was to carry away from a higher point the waters of the stream, thus leaving its channel dry, and at the same time to afford water for washing the alluvions. Although of sufficient strength and capacity for the ordinary volume of water, this structure appeared to me when I examined it, to be unfit to resist the floods which occasionally bring rocks and uprooted trees down the channels of these ordinary quiet streams. I remarked this to my fellow-traveller at the time, and the event soon justified my fears,—for in the month of July last the dam across the river, and a portion of the canal itself, were carried by a flood following a violent storm. Having repaired this damage, and expended for the canal and for some buildings, a sum estimated at from $12,000 to $15,000, the Reciprocity Company, I am informed, made an open cutting in the dried-up bed of the stream from lot 16 to lot 18, and extracted thence about $2,500 in gold.

"I must here call attention to a fact which is not without importance for the future of gold mining in Lower Canada, namely the subterranean working of the alluvions during the winter season. This was attempted in the winter of 1864-65 by about thirty miners, divided into companies of from four to six. By the aid of pits and galleries, they were able to carry on their search for gold throughout the winter, and to extract and wash a large quantity of gravel, in which the gold was so abundant as to richly repay their energy and perseverance. Among others was a mass of gold weighing over a pound. When I visited the Gilbert, in May last [1865], these subterranean workings were still going on, and I was able to examine them. The pits, fifteen in number, and all on lot 18 [DeLery], were opened on the left bank, at distances from fifty to one hundred feet from the stream, and sunk to the bed-rock, a depth of from twenty to twenty-five feet. They were connected by galleries, one of which draining the whole of the works, carried the waters into a pit, from whence they were raised by pumps and carried into the river. The auriferous materials were washed in rockers, generally at the bottom of each pit. Some gold was found in the gravel which covered the slates and sandstones, but the greater part was extracted from the fissures in these rocks. The same was true in most of the rich workings on this river, and particularly on lots 19 and 20, where of two layers of gravel, separated by a stratum of bluish or yellowish clay, only the lower one was auriferous. The bed-rock, formed of interstratified clay-slates and sandstones, is sometimes broken up [decayed], to the depth of five or six feet, and it is in the joints and between its laminæ, where the gravel has penetrated, and often become indurated, that the gold has been found in the greatest abundance and in the largest masses. It is impossible to form an estimate, even approximative, of the quantities of gold extracted from the Gilbert and its banks during the last three years, the interests of opposite parties having led some to depreciate and others to exaggerate the amount."

Operations in winter.

"The line of separation between lots 20 and 21 [DeLery], both of which are traversed by veins of quartz, was indicated to me as the upper limit of the rich alluvions of the Gilbert. I followed the course of the stream upwards, examining both banks as far as lot 34 in the concession of St. Gustave and found in the concession of Chaussegross numerous exploring pits, which became farther and farther apart. As no workings had resulted from these multiplied trials, I was naturally led to conclude that the alluvions along this portion of the river were poor in gold ; but as I wished to assure myself of this by personal examination, and also to study some of the facts relative to the

Probable upper limits of rich alluvions.

alluvions, agreeably to your instructions, I made an excavation on lot 21 of the concession DeLery, in the bed of the river, in a place where an eddy might have been supposed to favour the deposit of particles of gold. The pit was six feet by five, and was carried to the bed-rock, a depth of seven feet. Below two feet of sand was a similar thickness of gravel, reposing on a bluish clay holding boulders [boulder-clay]. Twenty-five cubic feet of the gravel washed in a rocker yielded only three very small scales of gold.

Lot 21, DeLery.

Lot 23, DeLery.

"I sank another pit on lot 23 of the same concession, in the bed of the stream, and about twenty feet above a band of clay-slate which traverses the stream, giving rise to a fall of eight or ten feet, and is exposed at low water. This excavation was a rectangle, eight feet by four, and was carried eight feet to the bed-rock. Here, beneath two feet of sand, followed by two feet of gravel, the blue clay with boulders [boulder-clay] was met with, as in the previous trial. The washing by the rocker of thirty cubic feet of this gravel gave only five minute scales of gold.

Lot 24, DeLery.

"I next examined lot 24 (DeLery), immediately below a saw-mill, under which I was assured gold had been found in the fissures of the slate-ridges, which here cross the stream at three different levels just above the mill, giving rise to a fall of twenty-five feet, broken into several cascades. After having removed about two feet of sand in the excavation, the yellowish clayey gravel was found resting directly on the bed-rock, which was six feet from the surface. The washing of twenty cubic feet of this gravel yielded only two particles of gold.

Lot 26, DeLery.

"Another excavation was made on lot 26 of the same concession, also in the bed of the stream, and very near an outcrop of quartz two or three feet wide which crosses the stream from north-east to south-west. After removing the sand, the gravel was met with, followed as before by blue clay resting on the bed-rock. Twenty cubic feet of this gravel, washed by a rocker, did not yield a single particle of gold.

Trial on lots 27 and 28, Chaussegros.

"The last, as well as the most important, of the trials which I made on the Gilbert, was on the line between the lots 27 and 28 of the concession Chaussegros, on the right bank of the stream, and near an exploring pit which was said to have given encouraging results. I began the excavation sixteen feet square, but at a depth of five feet reduced it to ten feet square, thus leaving on each side benches of earth four feet wide to facilitate the further workings. Beneath a foot of vegetable soil was a layer of three feet of yellowish sand, and another of the same thickness of gravel. This rested on a bluish clay filled with boulders [boulder-clay], which, from this cause and from its compactness, was very difficult to excavate. Towards the bed-rock, however, it became sandy, and more easily wrought. The thickness of this clay was eight feet, the whole depth of the pit to the rock being thus fifteen feet. Notwithstanding the proximity of the stream, no infiltration of water occurred till near the bottom, when two pumps were required to keep it dry. The washing by the rocker of thirty cubic feet of the gravel from this pit did not yield a single particle of gold.

"It seems then to be established that the rich deposit of the Gilbert River has for its upper or northern limit lot 21 of the concession De Lery, beyond which point, so far as examined, the alluvions, although generally more or less auriferous, are not workable. The irregularity in the distribution of gold in the gravel is noticeable throughout the region, but appears more marked on the Gilbert than elsewhere.

Lot 21, De-Lery, northern limit of rich deposit.

"Although the greater portion of the gold which has been found here is in small grains and scales, masses have, as is well-known, been found from an ounce up to five ounces, and even to a pound in weight. It appears to me, from the smooth, rounded and worn condition of its surface, that the original source of this gold must be somewhat remote. I have remarked that where the layer of gravel is found resting on the bluish clay with boulders, it is poor, but becomes richer when reposing directly upon the bed-rock ; while in the case of two layers of gravel separated by a stratum of this clay, the upper layer is generally without gold, while the lower is more or less auriferous. The constant absence of gold from these clays which are associated with the auriferous gravels, was certified by numerous miners, and confirmed by the washing of no less than one hundred cubic feet of the clays taken from my exploring pits at different levels and even from the surface of the bed-rock itself. These clays, however, contain besides numerous pebbles and boulders, notable quantities of cubic pyrites, black ferruginous sand, and grains of garnet."

Remarks on the source of the gold.

In the year 1867, Wm. P. Lockwood obtained leases covering three sections or more in the Gilbert River valley from the DeLery Gold Mining Company, eventually acquiring nearly all the mining rights on the east of the Chaudière, sections 3, 4, 7 and 2, also sections 1 and 5. From this date until 1893 or 1894, he carried on extensive operations throughout the valley, leading to important developments, and the recovery of a large amount of gold. In 1866 he began a survey of the Gilbert from its junction with the Chaudière to the boundary of Fraser, S. E., which was continued until the bed of the stream was measured and levelled throughout. His plans of working were comprehensive, but were thwarted in several ways, so that he was never able to

Commencement of Mr. Lockwood's operations.

carry them fully into effect. They embraced (1) systematic exploration as to the position and depth of the auriferous gravel along the old river bed, and (2) the tunnelling of this bed in such a way as to afford natural drainage for the whole mining district, the slope of the valley being considered sufficient for this purpose. To carry out these schemes, Mr. Lockwood states that it was desirable to ascertain (1) the average yield of gold per acre; (2) whether the gold leads were continuous throughout the lots, and if so what the area and entire yield of the ground to be worked might be, and (3) whether the old river-bed was conformable in slope and direction with the present river-channel. Mr. Lockwood met with serious difficulties, not only at the inception of his work, but throughout the greater part of it from a number of small operators who held claims and were carrying on mining in the concessions DeLery and St. Charles. Nor did he succeed in carrying out his schemes to completion, although he proved the continuity of the pre-glacial river-channel through the concessions referred to and showed that it was in the bottom of this channel that the gold existed in greatest quantity. His first explorations were in the upper part of the DeLery concession, afterwards he undertook mining on lots 13 DeLery and in St. Charles concession. It was between these two points that the local miners which Mr. Lockwood attempted afterwards to prohibit were at work. He states that from 1862 to 1894 gold to the value of one million dollars was taken out of that part of the Gilbert valley between lots 15 and 21 DeLery by himself and others.

Plans of work.

Amount of old obtained.

In the surveys and explorations which Mr. Lockwood carried on, it was found that the present channel of the Gilbert had an average gradient through concessions De Lery and St. Charles of fifteen to eighteen inches per hundred feet. To ascertain, among other things, the gradient of the ancient or pre-glacial river channel, he commenced his system of exploratory shafts. These show a gradient, so far as could be ascertained, in the old river-bottom between lots 8 St. Charles and 21 De Lery, of twenty inches or more per hundred feet. This old channel is from thirty to eighty feet below that of the present Gilbert for a great part of that distance. If this slope obtained in pre-glacial times it must have given the river remarkable concentrating power as regards the gold derived from the rocks within its drainage basin.

Gradient of present Gilbert River.

Gradient of pre-glacial river.

Before describing Mr. Lockwood's exploratory shafts it may be desirable to outline very briefly the main topographical and physical features of the Gilbert River district. In doing this the surveys, plans, and levels of Mr. Arthur Lockwood, already referred to, will be used.

Topographical features of Gilbert valley.

The Gilbert River, which is but a small stream, enters the Chaudière through a wide alluvial flat, with a comparatively gentle flow. The height of its mouth by aneroid measurements, based on that of the railway station at St. François, is 515 feet. This is the datum for Mr. Lockwood's levels along the Gilbert River.

Ascending this stream we find the eastern line of the first range, N. E., 8142 feet from the mouth of the river following its sinuosities, to be 126·5 feet above datum, or 641·5 feet above the sea. A constriction of the valley occurs at this point,—a dyke of instrusive rocks crossing it and apparently causing a waterfall. Very little gold mining has been carried on below this point. Proceeding up stream we pass from the first range, north-west, into lot 8, concession St. Charles. The Gilbert valley then expands, and at the mouth of Caron creek there are flats of considerable extent. A lake-like expanse seems to have existed here in pre-glacial times in which quicksands and other deposits were laid down.

Northern bank.

The northern bank of the Gilbert, above the lower line of St. Charles concession, maintains a tolerably regular contour as far up as the junction of the north-east branch at least, rising with a uniform grade from the river to an elevation of 250 or 300 feet above it. Opposite the mouth of the north-east branch, the slope or ascending surface on the north-west side begins to recede, and the valley of the Gilbert becomes considerably wider, and continues to widen northward to the concessions of Chaussegros and St. Gustave, according as the channel and flats on either side rise. The southern slope of the Gilbert valley is more irregular and broken and not so steep as the north slope. The base of this slope is also further from the river, flats of 50 feet to 100 and even 200 feet in width intervening. It is on this side and beneath these flats, etc., that the old pre-glacial channel, containing the auriferous gravel lies, between lots 8 St. Charles and 21 De Lery. The bottom of the present river-valley is, nevertheless, comparatively narrow, and the whole valley itself forms but an insignificant topographical feature.

Southern bank.

Bottom of valley.

Watershed of the Gilbert.

The watershed of the Gilbert comprises a rugged and hilly district, no part of which exceeds an elevation of 1200 to 1400 feet, the mean elevation not being more than from 900 to 1000 feet. The broken, uneven surface, appears to be largely due to the unequal disintegration which the rocks have undergone, these being of different character and different degrees of hardness. Much faulting and dislocation would seem also to have prevailed here; but the heavy capping of boulder-clay upon a large portion of the surface renders the study of the geological structure very difficult, and little has been done in working out the details.

Surface.

General succession of deposits.

The general succession of the deposits in the Gilbert River valley is much the same as in other places throughout the "Eastern Townships" district, being as follows, in descending order:—(1) Surface gravels and sand; (2) boulder-clay, sometimes irregularly stratified in the bottom; (3) yellow gravel, stratified; and (4) fissile slates, nearly vertical, usually oxidized in the upper part.

The gold is found in workable quantities only in the lower part of the inferior yellow gravels, and between the laminæ of the slates or in the crevices of other decaying rocks beneath.

Pipe-clay and quicksands.

In concession St. Charles, pipe-clay occasionally overlies the yellow gravels, coming in between these and the boulder-clay; and at the junction of Caron Creek and Gilbert River, where there appears to be a basin or depression of some depth, a considerable development of quicksands was noted by Mr. Lockwood in sinking a shaft.

The position of these quicksands is described below.

Mr. Lockwood's shafts and

In the following description of the shafts and pits opened in the Gilbert valley by Mr. Lockwood, or under his direction, we shall commence at the lower line of concession St. Charles and proceed up stream. The two concessions, St. Charles and DeLery, really comprise the gold area of Gilbert River.

Principal gold district.

On ascending the Gilbert River from the mouth across the first range N.E., into the adjoining concession of St. Charles, lot 8, we enter the principal gold district. Mr. Lockwood furnished Mr. Ingall and the writer with much of the data he had collected during the twenty-seven or twenty-eight years he worked in this gold field. He also gave us written notes relating to the shafts he sank, the materials passed through in sinking, the thickness of the auriferous gravels, quantity of gold extracted, etc. The facts in relation to these matters given in the following pages are compiled from his MS. notes as well as from my own observations. The letters and figures referring to the various openings are those of Mr. Lockwood's plans.

Shafts on north side of Gilbert, St. Charles concession.

Shafts A. and B. Lot 8, St. Charles.—Distance from the mouth of Gilbert 8144 and 8149 feet respectively; height of the top of the shafts above datum, 130·6 feet. These shafts were sunk "about 12 feet deep; the beds in each in descending order being (1), mixed alluvium, yellow clay and gravel with colours of gold; (2) blue clay (probably boulder-clay); (3) cemented ferruginous gravel, containing coarse gold and one nugget about two ounces, 1 foot; and (4) yellow slate-rock. A number of pits from two to twelve feet deep were sunk at this point, but the results were unsatisfactory. Coarse gold was found on the bed-rock of some of these."

Shafts, Lot 8 *St. Charles.*—No. 1, 44 feet deep ; No. 2, 54 feet deep, top 11 feet above river level; No. 3, 38 feet deep, top 6 feet above river level. Top of the deepest shaft (No. 2) was 150 feet above datum, the Gilbert opposite these three shafts being 139 feet. Mr. Lockwood states "these three shafts were sunk through about four feet of mixed clayey alluvium with gravel, to blue clay (boulder-clay) then timbered and puddled with 2 feet 6 inches of fine clay to make them watertight; then through fine clay in thin layers, perfectly dry, and remarkably hard (pipe clay), until the gravel (probably auriferous gravel) was struck, when the shafts filled with water, No. 2 so rapidly that some tools had to be left in the bottom. The water overflowed and continued to do so up till 1893. The results gave the information required and further work was suspended until a general plan of operations was decided upon."

Shaft Y.—This was a prospecting shaft, ten feet deep, in river gravel and boulders.

The shafts and pits, above described, are all on lot 8, concession St. Charles, and on the north side of the Gilbert River. Mr. Lockwood states that he is of the opinion that the old pre-glacial channel is accordingly on that side at this point, although on the south side of the present river further up.

Shaft or Pit No. 4, Lot 8, St. Charles.—This shaft "was sunk on the south side of the Gilbert, through gravel and boulders till surface-water was reached."

Shafts on south side of Gilbert, St. Charles concession.

Shaft No. 5, Lot 7, St. Charles.—This shaft was sunk to a depth of 35 feet. The beds passed through were, "8 inches of dry angular gravel; nearly 3 feet of alluvium; 32 feet of blue clay (boulder-clay) to gravel (probably auriferous gravel), when the shaft filled with water and overflowed until shaft X. was sunk 64 feet, which drained it."

Shaft X., Lot 7.—This shaft, which was sunk 64 feet to gravel, is just below the mouth of Caron Creek, on the south side of the Gilbert. The river at this point is 11,415 feet distant from the junction with the Chaudière, and 151·2 feet above datum. The deposits passed through were, "alluvium with silt, slates, clay, angular stones and gravel, 16 feet; then 48 feet of blue clay (boulder-clay) to gravel, when water rose to 61 feet in the shaft."

Shaft No. 6, Lot 7, St. Charles.—Just above the mouth of Caron Creek, on the south side of the Gilbert. This shaft was sunk to a depth of 33 feet. "River gravel and sand, 4 feet; soft sandy gravel, angular stones and quartz (boulders?) to water, 29 feet. The ground was so bad that this shaft was filled with clay from shaft 6*a*. described below."

Caron Creek.—"Sluiced gravel from bed of creek and from pits on each side. Fair show and some nice round gold obtained for some distance up the stream. The materials were sandy loam, gravel, clay and stones."

Shaft on lot 7, St. Charles.

Shaft No. 6a, lot 7, St. Charles.—Depth, 100 feet, or about 95 feet below the level of the Gilbert, near by. Distance from mouth of Gilbert, 11,540 feet; height of river above datum, 156·5 feet. Auriferous gravel reached at 85 feet below the bed of the Gilbert. A section of the deposits passed through, is as follows: (1) "Loam and river gravel, 4 feet; (2) hard, blue clay with large boulders (boulder-clay), 36 feet; (3) dark gray sand (clay-slate and quartz), soft and wet, 23 feet; (4) firm gray sand with rough stones and large boulders, 10 feet; (5) gravel and gray sand, (one large boulder 3 feet in diameter, filling the entire shaft), 14 feet; (6) ferruginous sand and gravel, very sharp, hard and firm, with boulders, 3 feet. Struck bed-rock at 97 feet, dipping south three feet in the bottom of the shaft. It was a dark-blue rock, worn perfectly smooth."

"This was a very difficult and dangerous shaft to put down. We had to blast boulders in soft wet sand, and had only two light 4-inch pumps, procured for prospecting. We did not take up the bed-rock, and left gold in the crevices; but we took an ounce and a half of nice, coarse gold with the gravels. We had to use strong timbers for ten feet of the shaft, with extra thick puddling (2 feet 6 inches to 3 feet of clay) in order to keep out the surface water."

This shaft seems to be at the junction of the two 'leads'—one in the old Gilbert valley, the other in the Caron creek valley. The bottom of the shaft was reached on February 13th, 1871.

Above lot 9, St. Charles concession, Mr. Lockwood states the underground water-flow is not connected with local surface drainage, but percolates through the same bed of gravel lying on the bed-rock the whole distance from Fraser concession.

Shaft No. 6 B., near last, Lot 7, St. Charles. Depth, 83 feet. "This shaft was sunk with great difficulty into firm, hard gravel." Preparations for extensive operations were then made by Mr. Lockwood, when on the 13th of January, 1877, his buildings and plant, the latter recently brought from England, were wholly destroyed by fire at a loss of $35,000.

The shafts, above described, near the confluence of Caron Creek and the Gilbert, were on the south side of the latter.

Shaft C., Lot 9, St. Charles.—This shaft was put down on the north side of the Gilbert in clay and gravel (fluviatile) to a depth of about 12 feet. Shafts on north side of Gilbert, St. Charles concession.

Shaft D., Lot 10, St. Charles.—Depth, 21 feet. Distance from mouth of Gilbert, 14,297 feet; height of river above datum, 181·2 feet. "Passed through, (1) drift; (2) blue clay (boulder-clay); (3) gravel and sand with large pieces of angular quartz."

Shaft No. 7, Lot 10 A., St. Charles.—Depth, 70 feet. Top of shaft, 8 feet above river level, shaft therefore 62 feet below the Gilbert. Sank near a bluff. Beds passed through, "alluviums and dark slaty sand with small stones and quartz and other large boulders,—all dry to bed rock; no auriferous gravel or gold. No flowing water."

The last three shafts were also put down on the north side of the Gilbert River.

Shaft (A.L.), Lot 11, St. Charles.—Depth to bed-rock, 60 feet; depth to auriferous gravel, 56 feet. Distance from mouth of Gilbert, 16,346 feet; height of top of shaft above datum, 201·3 feet. Beds passed through:—"Mixed soil and stones, 15 feet; blue clay (boulder-clay) 37 feet; sand and gravel to bed-rock, 8 feet. Fine gold in bottom gravels. A drift run towards shaft No. 12 struck gold in small quantities." Shaft on lot 11, St. Charles.

Shaft No. 8, Lot 12, St. Charles.—Depth 60 feet; depth below river level, 56 feet. Shaft on north side of Gilbert. Height of top of shaft above datum 212 feet; height of river above datum 208 feet. Beds disclosed in shaft:—"Clayey soil, 6 feet; clayey blue silt with small worn stones and quartz and occasional large boulders (probably boulder clay), 54 feet to bed-rock. No pump required. Drifted east and west 50 and 60 feet respectively; but found neither gravel nor gold. Rock surface rose rapidly in both directions." Shafts on lot 12, St. Charles.

Shaft No. 10, Lot 12, St. Charles.—Depth 25 feet. Below river level, 15 feet. "Gravelly soil, 4 feet; blue clay (boulder-clay) to bed-rock, 21 feet. Barren,—neither water, gravel nor gold." This shaft was on the south side of the Gilbert.

Shaft No. 11, Lot 12, St. Charles.—Depth 60 feet. Height of top of shaft above datum 250·7 feet; height of river opposite, 212·7 feet. "Mixed soil and stones, 15 feet; blue clay (boulder-clay) 37 feet, sand

and gravel to bed-rock, 8 feet. Fine gold in bottom gravels. A drift towards shaft No. 12 struck gold in small quantities."

This shaft is 80 feet from the river, on the south side.

Shaft No. 12, Lot 12, St. Charles.—Depth 64 feet. Height of top of shaft above datum 253 feet, height of Gilbert above same 212·7 feet. This shaft is on the south side of the river, and distant from it 100 feet. Deposits disclosed in shaft :—"(1) Mixed alluvium, 18 feet; (2) blue clay (boulder-clay), 40 feet; (3) sand and gravel to bed-rock, 6 feet. Drifted towards river in direction of shaft No. 11, also southward. The two exploring drifts gave two ounces of gold a day, and some nice nuggets, one weighing nearly five ounces. As soon as the continuity of the 'lead' and its average gold yield were thus established and traced from lots 14 and 15 De Lery, bed-rock was taken up and post holes for timbering made."

"Having secured these shafts and drifts they were left to be worked afterwards according to a continuous plan of operrations and drainage system from lot 7, St. Charles, to Miners' Claims on lot 15, DeLery concession."

Shaft No. 13, Lot 12, St. Charles.—Depth 40 feet. Distant from river on south side, 90 feet. "Soil, 3 feet; blue clay (boulder-clay) to gravel and water, showing position of the 'lead,' 36 feet."

Shaft on lot 13, St. Charles.

Shaft No. 14, Lot 13 A, St. Charles.—Situated on north side of the Gilbert. Height of top of shaft above datum 221 feet. The deposits were,—"Soil 4 feet, blue clay (boulder-clay) to bed-rock, 23 feet. Barren, stony, no gravels, no traces of gold 'lead'."

Shaft on lot 11, St. Charles.

Messrs. Sands, Oldson and Miller having acquired surface rights on lot 11, St. Charles, sank a shaft 38 feet deep in 1876, and although working without authority from Mr. Lockwood, took out a considerable quantity of gold, estimated at over 400 ounces. They testified to 205 oz. 18 dwt. 5 grs. taken out in five months.

The shaft they sank is nearly 70 feet from the Gilbert, on the south side. The top is 216·3 feet above datum, and the Gilbert at the nearest point is 203·3 feet.

Operations of the St. Onge Bros.

In 1876 the St. Onge Brothers and five other miners acquired a lease of a portion of lot 11 St. Charles, and were given Government licenses to mine for gold, notwithstanding the letters patent granted the De Lery family in 1846. Eighty or ninety feet south of the Gilbert they sank a shaft 37 feet to bed-rock, commencing work in September, 1876. The difficulty of keeping out the water was such, that a ditch 1800 feet in length had to be opened, and a water-wheel connected with pumps was driven by this contrivance. By these means they were able to prosecute their operations. Gold mining was carried on here for several years, although under great difficulties. From this shaft the returns show, however, that the St. Onges took out $70,000 worth of gold. Nuggets worth from $125 to $740 each were obtained.

In the same year, the St. Onges also acquired a lease of four acres on lot 12, St. Charles, situate on the south side of the Gilbert, covering ground prospected by Mr. Lockwood. The St. Onges, Mr. Lockwood states, admit taking a regular average of $3.60 a day per man from July, 1876, to July, 1880, and recovering altogether out of this property $190,000 worth of gold. Owing however, to various difficulties with which they had to contend, they eventually sold out.

The great success of the St. Onges caused a rush of miners to the Gilbert, among whom were the following companies:—Payne and Chapman, Forgie, North Star, Victoria, Gendreau and others, when difficulties arose between the proprietors of the ground or surface and the proprietors of the mining rights. Mr. Lockwood, to defend his interest, applied to the Provincial Government, asking for protection. His demand was not, however, complied with; but he was advised to take his case into the civil courts and test the validity of his lease, and of course, that of the letters patent. This Mr. Lockwood refused to do, and soon after entered into partnership with Mr. J. N. Gordon and others under the name of The Canada Gold Company, England, with Mr. Gordon as manager. Mr. Gordon on assuming control at once impeached several of the miners working on the property leased by Mr. Lockwood, and took them before Mr. H. J. J. Duchesnay, Inspector of the Gold Mining Division of the Chaudière, which so exasperated the men that serious disturbances were on the point of breaking out when the Government interfered. The consequence was that the objectionable clauses of the mining law were repealed, a new law enacted, and the validity of the letters patent of 1846 to Messrs. DeLery finally established by the courts in 1883. But meantime, the three shafts which Mr. Lockwood had put down on lots 11 and 12, St. Charles, and which he said were in good order in 1877, were entered by the trespassers, who blocked the drifts and interfered in such a manner with his mines that his men had to leave them. The law against these trespassers could not be enforced until 1884, when on opening his preliminary works on these lots he took out $10,872 worth of gold with thirty-five men. Before the work was interfered with he had taken out in October, 1877, 169 oz. 2 dwt. and 10 grs.

Difficulties as to mining rights.

The Canada Gold Company.

Gold extracted by Mr. Lockwood.

The favourable impression produced by the new mining law, which came into force in 1884 gave a fresh impetus to gold mining in Beauce

New companies formed.

county, and especially in the Gilbert valley. Several new companies were formed, among them the Ainsworth Company of New York on lot 13, DeLery, and the Beauce Mining and Milling Company on lot 14 of the same concession, under the management of Walter I. Smart, of New York. A short distance below these the Canada Gold Company (Limited), already referred to, under Mr. Gordon, carried on mining operations with Mr. W. Moodie in charge. On the neighbouring lot the mine of McArthur Bros. (Limited), formerly the St. Onge property, managed by Mr. Wm. Smart of Martintown Ontario, was being operated.

On the north-east branch of the Gilbert, a small company called The East Branch Company, wrought on lot 16, DeLery, and met with some success. About this time also Mr. Morey, of New York, began work on the lot adjoining, which he had purchased from Mr. L. Gendreau; while on the North Branch Mr. Asher, of Montreal, also carried on some explorations. On lots 29 and 30, concession of Chaussegros, Mr. Wilder, of Boston had reached what was supposed to be the old channel and obtained gold. From the returns made to the inspector's office it appears that during the month of October, 1880, the three companies, the Ainsworth, the Canada and the Beauce, took out 581 oz. of gold.

Changed methods of mining.

The new companies established in Gilbert materially changed the methods of mining there. Formerly the mines could not wash the gravel more than one-third of the year owing to frost in winter and drought in summer. Mr. Moodie, however, constructed machines under sheds which washed the alluviums with water pumped from the shafts every day. Mr. Ainsworth, whose shafts were at a considerable distance from the river, constructed a tramway along which the gravel was dumped and afterwards washed by the hydraulic process, when the rains swelled the river. For this purpose a ditch over 3000 feet in length was dug to bring the water from a small tributary of the Gilbert. The Beauce Company also used this ditch.

Among other companies and individuals who obtained leases or began operations about this time were Messrs. Coupal, on the North Branch of the Gilbert; Mr. P. A. Dupuy, on lots 16 and 17, concession De Lery; Messrs. Côté, Doris and Clouthier, concession St. Charles; Messrs. Cadot, Bernard and Company; The Eureka Company, comprising Messrs. Powers, Tomlinson and McDonald, in the same concession; Messrs. Nicol and Osgoode, on first range N. E.; Messrs. Poulin and Bernard at the Devils Rapids, and Mr. Spaulding on the old mines of the Gilbert.

In 1878, Mr. Lockwood put down two shafts, each about 70 feet deep, at the "north-west end of the St. Onges' ground, lot 11, St. Charles, and took out considerable quantities of gold." In 1879, the Canada Gold Company (Limited), referred to, was formed, J. N. Gordon, manager. From 1st July, 1880 to 1894, a large amount of gold was taken out of these two lots (12 and 13*a*, St. Charles), as the returns to the gold mining inspector show. Mr. Lockwood calculated that this portion of the Gilbert valley alone yielded $50,000 worth of gold per acre. Mr. Gordon, is reported to be one of the few who, after making money by gold mining in the Gilbert valley, retired. Although he is said to have spent $80,000, yet he declared a dividend before closing operations.

Yield of gold per acre.

Mr. Gordon's profits.

Besides the mining rights on St. Charles concession, lots 7, 8, 9, 10, 11, 12, 13 B, 13 C and 14, held at one time by Mr. Lockwood, he also purchased those of lots 13, 14 and 15, DeLery concession. A reserve on each side of the Gilbert River, one hundred feet in width, was set aside, and those portions of lots 14 and 15 DeLery, on the east, were laid off in claims (Miners' Claims), and numbered 1 to 82.

Lots held by Mr. Lockwood.

Miners' Claims.

Two shafts were sunk on lot 13, DeLery, — No. 1, to a depth of 79 feet, reaching 57 feet below river level at the nearest point. Here the Gilbert is 224 feet above datum, and the distance from the mouth is 19,713 feet. The shaft is on the south side, and about 135 feet from the river. No section of the deposits passed through is given, but the thickness of the auriferous gravel appears to be two or three feet. Shaft No. 2, furthest up river, was sunk 40 feet, or 35·6 feet below river level. Elevation of top of shaft about the same as last, and the distance from the river about 150 feet. Thickness of auriferous gravels, 4 feet; no other materials described.

Shafts on lot 13, DeLery.

Two shafts at the southern point of Miners' Claims were sunk through similar ground to that in the shaft put down in rear of claim 16 (described below), the only difference being that there were more stones and boulders. These shafts were nearly 600 feet from the river. The bed-rock was reached at 87 feet, and was found to be very much decomposed, the clay-slates showing numerous adhering nuggets. The mud lying in the auriferous gravel thinned out and was replaced by sand and dark silt, and the southern boundary of the old river-channel was found well defined. Mr. Lockwood carried in a drift until the (auriferous) gravel was replaced by clay and sand, quite dry, with hard slate-rock rising rapidly.

Shafts on Miners' Claims.

"Several shafts were sunk near the 100-foot reserve, as well as on claims 20, 24 and 23; the rock rose rapidly towards the Gilbert, and crops out all along its north bank to the hill ranges in the distance."

Miners' Claims—Cont.

Shaft on Claim 16.—This shaft, which is about 375 feet east of the Gilbert, was sunk in very bad ground. The top of the shaft is 327 feet (?) above datum, and the height of the river at the nearest point is 274 feet. The depth of the shaft to bed-rock was 78 feet, and the depth below the river about 25 feet. The deposits passed through were, (1) "Mixed soil, 3 feet; (2) yellow clay, sand and stones, 2 feet; (3) blue clay with some boulders (boulder-clay), 30 feet; (4) fine blue sand, small stones and quartz (boulders), 20 feet; (5) fine to coarse gravel with yellow clay and boulders, 16 feet; (6) very fine sand or solidified mud, 3 feet; (7) coarse gravel resting on loose, soft yellow slates (oxidized) with yellow clay in the cleavages, and very round nuggety gold, 4 feet. Drifts were opened in every direction to discover the course and width of the gravel. The first day's sluicing gave one nugget of 5 oz. 6 dwt. and 2 grs., and coarse, round, gold, 7 oz. 1 dwt. 2 grs., total, 12 oz. 7 dwt. and 4 grs.

"South of claims 17 and 22, two shafts were sunk in similar ground to that in rear of claim 16, to a depth of 85 feet. The bed-rock near the shaft is clay-slate; to the south it was a belt of quartzite. About five feet above the bed-rock, in compact mud, numerous pieces of semi-fossilized wood (small trees) were found. There was a steady flow of water passing through the bottom gravel, showing a true, ancient river channel."

Shaft on Claim 12, Lot 15, DeLery.—In regard to this shaft Mr. Lockwood states, "the ground here rises abruptly 30 feet from the 100-foot reserve. The reserve was full of shafts and old workings for about 500 feet, when I began operations there. These had yielded rich, but irregular returns at depths of 20 to 30 feet." This shaft was 69 feet deep, and showed the following series of beds: (1) Mixed alluvium 4 feet; blue clay (boulder-clay) 40 feet; coarse blue sand with small stones and boulders, 12 feet; heavy gravel to bed-rock, 13 feet. About 18 inches of the bottom part of the gravel, and 18 inches of the open yellow slates gave a fine show of round worn gold." The height of the Gilbert near this shaft, which is situated about 150 feet to the east of the river, is 278·7 feet above datum, and the distance from its mouth 22,462 feet.

Claim 14 and half of claim 19 were leased to the Poulins. "They got $100 worth of gold; but had to abandon the mine, as water was let in by other shafts in the 100-foot reserve."

A shaft on claim 18 was sunk 78 feet to bed-rock. "The materials and bed-rock and the quantity of gold obtained were so nearly the same as in the shaft on claim 12 as to need no separate description.'

The prospect shaft on lot 15 DeLery, and also those sank by Nash, McNolty, Fenton and Smith and by Smith and Dale, were all barren and unproductive.

Mr. Lockwood states that in exploring and testing these Miners' Claims with the Poulins, he took out very nearly 2000 ounces of gold. Gold taken from Miners' Claims by Mr. Lockwood.

In 1891, Mr. Lockwood made arrangements to work the abandoned ground near the line of concession St. Charles, up to his old works on Miners' Claims. The first engine-shaft was sunk on lot 13 DeLery, going down 66 feet to bed-rock, and passing through "(1) 6 feet of clay soil and stones; (2) 16 feet of soft, moist quicksands; (3) 36 feet blue clay (boulder-clay); (4) 8 feet yellow clay, angular stones and gravel to bed-rock."

"The rock in this shaft at 66 feet was soft contorted clay-slate in irregular masses. We sank in it 16 feet, and then tunnelled in the rock northward about 60 feet, and struck an old drift filled with broken timbers and clay. Continued the drift 193 feet northward from the shaft, and finding no gold, ceased work in this direction. Then tunnelled and drifted southward 135 feet. Tested the gravel from these drifts by a number of side drifts, but found the ground too poor in gold to pay the cost of working."

Mr. Lockwood also tunnelled and sank another shaft on lot 13 De Lery. The tunnel was 200 feet long and over 45 feet deep, passing through blue clay (boulder-clay) to gravel and bed-rock. A tramway was constructed in this tunnel and horse-power used. At the shaft, which was 43 feet deep and near the river's bank, he passed through 3 feet of stony soil; 35 feet of blue clay (boulder-clay); 5 feet of gravel to slate-rock. "The yield of gold was in every way disappointing, though for a considerable distance above and below these workings the ground was very rich." Operations on lot 13, DeLery.

"The bed-rock (clay-slate) in all these workings was in broken ridges covered by a deposit of poor auriferous gravel, in most part mixed with yellow sandy clay. Overlying this bottom gravel were irregular deposits of yellow and blue clay, and to the south mostly barren brown sand and blue silt with small stones. The yield of gold was so poor, and the work so costly that I gave it up after making a continuous heavy loss."

Mr. Lockwood states that during his "30 years' experience in gold mining in the Gilbert valley, he failed to find any upper auriferous gravels, that is, any deposits lying above the level of the present Gilbert River that offered a fair inducement for the employment of No upper gold-bearing gravels along the slopes of the Gilbert.

modern machinery to work them with profitable results." He is convinced that no such deposits exist in the Chaudière district.

Total gold won from the Gilbert.

Mr. Lockwood "calculates that the whole ground worked on the Gilbert 'lead' has yielded two million dollars worth of gold." The ground he himself "worked on the 'lead', including that opened by the Canada Gold Company, gave forty-five thousand dollars per acre, or from one dollar to one dollar and a quarter per foot."

"From lots 16 to 21 DeLery, 5192 feet measuring along the river, the ground was first worked in the autumn of 1862, and steadily from 1863 to 1867, in a partial manner, and mostly in the river's bed and along its banks. Since 1867, work has been carried on irregularly at various times (lately by the American Gold Mining Company). The width of the 'lead' wrought is from 50 to 100 feet, except on lot 16 where it is much wider. At the junction of the east branch, the bed-rock was reached in places at two feet, and in others from two to twenty-four feet, the surface being very uneven." The shallow portions seem to have formed 'bars' on the lower side of which gold was dropped. From lots 15 to 17 the gold was very coarse, much of it in nuggets from $\frac{1}{4}$ to 1 oz., and some from 1 to 6 oz.; besides others 12, 15 and 20 oz.; the largest were two over 30 oz., one at 35 oz. and another $51\frac{1}{2}$ oz." This was called the Kilgour nugget and was the largest found in the Gilbert valley.

Upper part of river.

Mr. Lockwood further states, that "on the upper part of the main Gilbert, I made several explorations and obtained coarse gold; near the forks and also near the low swampy ground about 41 and 42 Fraser, S. E. concession. The gold was coarse and thickly coated with iron."

Channel below Caron Creek.

"Below Caron Creek, on lot 8 St. Charles," Mr. Lockwood says his "chief work was to discover the course of the 'lead' which is enormous in magnitude and extent. The ancient channel does not follow the present Gilbert; but is on the north side, crossing quartz veins and cutting into them very deeply down towards the valley of the Chaudière, where a rich deposit of gold will be found."

"A good deal of work was done on lots 74 and 75, first range north-east, nearly all on shallow ground, from six to twenty feet deep, and many nuggets from 1 to 12 oz. weight were found; but the ledge dips very sharply on the right (north) bank of the river, where deep sinking is required to reach bed-rock and pay gravel."

Course of preglacial channel.

The foregoing facts go to show, therefore, that as stated by Mr. Lockwood and referred to on a previous page, the preglacial channel of the Gilbert, from lot 8, St. Charles, at least, up to about lot 21, DeLery, is deep, reaching 95 feet below the present bed of the Gilbert at the mouth of Caron Creek; but gradually decreasing in depth up stream to the junction of the north-east branch and beyond that. In this part of the valley he states, the ancient channel lies on the south-east side of the present one.

Mr. Lockwood ceased gold-mining operations in the Gilbert valley in 1893-94, and about this time the McArthur Bros. (Limited), acquired a lease of a large portion of the Rigaud-Vaudreuil gold fields, namely, sections 3, 4, 7 and 9, the latter being on the west side of the Chaudière and including the Mill River gold district. On the expiration of Mr. Lockwood's lease, McArthur Bros. renewed it, acquiring the above-mentioned sections for thirty years. McArthur Bros. (Ltd.)

About this time the American Gold Mining Company under Mr. F. Wadsworth of Boston, U.S., made arrangements with McArthur Bros. to work certain grounds in the Gilbert valley. Mr. Samuel Byrne who was the local manager, has furnished me with the following account of the operations of this company. American Gold Mining Company.

"The American Gold Mining Company began active operations on lot 18, DeLery concession, Gilbert River, on June 1st, 1893. The point selected for a beginning, immediately below what is known as Rodrigue Falls, was chosen on account of the sharp curve or elbow in the river just above, offering a better chance than elsewhere to construct a cheap temporary dam to retain water for carrying on experimental work. By this means we hoped to ascertain the value of the ground per cubic yard, and if results proved favourable, would erect a large hydraulic plant there. Operations of this Company in 1893.

"The first piece of ground worked was as I have stated, immediately below the outcrop of slate forming the falls on the line between lots 18 and 19 DeLery. This bed-rock was broken up to a depth of 12 feet, and heavy gold, some pieces as much as two ounces in weight, was found in the crevices and between the slates. This heavy gold was, however, for the most part found resting on a hard, smooth rock-bottom, between which and the upper or overlying, nearly vertical slates there was a gritty, gray sediment, half an inch to an inch thick, which held it. I got $25 worth of gold from one pan of this gritty material, included in that amount, however, was one nugget valued at $22.

"In the work carried on in this locality, we sluiced only the decayed rock and about six inches of the gravel above it, because repeated trials had failed to reveal 'colours' in any other part of the material. The piece of ground worked immediately below Roderigue Falls was found to contain about 1100 cubic yards, including the decaying bed-rock broken up as described. Out of this we took between $1,100 and $1,200 worth of gold, or about $1.00 per cubic yard.

"After cutting a drain through what remained of the falls, we worked in the old river-bed to the west, in that part adjoining lot 19. This piece of ground measured about 400 cubic yards, and we took out about $400 worth of gold from it, or $1.00 per cubic yard.

In 1894.

"In 1894 we constructed a flume of sufficient dimensions to carry the whole of the river water, even during floods, entirely clear of the works. With this we began ground-sluicing on the flushing system,—a system devised by myself. It consisted in damming the water above the flume to a certain level, then allowing it to rush through the flume which had a grade of four inches in every ten feet. The effect upon loosened gravel, boulder-clay, etc., was almost as great as that of a jet of water from the nozzle of a hydraulic monitor, and we were able to do very good work in this way. With an average number of fifteen men stripping bed-rock in this manner, we did as much work as with twenty-five wheelbarrows in the ordinary way.

"We never knew exactly how much gold the last-mentiond piece of ground yielded; but it was about $700 worth in 1894, and in 1895 probably about $500 worth, besides what was reported to have been carried off by midnight diggers. This, together with what was taken out of the same ground by the Leclerc Bros. in 1896, and in 1897 by Mr. Currie and myself, would bring the total production up to about 30 cents per cubic yard for the whole bank of 100x100x20 feet. It must be borne in mind, however, that this ground was previously worked,—some of it a number of times. Had we been permitted to take the gold from all the ground we stripped, it would, I think, just about have paid for labour, flume and other incidental expenses. But difficulties arising between lessee and lessor, we had to cease operations in 1896, and the company must have been several hundred dollars behind.

Total amount of gold obtained.

"Summing up the total amount of gold obtained, which was probably about $3,500, and the number of cubic yards wrought, 8500, we have an average yield of about 41 cents per cubic yard for the whole."

All this was obtained from open work, in the present bed of the Gilbert and on both sides of it.

Leclerc Bros.

The work of the Leclerc Bros. and others, on lot 18 DeLery, referred to by Mr. Byrne, was carried on for a few weeks only, after the

American Gold Mining Company had ceased operations in 1896. They ran two small drifts into the river's bank on the south side and were reported to have taken out $400 worth of gold. Two nuggets valued at $50 and $60, were, I was informed, obtained by these men. Their work was stopped by the owner of the land, or surface rights, so called, threatening them with an action for trespass.

In 1897, a company called The Gilbert-Beauce Gold Mining Company, whose promoter is Mr. Philippe Angers, Notary, of St. François, was formed to operate anew certain portions of the Gilbert valley. This company having acquired the right to work lots 15, 16, etc., DeLery, from the McArthur Bros. (Limited), proceeded to open a trench or open-cut to drain the ancient river-bed of the Gilbert above the McRae shaft on lot 15, by gravitation. These lots were wrought thirty years ago, or more, and proved to be the richest in gold in this district. Here the Kilgour and other large nuggets were found, and it is supposed that portions of the old river-gravels between the shafts and drifts still remain intact. It is to reach these that the present scheme was inaugurated. The great difficulty in deep mining in the Gilbert and other valleys in Beauce county is to get rid of the water, and it is believed this method is the most effective and economical hitherto devised for that purpose. By last accounts the bottom of the ancient river-bed had been reached near the McRae shaft in lot 15, and gold was being taken out. Gilbert-Beauce Gold Mining Company. An open drainage channel.

The foregoing facts regarding gold mining in the Gilbert River valley tend to show that the precious metal has not been equally distributed in the ancient bottom gravels, nor in the loose bed-rock beneath these. Only certain parts of these were found to be really workable at a profit. From the information obtained it would seem that gold occurs in greatest quantity at or immediately below the shoals and reefs of the old river-bottom referred to. The miners claim that the gold was originally laid down in 'leads,' and that when they find one of these they can follow it for a long distance. But these appear to be often interrupted and detached, and even when continuous the gold content is much less in some parts than in others. Mode of occurrence of the gold in Gilbert valley.

The alluvial gold of the Gilbert River valley really occurs in paying quantities only in the bottom of the yellow gravel and in the partially decomposed slates beneath. It contains a certain percentage of silver. The assay of a specimen from this river gave Dr. Hunt 13·27 per cent of silver. The fineness of the gold is $20\frac{19}{24}$ carats. Fineness of the gold.

Rivière du Loup.

Alluvial gold in Rivière du Loup.

The Du Loup attracted the attention of gold seekers at an early date, and considerable quantities of alluvial gold have, from time to time, been taken from the gravels along the lower part of this stream. In 1851-52 the Canada Mining Company, under Captain Richard Oatey, a Cornish miner, obtained the right to wash for gold on the flats of the Du Loup for about ten acres from its junction with the Chaudière, and some extensive operations were carried on. The results of Mr. Oatey's work have been published in the reports of the Geological Survey of Canada.* Great difficulties were met with from the scattered condition of the gold and from an insufficient supply of water during the summer months, the method adopted being the same as that used in washing alluvial tin in Cornwall. The gravel from about three-eighths of an acre, with an average thickness of two feet, was washed during the summer of 1851, and yielded 2107 pennyweights of gold, of which 160 was in the form of fine dust, mingled with about a ton of black iron sand, the heavy residue of the washings. Several nuggets were found weighing over an ounce. The value of this gold was $1,826, and the whole expenditure connected with the working $1,643, leaving a profit of $182. In this account is, however, included $500 lost by a flood, which swept away an unfinished dam; so that the real difference between the amount of the wages and the value of the gold obtained should be stated as $682. The average price of the labour employed was sixty cents a day. From the above statement it would seem that these gold-bearing gravels could be profitably wrought, if they proved auriferous throughout.

Mr. Oatey's work in 1851.

The Canada Company's work in 1852.

Another attempt was made to work these gravels by the same company in 1852, when about five-eighths of an acre of ground was washed at the same place, the total amount of gold obtained being 2880 pennyweights, valued at $2,496. Of this 307 pennyweights were in the form of fine dust mixed with the iron sand. A portion was also found in nuggets or rounded masses of considerable size. Nine of these nuggets weighed together 468 pennyweights, the largest of which was 127 pennyweights, and the smallest 11. Native platinum and iridosmine were obtained in the washings, but the quantities were so small as to be of no economic importance. The season for washing the gold extended from the 24th of May to the 30th of October, and the total expenditure for labour was $1,888, leaving a profit of $608. As a certain amount was, however, expended in constructing wooden

* Report of Progress, Geol. Surv. Can., 1851-52; Geology of Canada, 1863; Annual Report, Geol. Surv. Can., vol. IV. (N.S.), 1888-89, part K.

conductors, supposed to be available for some years, for bringing water from a small stream, a distance of about 900 feet, properly chargeable to construction account, the actual profits for the year would be about $680. It thus appears that from an acre of the gravel, with an average thickness of two feet, $4,323 worth of gold was taken, while the expense of labour, etc., after deducting all that was not directly employed in extracting gold, was $2,957, leaving a net profit of $1,366. The result of a week's working at this place, under the inspection of a member of the Geological Survey, during the season mentioned, showed a yield of 143 pennyweights of gold, valued at $124, while the wages of the miners during that time were $60, showing a profit of $64. Assays of the black sands from the Rivière du Loup show that they contain a considerable amount of gold which was not taken into account in the above computation, so that the net profit might be thus increased. Mr. Oatey gives a list of nuggets obtained in this locality in 1852, with their weights: June 7, 126 dwt. 19 grs.; July 30, 83 dwt. 21 grs.; August 25, 10 dwt. 20 grs.; same date, 38 dwt. 21 grs.; September 7, 98 dwt. 21 grs.; September 24, 55 dwt. 2 grs.; September 30, 23 dwt. 20 grs.; October 2, 16 dwt. 22 grs.; October 9, 13 dwt. 2 grs.

The greater part of the gold was taken out of the gravel on the alluvial flats by the river side, but a portion was obtained by washing the material from the banks above.

Black sands with gold.

In regard to the fine black iron sand in the Rivière du Loup gravels, Sir W. E. Logan reports thus,* "resulting from the season's work [1851]. . . . there was about a ton of fine black iron-sand in the Keeve or vat over which the copper bottom was used. The unseparated quantity of gold in this, after repeated trials, was ascertained to be 1·77 grains per pound avoirdupois; this would give $165\frac{2}{10}$ pennyweights to the ton, the gross value of which would be about £36 [$144]."

Work by Napanee company.

Owing to the gold becoming scarcer, and the licensees, (the Canada Mining Company,) having got into difficulties with the owner of the adjoining lot, they had to cease operations. Work was, however, resumed by a company from Napanee, which tried to sink a shaft through the slate near the mouth of Rivière du Loup, hoping to find auriferous gravel and sand beneath. This company worked for about three years and then also abandoned the property, it having been sold at the suit

* Report of Progress, Geol. Surv. Can., 1851-52, p. 26.

of Mr. Craig, and bought by Mr. Childs, notary, of Quebec, for him. The Napanee company never furnished any returns and were not very successful.

Search for quartz veins.

In June and July, 1867, a Mr. Maynard, of Boston, U.S., had a number of men employed in cutting a tunnel at Jersey Point, so as to traverse several of the quartz veins which here occur in the slates. This tunnel was about one hundred and fifty feet long, seven feet high and six feet wide and was timbered and secured. Portions of the quartz taken from some of these veins were assayed by Prof. Hayes of Boston, and were said to yield gold. Prof. H. Y. Hind examined this property in August, 1867, and prepared a report upon it.

Hydraulic operations in 1880.

Except some desultory work by the local miners, little mining seems to have been attempted on Rivière du Loup after this until 1879-80, when further explorations were resumed and the ancient bed of this river was reported to have been found. In 1880, Mr. A. A. Humphrey began systematic work here with the view of employing the hydraulic process in washing the extensive gravel banks along its lower course. A company of English and French capitalists called the Canada Gold Mining Association, was formed under his management in 1881, and a canal eleven miles in length opened along the west side of Rivière du Loup to obtain a sufficient supply of water for this purpose. This was completed in 1882, and gave a head of about 150 feet. The washing of a gravel bank on the east side of the river about a quarter of a mile from its mouth then commenced, and was continued until the autumn of 1883 when the work, owing apparently to imperfect facilities for saving the gold, having proved unsuccessful, was closed. No returns showing the actual amount of gold obtained by Mr. Humphrey are available, but it is known that the company lost heavily.

Section in hydraulic pit No. 2.

An examination of this pit (called Humphrey's hydraulic pit No. 2) was made by me in 1895-96 (see Fig. 2, p. 43). This pit affords a section showing the character and sequence of the pre-glacial and glacial deposits in the Chaudière district superior to any other met with. In descending order the following beds are exposed:—(1) Surface gravel and sand, 1 to 3 feet; (2) unstratified boulder-clay, containing glaciated boulders from five feet in diameter downward—some of them foreign to the locality, 37 to 38 feet; (3) irregularly stratified boulder-clay, or a deposit made up of coarse clay, apparently in lenticular beds, with glaciated boulders and pebbles, 15 feet; (4) unstratified boulder-clay, more compact than No. 2,—boulders not so large, and a greater number from local rocks, 20 feet; (5) dark-gray, unctuous, stratified clay with arenaceous layers, ochreous in places, 1 to 3 feet;

(6) gray, stratified, ochreous sand, ('quicksand' of the miners), containing a few pebbles, 12 to 14 feet; (7) compact, stratified clay, with variegated bands and an occasional layer of sand, the whole bed full of joints, breaking into rhomboidal shaped pieces, ('pipe-clay') 6 feet. Divisions 5, 6 and 7 maintain a strictly horizontal attitude as seen on the west side of the pit, but the bottom of No. 7 rests on the surface of a gravel-bed which slopes slightly to the north, *i. e.* away from the river, the slope being about two feet in forty; (8) gray stratified gravel, containing numerous pebbles and a few water-worn boulders. In the bottom there is a sand-bed eight or nine inches thick, with scarcely any boulders or pebbles. The materials are non-glaciated and local, and the strata dip northward as in the overlying bed. These gravels and sands are slightly auriferous; whole thickness, 5 feet. (9) Hard yellow oxidized gravel, stratified, strata dipping as in the two last divisions of the series, containing numerous worn boulders from two feet in diameter downward, non-glaciated, and all of local origin. The bottom of this member of the series was not seen, being covered by débris from the face of the bank and by tailings; but it apparently rests on ledges which crop out in the river-bed near by, and is probably as low as these. This gravel seems to be auriferous throughout, but especially so on the surface of the bed-rock; thickness, 28 to 30 feet. The material composing these pre-glacial beds appears to have been carried down stream in the direction of the flow of the present Rivière du Loup. (10) Non-glaciated rock-surfaces, broken and jagged, with gold in the crevices.

This section exhibits several noteworthy features, as, for example, (1) the bipartite division of the boulder-clay, (2) the great thickness of the pre-glacial deposits, about 45 feet, and (3) the change in the character of these from the bottom to the summit, denoting changes in the conditions of deposition and of drainage. The lower coarse beds have apparently been laid down in rapidly flowing and shallow waters at a time when the gradient of Rivière du Loup was considerably greater than at present, as referred to on a previous page, while the clay and sand beds in the upper part must have been deposited in quieter and deeper waters. The changed conditions of deposition are explicable only on the theory of differential changes of level in the region, as already outlined on a previous page, viz., an elevation of the hill ranges nearest the St. Lawrence (the Sutton Mountain anticline and the Stoke Mountains) and a corresponding subsidence in the large central belt occupied by Cambro-Silurian rocks.

Noteworthy features in this section.

Conditions of deposits.

About three miles above the mouth of Rivière du Loup, on the east bank, Mr. John Blue, of the Eustis Copper Mines, sank a shaft fifteen

Section in shaft sunk by Mr. Blue.

feet or more in depth during the autumn of 1895, disclosing the fol lowing series of beds, in descending order:—(1) River alluvium; (2) dark-gray boulder-clay; (3) gray stratified clay, hard and brittle, and (4) gravel and boulders, evidently pre-glacial. Colours of gold and particles of quicksilver were found in the gravel.

In a gravel terrace east of this shaft, on which the small Presbyterian church stands, gold occurs in fine particles. The materials of this terrace and their gold content appear, however, to be secondary, and due to post-glacial river action.

Humphrey's pit No. 1.

A short distance above this and near the mouth of Goldstream (shown on the Geological Survey maps as Grand Ruisseau) is the excavation known as Humphrey's pit No. 1. This is where Mr. A. A. Humphrey operated in 1880, before completing the canal. The washing was performed by the ordinary process of sluicing and it is reported that considerable quantities of gold were obtained from this pit.

Of these operations no authentic account is available as to the quantity of gold taken from the gravels, nor of the content per cubic yard; in some places, it is stated, one dollar's worth was taken, in others not more than ten cents worth.

Report by Prof. Hind.

During the operations of Mr. Humphrey on Rivière du Loup, Prof. H. Y. Hind made an examination of the alluviums of this valley and prepared a report on them. The report was not published. It deals exhaustively with the gravels, their origin, and the mode of occurrence of the gold in them; but what he took for the boulder-clay is, it seems to me, only the coarse fluviatile boulder-beds.

Work by Gendreau and Haycock, 1892.

About the year 1892, Messrs. Gendreau and Haycock commenced work in the lower part of Rivière du Loup. They first examined the gravels along the banks, and searched the bed of the river with some success, obtaining more or less alluvial gold. They afterwards built a dam across the Du Loup and erected a small three-stamp mill, about half a mile above Jersey Point, with the object of testing the numerous quartz veins occurring in this vicinity for gold. Their assays were favourably reported on by Mr. J. Obalski, Mining Inspector of the province of Quebec, in his report for 1894. Soon after this Mr. Haycock acquired the property himself, Mr. Gendreau retiring, and work was being carried on irregularly when I visited the locality for the first time in 1895. The Eustis Mining Company then acquired an option on the property, and during the whole season of 1895 the Messrs. Blue, of Eustis, Que., prospected it and tested the quartz veins. No work has followed the assaying or testing of these veins since that date,

Work by Messrs. Blue, 1895.

however, and it seems to be understood that the results were not encouraging.

In 1896, Mr. Gendreau began the further exploitation of the gold bearing alluviums of Rivière du Loup along the lower five miles of its course, and formed a small company under the name of the Quebec Central Gold Fields Company. This company has sunk several shafts on the west bank of the Du Loup on lots 9 and 10 of the Kennebec road range, section A of Jersey, in an endeavour to locate the old river-bed and test the auriferous character of the gravels. The bed-rock was struck at depths of about 40 feet. Operations were carried on with six or seven men and the company was supplied with pumps had it been found necessary to use them. Mr. Gendreau informs me that fine gold, and also nuggets weighing about an ounce were found in the gravels at the bottom of a 60-foot shaft. Work was suspended in the autumn of 1897, until the pumps were put in place and other preparations made for deep mining. Further work by Mr. Gendreau, 1896.

Along Rivière du Loup and its tributaries as far up as the International boundary, gold seems to have been found in the alluviums overlying the boulder-clay. In some instances it has also been met with in the recent alluviums, or in the flats along the streams which traverse the region. Good indications of gold occur in the Grand Ruisseau, (also called Millstream or Goldstream). Grand Condie River, near St. Come, has also furnished the precious metal. The Metgermette was prospected at the time Logan, Hunt and Michel examined the district, and it is said a good deal of gold was washed from the gravels of this river. Usually it occurred in the beds of the streams; but in the case of the Metgermette it was met with in the banks of stratified gravel at heights of fifty to one hundred and fifty feet above the river-channel. Gold found above boulder-clay.

The St. Lawrence Mining Company owned mining lands in the Townships of Jersey and Linière, on the Du Loup, Metgermette and Portage rivers, but is understood did very little work there. Gold was also found in the alluviums of Portage River, Oliva Stream, and indeed, colours could be found on every tributury of the Du Loup from its mouth to the International boundary. A number of mining claims formerly were taken up on the two branches of Metgermette River and some prospecting was done; but no gold mining has been attempted there for many years. The gravels are of considerable depth, and the gold very much scattered in them. The upper part of the Du Loup has not therefore offered such inducements to mining enterprise as its lower part and the Gilbert River. Gold on tributaries of Du Loup.

The Famine River.

Famine River.

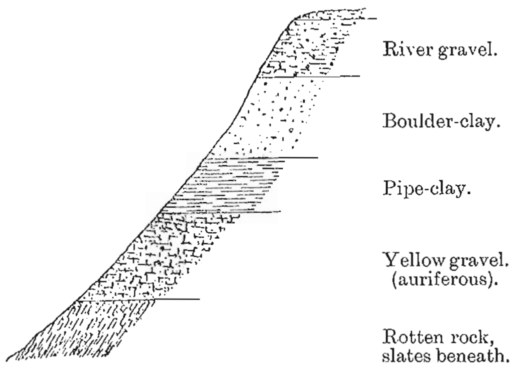
The Famine is the largest tributary of the Chaudière next to the Du Loup, and takes its rise close to the Maine boundary and at the head-waters of the St. John River. Alluvial mining has been carried on in the valley of this river from an early date, with frequent interruptions. The first record of work performed here was that by Dr. James Douglas, under the DeLery patent. When the Chaudière Mining Company acquired the right of working the Seigniory of Rigaud-Vaudreuil, in 1847, the mining rights of fief La Barbe, through which the Famine River flows, were also included. It does not seem, however, that any regular, systematic operations were begun in the valley of this river till the year 1864, or later. In that year leases were granted to Dr. James Reed and George Desbarats in concessions three and four, Township of Watford. During 1862 and 1863, Dr. Reed had explored this portion of the Famine and found "rich diggings" and some good-sized nuggets of gold. In consequence of this, twenty-two licenses for gold mining were issued by the Quebec Government in 1864 and 1865 on the Famine River, and mention is made in the report of the Select Committee on the Canadian Gold Fields (1865), printed by order of the Legislative Assembly, of the presence of gold in considerable quantities there. Capt. Richards and Mr. Beemer had carried on explorations for some years on the Cumberland, a branch of the Famine, joining it from the north-west, and gold was also found on the Abenaquis, a branch coming from the east. Capt. Richards sank shafts to the bed-rock along the Cumberland, and is reported to have found gold, but no returns showing the amount obtained are available.

Work from 1847 to 1865.

Work by St. Onge Bros., 1886.

About the year 1886, the St. Onge Bros. began operations on the Famine. They drove two tunnels into the north bank about two miles above the mouth, or three-quarters of a mile below the main falls of that river, and obtained gold. A section of the beds there exhibits the following series:—(1) Recent river-gravel containing many pebbles and boulders of all sizes up to two feet in diameter; (2) boulder-clay; (3) gray stratified clay ('pipe-clay' of the miners) from three to four feet; (4) yellow gravel, containing boulders and resting on the decayed rock-surface. This gravel is quite similar to that of the Rivière du Loup sections, and is auriferous. Its thickness is not more than five or six feet. The bed-rock (decayed) contains gold in the crevices.

Fig. 4.



SECTION IN BANK OF FAMINE RIVER, BEAUCE CO., 2 TO 3 MILES FROM ITS MOUTH. SCALE :—16 feet to 1 inch.

The St. Onge Bros. ran their tunnels in along the surface of the rock, which is very little above the level of the Famine River but it would appear that these tunnels were entered by the river water in time of floods. Whether the work proved a financial success or not, it demonstrated that the yellow, pre-glacial gravels and decayed rock-surface of this river also contained gold.

Black, wrinkled, fissile, rusty slates, dipping S. 20° E. <80°, traversed by diorite dykes parallel to the cleavage, occur here. Deposits at upper falls.

At the upper falls of the Famine River, the deposits observed are (1) superficial earth or soil; (2) boulder-clay, and (3) yellow gravel. Beneath these, however, rotten rock was noted.

The upper falls are caused by a trap or diorite dyke crossing the river-valley in a north-east and south-west direction, the river not having worn down the channel to its base-level of erosion since the eruption took place. This dyke, like others observed in the district, also extends parallel to the cleavage of the slates, which dip S. E. <75° to 80°. Gold occurs in the yellow gravels here.

Since the St. Onge Bros. wrought in the Famine River valley, no regular gold mining has been carried on. Some of the farmers occasionally wash or sluice for gold along the bed of the river, and not infrequently obtain as much as pays expenses and affords wages during the time spent in this work; but no deep or underground mining has been attempted since that above-mentioned, by the St. Onges. No recent work of importance.

Rivière des Plantes.

Rivière des Plantes.

This river is within the limits of the De Lery seigniory, and appears to have been first explored for gold in 1847 by Dr. James Douglas.

Michel's report on early work.

Mr. A Michel, whose report has been already referred to, thus describes the Rivière des Plantes and its character as a gold-bearing district.* "The river is bounded from the upper to the lower fall by high banks, and from its junction with the Chaudière to the greater fall, more than a mile from the high road, its course is successively over serpentine, diorite and crystalline schists. The bed of this rapid stream, which is filled with boulders and pebbles of various dimensions, has been advantageously wrought for gold by the country people, and Dr. Douglas, also undertook some years since a regular working above and near the little fall. This was, however, abandoned after having yielded from $2,500 to $3,000 in gold. More than two years since, in the month of October, 1863, I spent several days in the examination of this stream. The washing of pans of gravel from its bed generally yielded grains of gold, with the black sand which ordinarily accompanies it in this region. I know that a company of five *habitants*, by labouring for twenty days during the months of July and August last, at a point on this stream a little above the former working of Dr. Douglas, obtained between eight and nine ounces of gold from the gravel accumulated in the re-entering angles and cracks of the diorite. At the same time another company working somewhat higher up on the stream got little or nothing. At this latter place, it is true, the auriferous gravel was found resting not on the bed-rock, but on the bluish clay, and so far as has been observed in Lower Canada, the alluvions overlying the clay are generally poor. The gravels between the lower fall and the Chaudière have not been examined, on account of a mill to which the working would be prejudicial."

Work resumed in 1879-80.

About the years 1879-80, gold mining was resumed on Rivière des Plantes, when the miners having learned of the deep pre-glacial channel of the Gilbert and other rivers, began a search for the ancient bed of the stream in question. In this they were reported to have been successful. Messrs. Mathieu, Bérubé, and Gendreau, discovered the old auriferous gravels, which gave promising indications of gold, and immediately began their exploration. Mr. A. Mackenzie, of Montreal, also commenced work here by the hydraulic process, about this time, a mile or more above the mouth of Des Plantes, in the river-bank, and is said to have met with success.

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* Report of Progress, Geol. Surv. Can., 1863-66, p. 55.

In 1884-85, Messrs. H. Sewell, Bacon and others, from Montreal, began locating the old river-channel some distance below Mr. Mackenzie's works. A shaft was sunk in the east side of the river, about half a mile above its junction with the Chaudière. The bed-rock was reached at a depth of thirty feet, and consisted of sandstones, slates and diorites, with about four feet of well worn gravel, cemented with clay resting upon it. The rock-surface was followed for some distance by drifts and a rusty coarse gold in paying quantities found. Owing to the want of proper appliances for mining and sluicing and to other causes not known, this attempt at developing the mines on Rivière des Plantes was again abandoned. Operations in 1884-85.

When I examined the valley of Rivière des Plantes in 1895 and 1896, there was no gold mining going on. It was evident, however, from the abandoned workings, that most of the mining carried on here in former years had been in gravels of post-glacial, fluviatile origin in the narrow part of the valley situated from half a mile to a mile above the river's mouth. In the upper half mile of the auriferous portion of the valley, however, pre-glacial yellow gravels were observed to occur sparingly in the bottom of the beds. The old channel is apparently on the north side of the present stream. Mr. L. Gendreau, who formerly wrought here, states that the gold met with was usually coarse, and almost always rusty and dark-coloured from the presence of iron and other minerals in the bottom gravels. These gravels, although consisting of modified pre-glacial decayed rock material, do not seem to have suffered the same wear and transportation as those of other valleys in Beauce county. Gold chiefly wrought in post-glacial gravels.

At the distance of a mile, or a mile and a half above the mouth of Des Plantes, the river-valley widens and the ledges and bottom gravels disappear from view. Little or no gold mining has been attempted in this portion of the valley, although the upper gravels show 'colours' in most places.

The south-east branch of the Des Plantes, called Black River, seems to offer indications of being gold-bearing. At the junction of the main tributary 'colours' of gold were washed out of the recent alluviums from an opening in the bank, two or three feet deep. This stream rises in the elevated district of eruptive rocks and quartzites to the east of St. François and north of Gilbert River. The superficial deposits in its valley are very deep, and would require shafts, etc., to reach the auriferous gravels, if there are any in the bottom. No rock exposures were noted till approaching the source of the river. Black River.

Mill River.

Mill River. Work on Meule Creek, 1885.

Mill River is a small stream which flows into the Chaudière from the west, just above the village of St. François. A tributary called Meule Creek joins Mill River about half a mile from its mouth. It was known from an early date that gold occurred in these streams, but no mining was attempted until Messrs. McArthur, Coupal and Company began operations there about the year 1885. Prospecting for an old channel commenced some time afterwards, or in 1886, in the valley of Meule Creek. In September, 1888, Dr. R. W. Ells of this Survey visited the locality and reported that it had been tunnelled along the ancient channel, which is on the north side of the present stream-bed, a distance of over 600 feet, openings having been made for ventilation and the easier working of the mine. The old channel was found to be rich in gold, but the difficulties encountered in mining, owing to the quicksands and the unevenness of the rock surface beneath were very great. Dr. Ells states* that "at the time of my visit in September of that year the end of the tunnel at 400 feet was thirty feet lower than the present bed of the stream, which was about sixty yards to the east. The bottom of the old channel contained a good deposit of well-rounded, worn gravel, cemented with sand and clay, from which nuggets of gold from $10 to $153 in value had been reported. Difficulty in washing the gravel in order to save the fine gold was experienced, the system of sluicing not being properly arranged as regards fall and other appliances necessary for obtaining the best results." Work was eventually closed after taking out upwards of $4,000 worth of gold. It is reported that the company spent $18,000 in exploiting this mine.

Old channel.

Character of deposits.

The deposits disclosed in the tunnel were found to be, in descending order,—(1) Gravel and sand; (2) boulder-clay; (3) fine sand (quicksand); (4) gray silt and yellow gravel, about four feet thick; (5) rotten rock, three to four feet thick, in which most gold was found. The total thickness of the whole series of beds in Meule Creek valley is from 80 to 100 feet. In tunnelling along the rock-surface beneath these, the great difficulty was in keeping the openings free from water and quicksand.

Mr. Obalski's observations.

Mr. J. Obalski, Inspector of Mines for the Province of Quebec, who examined these mines as work was in progress, thus reports on them†:— "The auriferous layer, which appears to be the old bed of des Meules Creek, has been struck at a depth of 80 feet by a shaft which traverses

*Annual Report, Geol. Surv. Can., vol. III. (N.S.), 1887-88, p. 101 K.

†Mines and Minerals of the Province of Quebec, 1889-90, p. 63.

the slates and connects with it by a small drift. The draining of the mine is effected by means of a tunnel of 500 feet, extending to the Mill stream. The strata passed through in sinking the shaft to reach the gold-bearing gravel offered in this case much greater difficulty than at other mines. They appear to have been the following :—

Section of beds on Meule Creek.

	Feet.
Vegetable soil	......
Clay and boulders	30
Fine white sand, mixed with boulders	20
Blue clay	10 to 15
Hard gravel	10 to 12
Fine quicksand and water, impossible to keep out	10 to 12
Auriferous gravel	....
Slates (bed-rock)	....

"The width of this basin is about 100 feet, and the paying or workable part 25 feet. The depth of gravel is very slight, the gold occurring nearly always in the fissures of the bed-rock, the stratification of which runs in about the same direction as the auriferous deposit. The same basin has been traced for a distance of a mile by means of three other shafts and the tunnel by which the mine is drained.

Gold obtained on Meule Creek.

"The company [McArthur, Coupal & Co.] owns the mining rights on 5000 acres, but has only worked with a few men for the last three years, a part of this time having been devoted to exploring and preparatory work. It has taken out 275 ounces of gold, worth $5,000, the largest nugget secured weighing a little over eight ounces and being valued at $153. On the occasion of my last visit, in September, 1889, only four men were at work in the mine, and they estimated that the amount of the precious metal found represented an average of more than four ounces, or about $100 per 80 square feet. The same company has secured a large tract of land in the valley of the Gilbert, and there is room to hope that other important workings will be shortly undertaken there."

Recent operations.

During 1896 and 1897, Mr. Coupal has been operating on a small scale in the valley of Mill River itself above its junction with Meule Creek, and I understand has met with gold in paying quantities there. No work except this has been going on for some years, and the shafts and tunnel on Meule Creek are now falling in.

Slate Creek or Ruisseau de l'Ardoise.

Slate Creek.

Work by Mr. Humphrey and St. Onge Bros., 1883-86.

Slate Creek is a small stream flowing into the Chaudière on the north-east side of the village of St. George. While Mr. A. A. Humphrey was carrying on gold mining in the Rivière du Loup valley between 1880 and 1883, the St. Onge Brothers prospected this stream meeting with favourable indications. After operations were closed on the Du Loup in the autumn of 1883, Mr. Humphrey joined the St. Onge Brothers, entering into a partnership to carry on work along the valley of Slate Creek. Several shafts were sunk to test the ground, and finally one was selected and put down to a depth of 165 feet. Nearly a year was spent in sinking it, owing to the large quantities of quicksand met with. A layer of auriferous gravel was found at the above depth, resting on the bed-rock. Mr. Humphrey left the company in 1886, as the mine was not proving remunerative, and the St. Onges, after attempting to carry on the work themselves, at last abandoned the property, evidently from lack of capital to continue operations. The mine was subsequently sold for debt.

Prof. Chapman's report.

In June, 1886, Dr. E. J. Chapman, of Toronto, examined and reported on the St. Onge gold mine on Slate Creek for Mr. William A. Allan, of Ottawa, Ont. Although speaking encouragingly regarding it, he stated : "During my stay of three days at the mine, $1\frac{1}{4}$ oz., $2\frac{1}{4}$ oz., and 1 oz. (in all $4\frac{1}{2}$ ounces) were taken out of three small portions of ground. It is not pretended, however, that the present yield is sufficient to cover the mining outlay. But it is assumed, and I think with good reason, that the drifts are at present in what is probably, if not necessarily, the poorest part of the mine."

Dr. Ells's observations.

Dr. R. W. Ells, of this Survey, who visited Slate Creek at the time Messrs. Humphrey and St. Onge were at work, thus reports on this mine* :—"By the kindness of Mr. A. A. Humphrey, Manager of the St. Onge Gold Mining Co., the following statement of strata passed through in the last shaft sunk on the old channel of Slate Creek, is here presented :—

*Annual Report, Geol. Surv. Can. vol. III (N.S.), 1886, pp. 49-50 J.

	Feet.
Boulder-clay, boulders, both native and foreign	40
Sand	2½
Boulder-clay	20
Stratified clay, without pebbles	60
Quicksand, small pebbles and fine gold	40
Sand and gravel, containing gold in quantity, often coarse	4
	166½

It is evident from the above table that these old channels had not only been excavated, but had been partly filled up, and the streams diverted to their present courses, long prior to the glacial action by which the boulder-clay was distributed. It would also appear from the lack of gold in the boulder-clay, and from its presence in the underlying and more ancient sands and gravels, that the causes which were principally instrumental in the formation and distribution of the alluvial drift, over the greater portion of the Cambro-Silurian area, were distinct from those which strewed the surface so thickly with granitic and other boulders, and that they preceded the latter by a very considerable interval of time."*

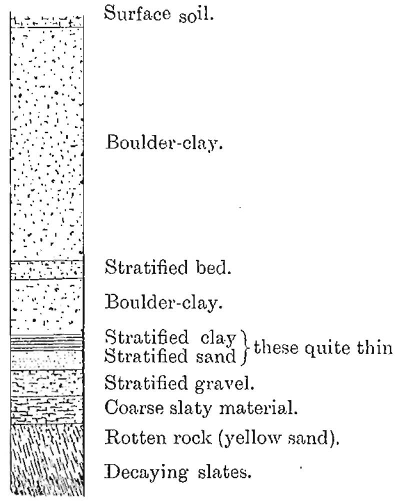
Since the St. Onge Brothers ceased operations here in 1896, no further explorations have been carried on at this place.

In 1895, Messrs. Hardman and Macduff began a new search for the ancient channel of Slate Creek. Starting from the bank of the Chaudière at St. George, they pushed boldly into the rising ground to the east, in almost a direct line towards the St. Onge shaft, about a mile distant. Great difficulties were experienced in keeping the tunnel open owing to quicksands and water. These quicksands and the overlying boulder-clay would occasionally rush into the works and fill in the upper end of the tunnel in such a way that it would take several days to clear it out again. After going in some 800 or 900 feet, it was discovered that the tunnel was too far north of the present stream and possibly of its old pre-glacial channel. Work was suspended in the autumn of 1896. Operations by Hardman & Macduff, 1895-96.

The succession of deposits disclosed in this tunnel is here given in descending order. The section is one of the most interesting met with in the Chaudière valley. Section disclosed.

* There seems to be some doubt as to the correctness of some parts of the above section. Sixty feet of stratified clay without pebbles, is a deposit different from any other known to me in this region, unless in the marine area of the St. Lawrence valley, and I am, therefore, inclined to think there are other subdivisions included in this. The same remark applies to the bed of quicksand 40 feet thick.

Fig. 5.



SECTION OF DEPOSITS IN HARDMAN'S TUNNEL, ST. GEORGE, BEAUCE CO., QUE.

SCALE :—Approximately 10 feet to 1 inch.

(1) Surface soil; (2) boulder-clay with an intercalated band of stratified clay, or stratified boulder-clay; (3) stratified clay and sand ("pipe-clay and quicksand"); (4) coarse, stratified, gravel and pebbles and a few boulders one or two feet in diameter—colours of gold occur in this gravel; (5) a local bed of coarse slaty material, with thin, broken quartz bands running through it. This is apparently decomposed slate, originally thrown down as talus at the foot of a slope or of a boss, although now very compact; (6) fine, yellow sand with ochreous streaks through it, passing into rotten rock beneath, the strata being in the same position as in the solid rock; (7) non-glaciated slates, dipping south-east at a high angle.

"Saprolite."

The most remarkable member of the series is number (6), which is unlike any other bed met with in connection with the gold-bearing deposits of Beauce county. Material of this kind found in the gold fields of the Southern Appalachians, where it is quite abundant, has been named *saprolite* by Dr. G. F. Becker, of the United States Geological Survey.* The occurrence of this rotten rock mantled by other pre-glacial beds in the east bank of the Chaudière, in a position exposed to the full force of the Laurentide ice as it invaded the district and

*Sixteenth Annual Report U. S. Geological Survey, 1894-95, p. 289.

moved from north-west to south-east, evidences the slight erosive action of the Pleistocene glaciers in some portions of the "Eastern Townships" of Quebec.

The Bras, Pozer, Samson and Gosselin Streams.

Gold was found in the alluviums of the Bras River at an early date, its occurrence there being noted in the Geology of Canada, 1863. It was traced along this stream for a distance of twelve miles from its mouth. Below the fall, which is about three miles from the mouth, a good deal of prospecting and washing has been done; but no regular systematic exploitation has yet been attempted. Bras River.

In the valley of the Pozer River, some exploratory work by Mr. Humphrey led to the discovery of an old channel. A shaft about 40 feet deep was sunk near the line between the first and second concessions, passing through, in descending order:—stratified gravel, boulder-clay and yellow gravel. Whether the latter proved auriferous or not I could not learn. The bottom was not reached, as water came into the shaft so rapidly that the work had to be abandoned. Nothing seems to have been done there since, although gold has been panned from the gravel of the river-bed in several places. Pozer River.

The Samson, a branch of the Chaudière, entering it about 20 miles east of Lake Megantic, has been prospected for gold, and is reported to have given promising indications. Actual mining had not been undertaken there, however, at the time of my examination of the region. Samson Stream.

The Gosselin Stream in St. Victor de Tring, was explored many years ago. Mr. Kennedy sunk a shaft 60 feet deep, and reached the ancient channel, but the results of this work were not ascertained. Gold was found in the gravels and sands of a number of the branches of the Bras River, in the Township of Tring, but beyond prospecting these nothing has been attempted. Gosselin Stream.

Main Chaudière Valley.

Although it is generally held that the valley of the Chaudière River itself must be, in some parts at least, rich in gold, yet alluvial mining has been attempted only in a few of the shallower portions of its bed, namely, at the Devils Rapids, near St. François, and at the Big and Little Falls, three miles above the mouth of the Du Loup. At the former place, where the river is confined to a narrow, rocky channel, a con- Main Chaudière valley.

siderable amount of gold has been found from time to time in gravels and in crevices of the rocks beneath. Mr. Michel, in the report already referred to* thus speaks of the occurrence of gold here,—

Michel's observations at Devils Rapids.

"Alluvial gold has been profitably sought for in the Chaudière River itself, at its junction with several rapid tributary streams. But it is at the place called the Devils Rapids, where the Chaudière makes a sharp turn and runs west-south-west, that gold has been most abundantly found in the cavities, fissures and cracks of the clay-slates which often form the bed, both of this river and its tributaries, and are here seen running in the direction just mentioned, forming parallel ridges which are uncovered in low water; at which times the country people are enabled to break up and search these slaty rocks to the depth of several feet. The fissures of the rocks are filled with a clayey gravel in which the gold is met with, and I have seen the metal to the value of several dollars extracted from between the layers of the slate. In one of these bands of slate, which the country people call veins, the gold is tarnished by a black earthy coating of oxyd of manganese. This deposit of alluvial gold occupies a distance of about a mile of the river's bed, and is situated below the gold-bearing quartz vein, which you (Sir W. E. Logan) have described in your Report for 1853-56, page 370, and which is known in the locality as the O'Farrell vein; it has now been broken away down to the level of the slates. I was assured that the alluvial gold is found in greater abundance and in larger pieces in its vicinity.

"I observed at the Devils Rapids an excavation on the right bank and about twenty feet distant from and below the Kennebec road. Here, on lot 53 of range 1, north-east, a gallery was opened, having the slate-rock for its floor, and continued for about 200 feet in a hard alluvial conglomerate cemented by clay. According to the information given me, the whole amount of gold obtained in this working was only about $150.

"Gold has also been found in many places in the bed of the Chaudière at low water, and I do not doubt that companies willing to incur the necessary expenses, might work with profit, certain portions of this river between the rapids just named and its junction with the Du Loup."

Conditions at Chaudière Falls.

At the Chaudière Falls, already mentioned, gold has been washed from the gravel and sand, in the river-bed in considerable quantity from time to time. The conditions of its occurrence there are not unlike those met with at the Devils Rapids, the river flowing over

*Report of Progress, Geol. Surv. Can., 1863-66. pp. 54-55.

ledges and rocky beds, in the crevices of which the most gold is to be found. On the west bank of the river a great accumulation of yellow gravel occurs overlain by boulder-clay. A section of the beds here, from the surface downwards, is as follows :—(1) stratified gravel and loam ; (2) boulder-clay ; (3) the yellow stratified gravel referred to, containing numerous boulders of local rocks ; (4) rock. The height of the bank is about 120 feet, and the thickness of the pre-glacial gravel from 40 to 50 feet. The latter was washed for gold, and found to be feebly auriferous. This gravel extends along the bank here for a quarter of a mile or more, lying upon a rocky floor about 50 feet above the level of the river.

Little known of deep-lying deposits.

In the deep-lying portions of the Chaudière valley, although some attempts have been made to find the auriferous beds by shafts, very little is yet known concerning them. It appears, however, that the ancient channel has suffered deformation in pre-glacial and also in post-glacial times, for, while the rock surface at the Devils Rapids is exposed in the channel and there is no evidence of an older or deeper course for the river on either side, yet above the rapids, the ancient valley, as it now stands, is considerably below that level. Indeed, it would seem that the river-bed at these rapids must have sustained a transverse local uplift, with perhaps a correlative subsidence of a belt of country crossing the Chaudière valley between that point and the mouth of the Du Loup. The ascent of the river from these rapids to the last-mentioned point, is from 45 to 50 feet (aneroid), and shafts have been sunk in three places in that distance as described below :—

Shafts sunk between Devils Rapids & Du Loup.

On the east side of the Chaudière River, on a flat just above the Devils Rapids, a shaft was put down under Mr. Lockwood's direction. The following series of deposits was passed through :—

		Feet.
1.	Surface soil mixed with sand and heavy river gravel, about	15
2.	River sand and gravel, finer than above, about	4
3.	Blue clay, with a few boulders of no great size (probably boulder-clay) about	30
4.	Clay and sand with small stones, about	21
		70

Water coming in rapidly, the shaft had to be abandoned. Neither yellow gravel nor bed-rock was reached, nor was any gold obtained.

Another shaft was sunk by Mr. Lockwood's men on the east bank of the Chaudière and near the mouth of Gilbert River, disclosing the following beds in descending order :—(1) "Loose heavy gravel, about

10 feet; (2) blue clay, (possibly boulder-clay, thickness not given); (3) close (compact) hard clay, a few feet (apparently 'pipe-clay'); (4) clay, mixed with sand and fine gravel." At a depth of about 60 feet water came in so rapidly that the miners had to abandon the shaft. The bed-rock was not reached here either.

On the west side of the Chaudière, opposite Jersey Mills, a shaft 77½ feet deep was sunk in a terrace, the level of which is 18 or 19 feet above that of the river at the nearest point. The bottom of the boulder-clay was not reached in the shaft. Evidently an old pre-glacial channel of the Chaudière exists here, whether occupied by the auriferous Tertiary gravels or not, remains to be determined.

Great depth of old channel.

The above sections correspond roughly with those observed by me in other parts of the Chaudière valley, and show also the great depth of the ancient channel of the river in this part of its course compared with the present one. But the facts, while showing the depression or sag here, do not throw any light on the question as to the existence of gold in the river bottom. Mr. Lockwood informs me that, so far as he is aware, nothing is known as to the auriferous character of these deep-seated beds. The opinion prevails, nevertheless, that the deep-lying portion of the Chaudière valley between the Devils Rapids and Big Falls, must have been the receptacle for a large amount of gold, carried into it by the Gilbert, Famine, and Du Loup rivers from the east, also by the Pozer and other smaller streams from the west, but this has yet to be proved by boring or some other means. If auriferous gravels exist there, the fact that they lie wholly below the level of the rock-barrier at the Devils Rapids, renders the exploration of those in the old river bed in this part of its course one of very great difficulty, and only deposits of considerable richness would be likely to prove remunerative.

Difficulty of exploration.

Character of barrier at Devils Rapids.

In proof that the barrier at the Devils Rapids is merely a local one, and the result of a transverse uplift in this part of the valley of the Chaudière, it may be stated that at St. Francois village, below these rapids on the west bank, a shaft was sunk some years ago to a depth of 60 feet, or about 50 feet below the level of the river at the nearest point. Mr. Phillipe Angers, notary, of St. François, informed me that he obtained the facts in regard to this shaft at the time it was sunk, and that the bed-rock was not reached nor any gold discovered. The rock *in situ* is exposed on the east side of the Chaudière a short distance further down, and the pre-glacial valley of the river appears to be close to the foot of the bank or hillside on the west for two or three miles immediately below the Devils Rapids.

Mr. L. Blanchet, of the Registry Office, St. François, had a shaft sunk just at the foot of the rapids, on the west side of the river, reaching a depth of twenty feet or more without finding bed-rock. Water coming in very fast the work had to be stopped. Oxidized gravels were struck, but no gold.

The facts go to show that the pre-glacial valley of the Chaudière, immediately below the Devils Rapids, is also very deep.

Occurrence of gold general above Beauce Junction.

Gold has not been found in the alluviums of the Chaudière valley below Bisson, two or three miles north of Beauce Junction; but it occurs everywhere above that, very nearly to the source of the river, and also in the valleys of the tributaries. The pay-gravels are, however, so far as known, embraced within a limited area, not more than eighteen miles long by five or six miles wide, and, indeed, may be comprised within even a still smaller space. Of the total gold production of the Chaudière or Beauce district, amounting to two million dollars or more, a million and a quarter, or perhaps a million and a half, have been taken from the alluviums of the Gilbert River valley alone. Although the district as a whole, cannot be compared with other well-known gold producing regions, its accessibility, and the reduced expense with which gold mining can be prosecuted, are considerations altogether in its favour. It is not supposed that the alluvial deposits are exhausted, though so much has been extracted during the last fifty years. Even in the Gilbert valley there must be many partings and walls between the old workings, still intact, that are as rich as those portions wrought in former years. The Gilbert Beauce Mining Company of St. François, recently organized, operating in the ancient alluviums of that valley, proposes to test these and has already done so with some success.

Post-glacial and pre-glacia deposits.

Reviewing the facts in regard to the occurrence of gold in the valleys of the Chaudière and its tributaries, it would seem that there are two kinds of auriferous gravels there—the post-glacial, feebly auriferous, as a rule; and the pre-glacial, usually oxidized and containing most gold, especially in the bottom. These are found throughout in the river-beds of the auriferous area.

Sedentary and assorted deposits.

The post-glacial gravels and sands containing fine gold in small quantities, overlying the boulder-clay, wherever found here, whether in terraces or alluvial flats, are mainly such as have been assorted and re-assorted from the pre-glacial, yellow, auriferous gravels of the river-valleys. The latter, as has been shown, are of Tertiary age or older, and consist of two kinds, sedentary or residuary beds, or rotten rock *in situ*, that is, decayed rock-materials which have not been removed from their original situation; and modified, worn, assorted and re-assorted materials, often overlying the sedentary beds, which have been removed from their original situation by atmospheric agencies, rivers, etc., and in the course of transportation have had the materials worn and rounded. These are usually coarse and oxidized in the bottom, and finer towards the summit, changing into clay- and sand-beds. These modified deposits are, of course, stratified, in this showing their mode of origin, and the valleys of south-eastern Quebec appear to have been occupied to a greater or less depth with them at the close of the Tertiary period. The glacial period then ensued, when the boulder-clay was thrown down, often in thick beds, and mantling all the sands, clays and gravels described. At the close of the ice-age, when the glaciers retreated, the rivers began to clear out their ancient channels,—a process which is still going on, few, if any of them, having yet reached the base-level of erosion. In those portions of river-valleys where erosion has extended to the old auriferous beds beneath the boulder-clay, these have been attacked, and the materials have been transported further down the valleys either in terraces, or flats, or in the river-bottoms. In some portions of the valleys these deposits have been again eroded and have undergone a further reassortment. Thus has the gold now found along the present river-courses been distributed, the coarser in the bottom, the finer in the banks and terraces.

Gold at intersection of river channels.

It has been observed that where the latest channels intersect the ancient ones, these transporting and concentrating processes have had the greatest effect, and that just below these intersections the most gold occurs in the river-bottoms. It appears further that the same mode of distribution and concentration prevailed in pre-glacial ages, the greatest quantities of gold having been found, according to Mr. W. P. Lockwood and others, at and immediately below certain shoals or bars in the ancient valley of Gilbert River.

Dr. A. R. C. Selwyn writes in regard to these gold bearing gravels:* "The chief reason why the rich spots where it [alluvial gold] has hitherto been worked are so limited in extent is that they represent the places where the old channel or river-bed has been intersected by the existing one, and cut into down to the bed-rock, re-distributing its contents along the present river-course, and thus enriching, for a limited distance, the recent alluvions."

Origin of the gold.

Of the origin of the gold in the Chaudière district very little is known, as none of the alluvial gold has yet been traced to its source, and no gold-bearing quartz veins with more than a trace of the precious metal have been discovered. Even in the richest gold producing district—

* Report of Progress, Geol. Surv. Can., 1870-71, p. 276.

the Gilbert River—although it is generally held that the gold there is entirely local, the precise locality or source whence it came has not hitherto revealed itself. Dr. Selwyn says, in the report already quoted: "The worn and comparatively heavy character of much of the gold which has hitherto been procured from the shallow washings in the Chaudière district, does not, I think, indicate that it has been derived from distant sources, so much as that it has been subjected to repeated and long continued abrasion in the drifts." These remarks are applicable to every part of the Chaudière district in which alluvial gold occurs in workable quantities. But, of course, this view can only be regarded as provisional, until gold has actually been found in the rocks in proximity to these alluviums in such quantity as will show that both they and the gold have been derived from the same source.

Little Ditton River.

The alluvial gold mines of Ditton are situated on the Little Ditton, a branch of Ditton River, which is the west branch of Salmon River, an upper tributary of the St. Francis. The principal mines here are the Pope mines, called after the late Hon. J. H. Pope, and are located on lots 39 and 40, range 9, Ditton township. Mr. Pope carried on mining here for many years, and is reported to have extracted from the gravels of this stream, just above the bridge on the Chartierville road, seventy-five thousand dollars worth of gold. Here, as in the Chaudière area, the gold occurs in the lower part of coarse oxidized gravels, and in decayed rock, principally slates, beneath. The bed of the stream and the terraces and flats for the space of half a mile, were wrought by Mr. Pope, who sometimes employed from ten to fifteen men. A few large nuggets and a good deal of coarse gold were found. About the year 1884 or 1885 however, Mr. Pope ceased operations, but desultory mining has been carried on at intervals since. The mines were sold to the Ditton Gold Mining Company (Limited), of Toronto, in 1891, which began work a short distance above the bridge, on the ground from which Hon. J. H. Pope had obtained such quantities of gold. Not meeting with success, this company soon abandoned the property. This property, consisting of a large tract of timber lands as well as the mining rights, formed part of the estate of Mr. Pope, and is now in possession of one of his heirs, Mrs. W. B. Ives, of Sherbrooke, Quebec.

Little Ditton River.

Operations by Hon. J. H. Pope and others.

Mr. Obalski, Inspector of Mines for Quebec, thus reports concerning work carried on at the Ditton Mines:—"In September, 1889, three parties of miners, numbering ten men, were digging on small claims, and on one of these I saw $30 worth of the precious metal, including a piece worth $15, collected in a single day.

Report by Mr. Obalski, 1889.

Each pan washed on this stream, as well as on the Ditton and Salmon rivers shows gold, and I was assured that the metal had also been found on several of their tributaries, among others on lots 5 and 6 of the VIIIth range of Ditton, and 4 and 5 of the IVth range of Chesham (Salmon River) where some small workings have been begun." Mr. Pope, during his life-time, and also the present owners of the mines, usually gave a few parties liberty to work on their own account in different parts of the valley, without exacting any royalty or rent from them, such work, however, being mostly in the nature of prospecting.

"On account of the slight depth of the alluviums covering the pay-gravel, these works are easily executed, open pits or cuttings being sufficient, and shafts being rarely needed."*

Report by Dr. Ells, 1886.

In reference to the Ditton gold mines, Dr. Ells thus reports:—"That attention has not been directed to this locality is in a large measure due to the fact that what is regarded as the most promising field for work, is entirely in private hands, and no royalty being in consequence paid to the Government, no official returns are available as to the amount of the precious metal obtained. Alluvial gold has, however, been found there and worked for many years. The place where operations have been more particularly carried on is on the Little Ditton stream, on lots 23 and 24, range IX., Ditton. Nuggets ranging in value from $50 to $150 are reported as having been found. Though a considerable amount of work has been done on this stream and a large quantity of gold obtained, no scientific mining has been attempted. The ground being generally low, the facilities for getting rid of the tailings are very poor, and in many of the trials the bed-rock does not appear to be reached. From the specimens already obtained, and the generally favourable results of the work already done under unfavourable circumstances and with ordinary appliances, it is evident that much rich ground must exist in this vicinity." †

Negative results of quartz assays.

The writer made an examination of the Little Ditton valley and the upper portion of the Ditton River itself in 1895, and again in 1896. Specimens of quartz were collected at several points, especially from a shaft sunk in a quartz vein from two to three miles above the bridge on the Chartierville road. These were assayed for gold in the laboratory of the Geological Survey, but with negative results.

Sluicing in 1896.

Sluicing was carried on during both seasons for a short time. In 1896, two men from Scotstown, Messrs. McCritchie and McKay, were at work about a quarter of a mile above the bridge referred to, at the time of my visit. Here they washed the gravel for some weeks and obtained gold. One

*Mines and Minerals of the Province of Quebec, 1889-90, p. 64.

† Annual Report, Geol. Surv. Can., vol. II. (N.S.), 1886, p 56 J.

nugget, weighing an ounce, was found at the bottom of the gravel close to the bed-rock. The chief auriferous deposits occupy this position and are partly residuary and partly stratified. They are rusty and oxidized, as is also the upper portion of the rock beneath. These are all evidently pre-glacial, although the boulder-clay is rarely seen in contact with them in the Little Ditton valley. Overlying them are alternating gravel and sand beds, as shown by the following section exposed on the north side of the river about a quarter of a mile above the Chartierville bridge Section.

1. Loam or river wash from 2 to 4 feet thick.

2. Gray gravel, packed full of pebbles well rounded, from 6 inches in diameter downward; thickness about 1 foot.

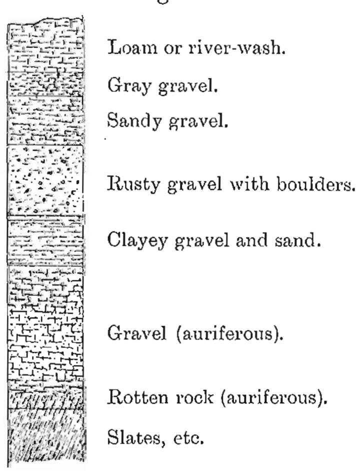
3. Sandy gravel with two layers of pebbles, the same size as in No. 2, the whole very dark or black from the presence of iron or manganese, thickness from 2 to 3 feet.

4. Gravel, rusty, oxidized, packed with boulders of all sizes up to 2 and 3 feet in diameter, from 2½ to 3 feet thick.

5. Clayey gravel and sand with a few boulders from 6 inches to a foot in diameter, rusty in places; thickness from 1 to 1½ feet.

6. Coarse gravel, ochreous, with round boulders from 6 to 9 inches in diameter in the upper part, but angular and embedded in material resembling rotten rock in the lower part. This rests on jagged, broken rotten slates, non-glaciated. The gold is found in the lower portion of No. 6, and on the rock-surfaces, as well as in the clefts beneath.

Fig. 6.



SECTION IN LITTLE DITTON RIVER VALLEY.
SCALE:—8 feet to 1 inch.

All the materials except the lower part of No. 6 are stratified.

The thickness of the several members of the series differs going up stream, some of them being absent in another pit immediately above the one in which the section was measured.

Absence of boulder-clay.

The absence of boulder-clay in the bottom of Little Ditton valley leads to the presumption that all the beds are of post-glacial origin except the inferior member of No. 6, which contains angular pebbles and stones and seems to be rotten rock resting on decayed and decaying rock-surfaces.

Source of the gold.

The rich deposit of auriferous gravel at the Pope mine, occurs just where the old pre-glacial channel is traversed by that of the present river; but the source of the gold in this part of the Ditton valley has not yet been traced. Has it been brought down stream from the pre-Cambrian at the International boundary five or six miles distant? Against this view there is the fact that a number of large nuggets,—one valued at $138—have been found at or near the Pope mine, which could hardly have been transported that distance by the river. If we suppose, on the contrary, that the gold is derived from the Cambrian rocks, the fact has to be borne in mind, that a number of specimens of quartz from veins in the part of the river yielding auriferous alluviums, failed, on assay in the laboratory of the Survey, to yield any traces of the precious metal.

The gold in fluviatile gravels.

The deposits occupying the valley of the Little Ditton appear to be all fluviatile, except the rotten rock in the bottom, and are due mainly to the erosion of the boulder-clay and other materials which occupied it at the close of the glacial period. Although the boulder-clay has been thus eroded in the river-channel it is still to be found on the slopes on either side of the somewhat deep valley. On the north it seems to cap deposits of the yellow stratified gravels.

The gold-bearing alluviums extend along Little Ditton valley from its confluence with the main Ditton up to its source near the International boundary in the vicinity of Prospect Hill, an intrusive mass of diorite.

Further occurrences of gold.

Alluvial gold has also been reported from two branch streams of the Salmon River flowing southward off Big Megantic Mountain. It has likewise been stated that it occurs in the valley of Spider River which flows north-westward from the International boundary through a granite district into Spider Lake.

Stratified deposits in upper valleys of Ditton and Little Ditton.

The district drained by the upper branches of Ditton River, is occupied by thick deposits of boulder-clay overlain by stratified sediments. Sedentary beds of decayed rock-material lie beneath, but whether in continuous or detached sheets has not been ascertained. A wide undulating plain 1800 or 1850 feet in height above the sea, extending along the foot-hills and abutting against them, exists here. The sedimentary deposits of this plain appear as if they had been laid down in a lake or in the sea. No barrier exists at present to the north capable of holding in a body of water at this elevation. The upper portion of the valleys of both the Ditton and Little Ditton rivers are buried in these deep sediments as far up as the foot-hills. No Laurentian boulders were met with in this district, the superficial materials being mainly such as have accumulated in this particular locality from the decay of the underlying rocks, together with that transported northward from the mountains along the International boundary, which are here 2500 to 3000 feet high or more. The question arises, therefore, has the gold found here accumulated in the alluviums during the decay of the rocks and undergone transportation north-westward as the sediments were transported and deposited? Different relative local levels have existed and these may have effected a greater erosion of the beds in Tertiary and Post-tertiary times, and brought about such a reduction of the surface of the region and especially of the ancient barrier or barriers which held in lakes, if any ever existed, as to have obliterated them. By these changes whatever gold was in the rocks, and in the decayed materials which gathered on the surface, would gradually find its way into the river-valleys. But whatever changes occurred, the fact remains that we have here a remarkable accumulation of sediments along the foot-hills and in the old river-beds in the bottom of which gold occurs. The sediments when cut into and transported greater or less distances by the post-glacial rivers, have thus left, by concentration, considerable quantities of gold in the shallow portions of the beds of the several branches of the Salmon and other rivers in this part of the "Eastern Townships."

Materials local.

Mode of accumulation of deposit here.

Dudswell District.

The Dudswell district is one which has only recently come into prominence as regards gold mining. This district occupies the south-eastern and eastern slopes of that portion of the Stoke Mountain range lying between Dudswell Lake and Stoketon, or Ascot Corners. All the streams flowing down from this mountain (which is locally known as Dudswell Mountain), south-eastward, southward and south-westward, have been found to contain alluvial gold. These streams have local names which do not appear on the Geological Survey maps. The

Dudswell district.

First work 1891-92.

earliest work in this district was that begun by Messrs. Rodrigue and Mathieu on the Hall Stream, lot 11, range VI., Dudswell, in 1891-92. Two shafts from forty to fifty feet deep were sunk to bed-rock. These were not, it appears, put down in the deepest part of the old channel, and consequently when drifting was attempted great difficulties were experienced in keeping the works free from water. Although gold had been found in the stream-bed for some years, yet the gravels in the bottom of the shafts did not yield any satisfactory returns, and finally after spending a large amount of money and labour here the works were closed. It is said one nugget worth $90 was found in the gravels of this stream in 1893. Messrs. Rodrigue and Mathieu afterwards prospected other streams flowing off Dudswell Mountain, finding gold on almost every one of them. But as Kingsley Brook seemed to afford the best results, they continued operations there for some years.

Work on Kingsley Brook.

In 1895, on the occasion of my first visit to Kingsley Brook, I found these gentlemen at work with four or five men, and so far as could be learned they were meeting with fair success. Two nuggets worth about $90 had been found a short time previous. Gold had been found in several places along the stream-bed. Respecting operations here, Mr. Obalski thus reports:—*"Gold has also been found on the upper portion of the stream. Some prospects were also made on the neighbouring streams, especially Harrison Brook. The valleys of the streams running down from Stoke Mountains are rather narrow and shut in. It has not been proved that the auriferous alluvial area is extensive, but there is an important fact to be noted, and that is that several pieces of quartz weighing one or two pounds, containing gold visible to the eye, have been found in the streams . . . These pieces are generally yellowish in colour. Three years ago, on the Hall Brook, a large block of stone very little rolled was found, containing many visible specks of gold. This rock was a kind of quartz conglomerate with average grain, crossed by narrow strips of quartz."

Gold in quartz fragments.

Work since 1895.

No work has been going on at Hall Stream since 1895. In the four streams west of this, however, namely, Rowe, Kingsley, Maynard or Harrison, and Big Hollow, more or less alluvial mining has been in progress every summer, though with varied and uncertain results. On Kingsley Brook a good deal of work has been done, first by sluicing in the ordinary way, and latterly by hydraulic washing. Several thousand dollars worth of gold must have been obtained, though the exact amount cannot be ascertained. Messrs. Rodrigue, Mathieu, Coupal, Hayemal, Sotero and others operated on lot 3, range IV., Dudswell,

*Report of the Commissioner of Crown Lands, Quebec, 1895, p. 55.

until 1896, while Messrs. Osgood and Hall wrought on lot 4 of the same range. Several good spots were found, though the gold was somewhat irregularly distributed.

Deposits in Kingsley Brook.

In the valley of Kingsley Brook the deposits, glacial and pre-glacial, seem to have undergone similar denudation and assortment to those of Little Ditton River. Here, however, they seldom exceed a thickness of three or four feet. A section of the beds in descending order is as follows: (1.) One to three feet of mould or alluvial wash, becoming coarser in the bottom; (2.) gravel, brown and ochreous, with angular or slightly worn pebbles, and a few boulders, some of which are from five to ten feet in diameter. These stand up above the surface and are glaciated. The materials of the gravels seem to be local, or transported only short distances by the stream, and are auriferous; thickness, one to two feet. (3.) Compact, ochreous gravel, generally in thin detached masses; the materials as in number (2), but so hard and compact that a pick is required to remove them. This is probably the equivalent of the yellow gravels of other river-valleys,—the remnants which have escaped denudation. They contain gold; thickness from three inches to two feet. (4.) Gray schistose rock, slaty in places, non-glaciated. In the crevices of this, and below reefs and ledges, or in the lee of the large boulders, most gold is found in the gravels.

Maynard Brook.

In Maynard (Harrison) Brook the succession of the deposits and mode of occurrence of the gold are very much the same as in Kingsley Brook, except that the beds are rather deeper, and the valley wider. Great quantities of black sand were noted here. The amount of gold taken out of this stream was not nearly as great as that obtained in Kingsley Brook.

Rodrigue Mining Co., 1896.

Early in 1896, a company called the Rodrigue Mining Company was formed to operate the gold mines of Kingsley and adjacent brooks, and Mr. H. C. Donnell, of Boston, Mass., appointed manager. Having secured the mining rights of this stream, a dam was constructed near its source, and an 80 horse-power boiler and hydraulic pump were put in, principally to work the gravels. Mr. Donnell started on lot 3, range IV. first, extending his operations up the valley of Kingsley Brook. On the occasion of my visit, in the summer of 1896, he informed me that he was finding gold in paying quantities. Eight or ten men were then employed. Though sluicing the gravels from the lower part of the valley upwards, his ultimate object, he stated, was to discover the auriferous quartz or matrix, which he hoped to do as he uncovered the rock-surface in the progress of his work. The boiler was large enough to furnish power to drive a 50 or 60-stamp mill, and could be utilized for that purpose when gold was discovered in the rock. Later it was found that the upper two or three feet of the schists and slates in the bottom of Kingsley Brook valley being decayed, and full of joints and crevices, contained quite an appreciable amount of gold. Mr. Donnell set about mining these, and sank his sluice boxes into the decayed rock some depth. The discovery of alluvial gold in these rock-fissures and openings implied, he claimed, an amount of work with profitable results which the gravels alone could not afford.

Operations in 1897.

In the summer of 1897, the Rodrigue Mining Company was still carrying on operations, but did not seem to be meeting with the success that was anticipated. The occurrence of the gold was found to be irregular; water became scarce in the midsummer months, and the large boulders met with in the valley were found to be a serious hindrance to hydraulic work. Attempts were made to obviate these difficulties, first by raising the dam, and second by blasting or removing the boulders by derricks. In the autumn of that year the Rodrigue Mining Company sold out to another Boston company.

Rowe Brook.

On Rowe Brook, from one to two miles north-east of Kingsley Brook, lot 8, range IV., Dudswell, alluvial gold mining was prosecuted during the season of 1896 by Messrs. Hayemal and Sotero for some months, who reported gold in paying quantities obtained by sluicing. A clean-up witnessed while visiting this stream seemed to prove this statement, about $3.00 worth of gold being obtained as the result of three-fourths of a day's work by one man. The gold was coarse and unworn. This stream is larger than Kingsley Brook, but the gradient of the valley is not so steep. The depth of the superficial deposits seems to be about 8 or 10 feet.

Big Hollow Brook.

During the summer of 1897, some prospecting was done in the valley of Big Hollow Brook, which lies to the south-west of Maynard, (Harrison) Brook, but the particulars were not ascertained.

Deposits of Dudswell chiefly post-glacial.

The deposits in the valleys of all the streams flowing off Dudswell, or Stoke Mountain seem to be closely similar to each other and to have the same origin, that is, they are mainly post-glacial. Boulder-clay was observed only on the slopes of the valleys, and the only material met with which may be pre-glacial is a dark rusty gravel, forming a hard-pan, in detached masses, lying immediately on the surface of the decayed rock and containing a little gold. This material, seen in several places in the bottom of Kingsley Brook, is often so compact that a pick is required to remove it. It varies in thickness from three inches to a foot or two.

All the other materials occupying the valleys of these streams are assorted and fluviatile, and contain boulders of various dimensions, foreign to the locality, some from five to ten feet in diameter. Gravels predominate, but occasionally clay and sand occur. It is in the bottom of these that the most gold is found.

Gold easily worked.

Alluvial gold mining seems capable of being prosecuted at less expense at Dudswell than in the Chaudière district, as the beds are shallow and contain neither boulder-clay nor quicksands, except in the flats and terraces, where the streams escape from the mountains. But the gold-bearing area here is limited, and the precious metal is irregularly distributed in the gravels. The probability is, therefore, that unless gold in workable quantities is found in the matrix, mining will soon become unprofitable.

Lambton.

Lambton. Michel's observations.

Gold was found in the township of Lambton many years ago, but only in small quantities. Mr. Michel visited this locality during his examination of the gold-fields of south-eastern Quebec, 1863-66, and reported on it thus:—"I made an examination of lots 1, 2 and 3 in ranges A and B of Lambton. Particular regard was had to a stream which traverses lot 1 of range A, running northwards, for the reason that some ten or twelve years ago explorations were made, resulting in the discovery of considerable quantities of gold. At the commencement of my examinations, I found in the bed of the stream, in a place which had not been worked, and almost at the surface, a small mass of gold, differing entirely in form and in size from that generally found in the region. A large and deep excavation at this place, and the working of a large amount of the materials extracted, gave no more gold like that first found, but only a few rare and fine particles.

"The exceptional fact of the presence of this mass of gold at the surface, which I mention without comment, can have no bearing on the value of the alluvions which I have examined in this township. Although richer than those of the Magog River, I am persuaded that they cannot be wrought with profit. I found, nevertheless, an appreciable quantity of fine and scaly gold in the gravel from a large number of excavations on the lots already mentioned. The auriferous gravel here reposes upon a yellowish clay, which holds boulders and great masses of rock, and is so thick, and at the same time so hard and difficult of excavation, that I did not think it worth while to carry the excavation to its base. I was informed that pits thirty feet deep had been sunk here without finding the bottom of the clay. In one case, however, in the vicinity of Lake St. Francis, on lot 3 of range A, I sank to the clay-slate bed-rock without finding a trace of gold even in its crevices." . . . .

Gold at Lambton.

"A water-course which I may designate as the Lambton River, rises from a marsh to the south-east of the village, crosses the road from Sherbrooke to Vaudreuil at about a mile from the church, passing through lots 13, 12, 11, 10, 9, 8 and 7 of range A, and lot 11 of range III., before falling into Lake St. Francis. Having learned while at Lambton that gold had been found at several places, and in appreciable quantities in this stream, I determined to examine it. Two excavations were therefore made on lot 8 of range A, of Lambton, about one hundred and fifty feet apart, and in the bed of the stream, and continued, the one into the left and the other into the right bank. I here found gold disseminated throughout a layer of gravel resting upon a decomposing slate, which was so tender as to be readily removed with the shovel to a depth of from one to two feet. The gold seemed to me to be more abundant on either side than in the bed of the stream, and its quantity was such that the gravel might be wrought with profit if the auriferous area were more extended. The superior limit appeared however, to be lot 9, which like lot 8 was traversed by veins of quartz; explorations on lots 10, 11 and 12 gave but insignificant quantities of gold. The precious metal in this vicinity is generally so rough and angular, and even dendritic in form, as to suggest that it has not been brought from a great distance."

No work has been performed in the Lambton district since Mr. Michel's examination. Several valleys and beds of streams in the ridge west of St. Francis Lake, which is a continuation of the Stoke mountains north-eastward from Dudswell, would be worth examining and prospecting; but the streams have cut deep courses among the hills, and it would be a very difficult task to reach the bottom of their old channels. Hence no systematic exploration of this part of the country has been attempted. Dr. Ells says:—"A belt of Cambrian slates, however, cut by granite, crosses Lake St. Francis about midway, where the conditions for gold should be more favourable. This area has, however, never been tested, and certain portions of the Cambrian slates, along with the serpentines and diorites of Thetford, Broughton and Adstock, and extending thence northward to the Chaudière at the Bras and the Colway, present many features in common with the rocks of the gold-bearing districts on these streams."*

*Annual Report, Geol. Surv. Can., vol. IV. (N.S.), 1888-89, p. 73 K.

Ascot, Magog, etc.

During Mr. Michel's explorations in south-eastern Quebec, he examined the auriferous deposits of Ascot, Orford, Magog, etc. Two companies were at work here about that time, the Golconda Mining Company on Grass Island Brook, a mile and a half above lot 6, range XII. of Ascot, where they carried on some work and planned an establishment. On the lot above mentioned, Mr. Michel opened three excavations, one in the bed of the stream, and the two others upon its banks.* "The bed-rock was met at an average depth of six feet. The sections resembled those in Orford, [described below,] and the gold seemed irregularly distributed in the gravel, but more abundant. I doubt, however, if the auriferous zone, having this stream for its axis and extending about twenty-five feet on either side, could be wrought with profit." Gold at Ascot, Magog, etc.

Mr. Michel states that this company (The Golconda Mining Company) had a subscribed capital of $5,000,000, and in their prospectus ascribed extraordinary richness to lots 2 and 3 of range XII. of Ascot, traversed by Grass Island Brook. They speak, in fact, of $14,000,000 of workable gold, of which $3,000,000 are supposed to be in the alluviums, while the quartz and the slates found on the property were declared, according to published assays, to contain an average of $153 in gold, and $7.53 in silver, to the ton. If ever an enterprise of this kind merited to be carried on with energy it might be supposed to be one supported by such reports, and by multiplied assays so highly favourable, yet all working at the Golconda Mine was abandoned in September, 1865. The Golconda Mining Co.

As regards the character of the deposits and mode of occurrence of the alluvial gold, Mr. Michel thus writes:—"Three layers are here distinguishable beneath the layer of vegetable soil, the first a yellowish clayey gravel, containing grains of pyrites and a little fine gold; the second, a stratum of large pebbles and masses of quartz and slate cemented by a blackish clay and without gold; while beneath this, resting on the slates, was a layer of iron-stained gravel, richer in gold than that above. The average thickness of the deposits here was about six feet. This condition of things is like that described on the Gilbert, where the sterile boulder-clay rests upon a rich auriferous gravel." Character of deposits.

The other gold mine was that owned by another American company called the Ascot Gold Mining Company, on lot 11, of range IX. of Ascot Gold Mining Co.

*Report of Progress, Geol. Surv. Can., 1863-66, p. 63. *Ibid.*, pp. 63 and 65.

Ascot. Remarkable results were also said to have been obtained from the workings in this mine. Mr. Michel states that, according to a report in the *Sherbrooke Gazette*, of November 18th, 1865, there was extracted from this mine by 553 hours labour, an amount of gold equal to $996, corresponding to $1.81 per hour for each labourer. As, however, the working had been abandoned at the time of Mr. Michel's visit, he had not the means of examining it.

Examinations at Orford.

An examination of lot 19, of range V., of Orford, was also made by Mr. Michel, as it presented a special interest owing to discoveries reported to have been made on neighbouring lots, several of which had been sold at high prices as containing workable auriferous alluviums. Mr. Michel says:—"The explorations which I made upon the lot above mentioned were not very satisfactory, although gold was found in three out of five trial-pits sunk pretty far apart in the beds or on the banks of two rapid streams, which run parallel to each other lengthwise through the lot, and fall into the Magog River. Beneath a layer of vegetable earth the argillaceous gravel is found resting directly upon the slate. The gold is distributed irregularly and very sparsely throughout this layer of gravel, whose thickness is extremely variable, and did not seem to be more abundant nor in larger grains on the bed-rock than elsewhere. One of the excavations, however, offered an exception to the conditions just described. It was sunk to a depth of twenty-nine feet, and after passing through two or three feet of vegetable soil and a similar thickness of auriferous gravel, presented a mass of extremely compact bluish clay inclosing boulders, and continuing down to the bed-rock, which consisted of white quartz and black slate. Thirty cubic feet of the gravel, washed by the rocker, yielded a few small particles of gold, but not a trace of the precious metal was found in the residues from the washing of twenty-five cubic feet of the bluish clay extracted from various depths. It contained, however, small crystals of black ferruginous sand, besides numerous boulders and small rolled pebbles of divers colours.". . . .

"It would appear from the results of my examinations, as well as from the information received from the country people who have sought for gold in this vicinity, that although the alluvions of the Magog may be said to be auriferous, the precious metal in them is in too small quantity to warrant working."

Mr. Michel's observations and conclusions, it may be remarked, hold good to the present day.

Massawippi Lake.

Alluvial gold in small quantities has been known for many years to occur in the valley of a small stream flowing into the west side of Massawippi Lake, on lot 14, range VI., Hatley, Stanstead county. Mr. Charles Rodrigue prospected and wrought the gravels of this stream for gold, but was unsuccessful. In 1894 or 1895, Mr. Wm. Jamieson, of Magog, Que., who had acquired the mining rights of this property, did some sluicing and reported having extracted about $50 worth of gold. It was then purchased by an English company, represented by Mr. James Stark, of Liverpool. In May, 1896, when the writer visited this region he found Mr. Stark at work there with twenty two men. Some gold was found in the gravels, but not in sufficient quantities to pay for working them. Mr. Stark's object was, however, to find it in the matrix. Broken quartz seams, with sulphide minerals, traverse slaty and talcose rocks mapped as pre-Cambrian. Specimens brought to the office and assayed for gold in the laboratory of the Geological Survey failed to show it. Work was discontinued after a few months. Alluvial gold at Massawippi Lake.

The stream along which the alluvial gold occurs, runs entirely across pre-Cambrian rocks, and the gold appears, therefore, to be derived from these. It is rough and apparently has not travelled far. The valley of the stream is not unlike that of Kingsley Brook, Dudswell, and the mode of occurrence of the alluvial gold is also much the same, except that the beds are of less thickness, nor did I observe the oxidized hard-pan in the bottom. This similarity of character and conditions can be observed throughout the Stoke Mountain Range, wherever gold has been found.

General Observations on the Gold-bearing Alluviums.

In the foregoing pages an attempt has been made to collect together and co-ordinate all the information possible to be obtained respecting the alluvial gold of South-eastern Quebec. As has been shown by a number of geologists and mining experts who have studied the alluvial deposits of this region, the original distribution of the gold in the pre-glacial river-beds here appears to be the same as in other countries. But the great changes of climate and the oscillations of level which took place in the latest geological periods, have subjected these deposits to greater denudation than elsewhere; and in the valleys and upon the lower grounds they are buried beneath immense accumulations of boulder-clay and other products of the ice age. In Australia, Cali- Remarks on the gold-bearing alluviums generally.

fornia, Africa, South America, etc., where similar gold-bearing alluviums occur, they have not been eroded by grinding ice-sheets of Pleistocene age, nor overwhelmed by a thick covering of boulder-clay. Overlying the true auriferous gravels in a number of the larger river-valleys in the region in question, or occupying a position between these and the boulder-clay, occur beds of fine sand and clay which are called 'quicksands' and 'pipe-clay' by the gold miners. In the valleys of the Chaudière, Du Loup, Gilbert, Famine, Des Plantes and Mill rivers, and also in the upper part of the Little Ditton, these sands and clays are developed in great thickness, and, together with the overlying boulder-clays, form one of the greatest obstacles to alluvial mining in the deeper workings.

Degradation of the land.

The inquiry respecting the causes which produced the present condition of things takes us back to an early period in the geological history of the region,—soon after it first emerged from beneath the sea and became dry land. Subaerial denudation than began and has been in incessant operation ever since. The larger rivers then had their origin and began to carve out their valleys. Throughout the long ages which have intervened, these forces of nature, under varying conditions, have been actively engaged in wearing away and reducing the surface of the land. This reduction has been unequal, because of the unequal hardness of the rocks, and their power of resisting erosion. The degradation of the surface from these agencies must have been enormous, amounting to several hundreds, perhaps several thousands of feet, entirely changing the appearance of the country ; the existing residual forms of relief being, in no small degree, the result of this denudation. Regional and orogenic movements have taken place during these ages, the effects of which are evidenced in the mountain ranges as well as in the folding and crushing of the strata, and the dislocations of the river-valleys. The records of the earliest of these are nearly all lost or so imperfectly recorded that it is not possible to reconstruct the original physical features of the country.

Probable condition of things in the Tertiary.

Coming down to the Tertiary period we can, perhaps, form some conception of the appearance of the region, though in an imperfect manner, if we suppose it stripped of all the boulder-clay and overlying deposits. Except as regards some of the more prominent hills and summits, the surface of the rocks would be mantled by a thick sheet of their own débris. On the slopes and in the river-valleys this material would be largely denuded, and portions of the decayed rock-material would form stratified beds, especially where it had undergone modification and transportation by fluviatile agencies. It is to these modifying agencies that the concentration of the gold in the river-bottoms is due. The larger and deeper valleys of the "Eastern Townships" evidence thick accumulations of these deposits.

Gradient of rivers in Tertiary and Pleistocene.

In the Tertiary period there would seem to have been a steeper gradient for the old rivers of the "Eastern Townships" than at present. The dislocated portions of their valleys, referred to on a foregoing page, and the fact of the old channels having been more deeply eroded than the present ones, are evidence in support of this view, their erosive action apparently, having been, more powerful. If the gradient of the Chaudière River, for example, were the same now as at the period of the deposition of the yellow auriferous gravels, the river and its tributaries would probably have cut down through these to their ancient base-level during post-glacial time. But the differential or orogenic uplift of the whole Sutton Mountain axis, or rather of that belt of country occupied at present by eruptive rocks, extending from Lake Memphremagog to the Chaudière River and north-eastward to Cranbourne, took place apparently some time in the Tertiary, changing the drainage of the whole district to the south-east. This was probably only one of several oscillatory movements tending in this direction, but when it occurred, the uplift referred to was evidently sufficient to cause a ponding of the rivers in certain parts of their courses. In the valley of the Chaudière we have evidence of this ponding in that portion extending from the Devils Rapids to the junction of the Du Loup, as well as in the lower parts of the Gilbert, Famine, etc. Considerable quantities of fine stratified clay and sand were laid down at this stage (pipe-clay and quicksands) usually resting upon the old stratified auriferous gravel, locally known as the yellow gravel from its highly oxidized condition. These beds seem to have been deposited just before the advent of the glacial period.

The original pre-glacial gradient indicated by these dislocated valleys seems never to have been restored, although there is evidence of the North-east Appalachians having been from 300 to 500 feet higher than at present in the later Tertiary and early Pleistocene, as shown on a previous page.

Pre-Pleistocene clays and sands.

After a considerable deposit of these fine clays and sands had been laid down, glacial conditions supervened, and ice began to form upon the surface of the region and to move in the directions shown by the striæ already recorded. At the close of the glacial period the whole country was evidently at a much lower level than at the present day, as shown on page 50 J, and the sea not only invaded the St. Lawrence valley throughout its whole extent, but also the valleys of its principal tributaries, such as the Chaudière and St. Francis, and thick deposits of material, constituting the Leda clay and Saxicava sands, were laid down upon the boulder-clay. On the rise of the land which followed, fluviatile beds have been superposed on the series in river-valleys, often to a considerable depth, especially in those of any size. As the materials of these fluviatile beds are partly derived from the boulder-clay and pre-existing formations, they usually contain gold in auriferous districts, although seldom in paying quantities.

Irregular distribution of gold in the alluviums.

From the observations of geologists and mining men in the auriferous area in question, it has been ascertained that the alluvial gold is not regularly distributed in the ancient river-bottoms, some portions being rich, while others do not yield the precious metal in remunerative quantities. This distribution does not seem to follow any rule or law, although probably there were reefs and shoals in the old river-channels, which proved to be resting places, and immediately below which the particles of gold would find shelter from the force of the currents. The richest gold-bearing spots are often isolated from each other, and consequently what is termed a "lead" is seldom continuous for any distance. Even when it is supposed to be continuous, interruptions are not infrequent, the "lead" being taken up or renewed on one side or the other and continued on again for a further distance. This irregularity causes the miners to infer that some river-bottoms have two or more "leads." But the fact merely serves to show how unequally the gold has been distributed in the alluviums, and proves that the distribution was governed by the strength of the currents and the form of the river-bottoms. Where the currents slackened, or where there were shoals or reefs, the particles of gold would be most likely to be dropped. The occurrence of gold in the crevices of the rocks under the river-beds, and especially between the folia of slates which are more or less tilted, is a somewhat difficult problem to solve, although one common to many gold-bearing districts. Only on the supposition that the particles of gold have been passing over these rock-surfaces for a very long time, can it be conceived how such a number could become lodged in these rock-crevices and openings. The movement of the gold particles must have occupied a prolonged stage of the river's history, or a series of successive stages which must have extended over a very long period, even geologically speaking. During this time there seems to have been a constant movement of the materials occupying the ancient river-bottoms—at one time deposition, at another erosion, the latter often reaching to bed-rock in places. By these processes the gold particles would find the lowest level and become lodged in the clefts of the

Causes of this.

rocks. Prolonged shifting of the gravels and their gold contents in this manner, assorting and re-assorting the materials and the sifting out of the least weighty, allowing the gold and other heavy particles to settle to the bottom,—were the processes which produced the present condition of things in the valleys containing the auriferous alluviums.

Very little gold except in river bottoms.

The question is often asked whether the auriferous alluviums of economic importance are all confined to the river-valleys, or whether or not they are also to be found on the slopes of these valleys and in other parts of the gold-bearing districts beyond these. Very little prospecting, so far as the writer is aware, has been done, except in the river-bottoms, but what has been attempted on the higher grounds has not tended to encourage the belief that there are workable deposits on the higher slopes. Of course it is quite an easy matter to find placer gold almost everywhere within the gold-bearing districts in minute quantities, on the higher as well as on the lower levels; but the difficulty is to get it in quantity sufficient to pay for working. As already pointed out, even in the valley bottoms where the gold has undergone the greatest amount of concentration, it is only in spots that pay gravels are found. On the upper slopes and in tracts outside of the river-valleys, no instance of its having been met with in remunerative quantities has come to my knowledge. On this point Mr. Wm. P. Lockwood states: "I have during the last thirty years endeavoured to find upper auriferous gravels of paying quality, I mean any considerable deposit above the level of the present rivers offering fair inducements for the employment of machinery and modern methods to handle with profitable results, and have failed. I am convinced no such deposits exist in the Chaudière district."

Hindrances to alluvial mining.

The superficial deposits of the "Eastern Townships" of Quebec containing gold are differently constituted from those of other known alluvial gold mining regions, except, it may be, in British Columbia the Yukon and Siberia. Below the boulder-clay and quicksands, the beds are practically the same as in most other countries, consisting of clay, sand and gravel, becoming coarser and more oxidized towards the bottom. The boulder-clay, quicksands, etc., usually mantle and conceal all the auriferous alluviums, and are apparently greater hindrances to alluvial mining than even the lava beds of Australia and California. Either in sinking shafts or in drifting, they constitute the great drawback to the exploitation of the deeper alluvial mining of Beauce county. This fact, together with the scattered distribution of the precious metal in the gravels beneath, already referred to, are conditions which render gold mining here precarious and uncertain. In the ancient pre-glacial channels, the gold has, of course, been more or less concentrated; but when it is considered that these often lie below the present water-courses, and that tunnels or drifts at these levels are likely to receive a portion, at least of the drainage waters, the expense of exploration is great and only alluviums of considerable richness can prove remunerative.

Gold mining chiefly in the shallow beds.

Gold mining in the region in question has consisted largely in the exploration and washing of the gravels in the shallower beds, and but little has been attempted in the deeper portions, or where the auriferous deposits lie below the level of the present river-beds, except in the Gilbert valley, where alluvial mining was carried on at various depths from 30 to 80 feet below the channel of the present river, as shown on a previous page. The future exploration of these deep-lying deposits seems to be the direction in which mining efforts should lie, especially in the valley of the Chaudière and the lower parts of the main tributaries. Although great local difficulties present themselves in attempting to explore these valleys in the particular localities mentioned, they would appear, nevertheless, to offer an inviting and ample field for the mining engineer and practical miner. While the prevailing opinion in regard to these deposits is that they are rich in gold; their auriferous character should be sufficiently tested before development work is undertaken. If the gold-bearing gravels were known to be equally rich, or to have the same value throughout, they might be opened in the most accessible locations at the surface and worked thence downward; but these auriferous beds do not all seem to be equally rich, and, moreover, some portions at least, will likely be found not to contain gold in paying quantities. The necessity for exploring and testing them before commencing work is therefore evident. To effect this exploration adequately, it would seem that boring machines might be utilized to good advantage, especially in the Chaudière and Ditton districts. With appliances of this kind the position of the old river-channels, in which the alluvial gold is supposed to have been concentrated, could be located at less expense and in much less time than by shafts or tunnels, the thickness, and probably to some extent the paying character of the auriferous beds beneath made known, and the advantages or disadvantages with respect to drainage ascertained before commencing actual mining operations.

Boring machines.

Preliminary exploration of this kind therefore seems to be necessary to prove the gold contents and show, if possible, whether these would warrant the expenditure necessary to work the deep-seated auriferous deposits. Some portions of the deposits, it is evident from the great expense attending their exploration, will require to be very rich in gold in order that they may be profitably mined, while in other places there does not seem, as already stated, to be sufficient gold to prove remunerative under the most favourable conditions for extracting it. A thorough study of these, and of the mode of occurrence of the gold in them, drawn from actual examination, are desirable, and in this investigation the experience of the old miners who have spent a large portion of their lives, and in some cases considerable sums of money, might be made use of to advantage. Knowledge and skill are, however absolutely necessary to success, and these if acquired from a study of the peculiar phenomena of the region itself, will prove to be the most serviceable.

Source of the Alluvial Gold.

Although the gold-bearing alluviums of South-eastern Quebec have been wrought and studied for more than half a century, by geologists, mining engineers and others, and a considerable mass of literature relating to their distribution and mode of occurrence published, yet very little is known concerning the true source of the gold found there. Logan and Hunt regarded its source as being in the oldest rocks of the region. In the Geology of Canada, 1863, it is stated :— Source of the alluvial gold.

"The source of the gold appears to be the crystalline schists of the Notre Dame Range; the materials derived from their disintegration, not only constitute the superficial material among the hills of this range, but are spread over a considerable area to the south of them. These same gold-bearing rocks may be traced south-westwardly, along the great Appalachian chain to the southern United States, and are supposed to belong, for the most part, to the Quebec group."* In Notre Dame Range. At that time native gold had been found "in small grains with galena, blende and pyrites, in a well-defined quartz-vein, cutting slates which were supposed to be of Upper Silurian age, (since referred to the Cambrian), at the rapids of St. Francis, on the Chaudière. At St. Francis. In Leeds, at Nutbrown's shaft, masses of native gold of several pennyweights are found with copper-glance and specular iron-ore, in a vein of bitter-spar, and small grains of the metal have also been found imbedded in the white garnet-rock described on page 496." Leeds. "The gold of Eastern Canada appears not, however, to be confined to the rocks of the Quebec group. Although it occurs in these with the copper ores of

* Geology of Canada, 1863, p. 519.

Ascot and Leeds, and in the garnet-rock of Vaudreuil, it is also found with mispickel and argentiferous galena in veins of quartz which traverse the upper slates."*

A considerable number of assays of supposed gold-bearing quartz have been made from time to time in the laboratory of the Geological Survey of Canada, and by reliable and competent assayers, which although affording merely traces of gold in many instances, yet serve to show that the rocks of the district really do contain the precious metal.

Gold in quartz veins of Rigaud-Vaudreuil.

When Mr. A. Michel made his examination of South-eastern Quebec, (1863 to 1866) he collected a number of specimens of quartz in the auriferous districts which were assayed by Dr. T. S. Hunt, of the Geological Survey. Brief descriptions of the quartz veins supposed to be auriferous, examined by him, and of the assays of specimens therefrom by Dr. Hunt are taken from their reports and here presented.†

In the seigniory of Rigaud-Vaudreuil, Mr. Michel found on lot 83, range I., north-east, a vein of quartz running north-northeast, with a south-easterly dip. The mass was not homogeneous, but composed of a net-work of small veins of quartz impregnated with oxide of iron. A portion of this quartz sent to Boston was reported to have yielded at the rate of $37 worth of gold to the ton; while another assay on the spot by a Mr. Colvin gave $106 to the ton. A mechanical assay, by crushing and washing twenty pounds of the quartz, of which specimens were furnished Dr. Hunt, gave five very small particles of gold. Dr. Hunt's two assays (No. 1) yielded no trace of gold.

In St. Charles

On lot 21, concession St. Charles, a large quartz vein was also seen following the strike of the rocks north-east. This vein the thickness of which was seventeen or eighteen feet, was divided by joints into irregular masses, separated by ochreous and earthy matters, though apparently compact at the bottom. On the north side a vein of brown decayed material was noted, having a thickness of from four to twelve inches, and running parallel with the quartz vein. A portion of this quartz assayed at Toronto, it was said, gave $136 worth of gold to the ton, and another assay by Mr. Colvin, $54 worth. The certified assay of Dr. A. A. Hayes, of Boston, yielded, for the quartz of this vein, $77.56 in gold and $2.55 of silver to the ton. Of five assays of this quartz by Dr. Hunt (No. 2), four gave an average of only six dwt. thirteen

* Geology of Canada, 1863, p. 519 and p. 745.

† Report of Progress, Geol. Surv. Can., 1863-66. The numbers in parentheses, 1 to 12, are the same as in Dr. Hunt's report on the result of the assays.

grains of gold, = \$6.76; while the fifth, in which a large scale of gold was seen in sifting, and was added to the assay, yielded at the rate of four ounces eighteen dwt. = \$101.29; the average of the five assays being \$25.66 per ton.

On lot 62, of range 1, north-east, an outcrop of a quartz vein occurs, in which a superficial opening had been made. It was reported that an assay of the quartz, made in New York, gave \$15 in gold and \$22 in silver to the ton of rock; but by an assay of Mr. Colvin, it gave not less than \$106 to the ton. Two assays by Dr. Hunt (No. 3) gave no trace of gold. In range 1, N. E.

A small opening on lot 19, of the concession St. Charles, exposed a vein of quartz in slate running north-east, dipping south-east. The vein has a thickness of twenty-four feet, and an irregular jointed structure similar to that on lot 21. An assay of this quartz by Dr. Hayes gave \$70.95 of gold, and \$2.00 of silver to the ton. Six assays of this (No. 4) were made by Dr. Hunt. Of these, the mean of four gave four dwt. twenty-one grains of gold = \$5.03; and that of two others, in which, as in No. 2, a scale of gold was seen and was ground up with the powder, was three ounces two dwt. = \$64.07. Average of six assays is thus \$24.71 to the ton. Lot 19, St. Charles.

From lot 39, of range I., north-east, a speciman of an outcrop of quartz, was assayed by Dr. Hunt (No. 5). Two assays gave no trace of gold.

An outcrop of quartz on lot 26, concession DeLery, has a breadth of three or four feet, and runs north-east. The mechanical assay of twenty pounds of this quartz gave Mr. Michel no trace of gold. In concession DeLery.

The vein of quartz crossing the Gilbert on lot 20, concession of DeLery, seems, according to Mr. Michel, to be an extension of that met with on lot 19, concession St. Charles. The course of this vein is also north-east, with a dip to the south-east, and at the outcrop, where it is seven or eight feet wide, it is divided by material derived from the wall-rock into two distinct veins, which evidently tend to unite below. The quartz is cavernous and the materials associated with it are generally ochreous. Mr. Michel submitted twenty pounds of the quartz from the right bank of the Gilbert to a mechanical assay, by pulverizing and washing it, and found in the residue twenty-two particles of gold, very minute, but visible to the naked eye. The assays of this quartz by Dr. Hayes gave from \$16 to \$18 to the ton.

Two assays of this quartz (No. 6) by Dr. Hunt, yielded a mean of fourteen dwt. sixteen grains of gold = \$15.15 to the ton.

In range 1, N. E. — On lot 53, range I., north-east, Rigaud-Vaudreuil, already mentioned, comprising the bank of the Chaudière at the Devils Rapids, there are numerous exposures of the rocky strata. Among these is a strong band of sandstone (according to Mr. Michel) with a north-east strike, the strata being traversed by numerous little veins of quartz running east-south-east, and among them a well-marked vein a foot in width. To the east of this sandstone is an outcrop of quartz exposed for a distance of twenty or thirty feet, divided by joints filled with foreign material. A mechanical assay of this quartz by Mr. Michel failed to show a trace of gold, while the assay of the same quantity of quartz from outcrops on lot 51 A, gave five small particles of gold.

Dr. Hunt states in regard to this (No. 7) on lot 53, range I., north-east, that two assays gave no trace of gold.

Buldoc Creek. — Another quartz exposure having been observed on lot 59 A, range I., north-east, near Buldoc Creek, Mr. Michel examined it and states that it was an incoherent mineral mass, consisting of quartz mixed with the encasing clay-slate and sandstone, but apparently forming a vein running north-east. A mechanical assay of this material gave him six very small scales of gold.

Two assays of this (No. 8) from lot 59 A, range I., north-east, gave Dr. Hunt no gold.

Aubert-Delisle. — On lot 9, range I., of the seigniory of Aubert-Delisle, a vein of quartz extending east-north-east, and dipping south-south-east was found in the bottom of a pit twenty-five feet deep. It is imbedded in slate, and divided by an admixture of the wall-rock into several parts, one of which is four feet wide. A specimen of this sent to Dr. Hunt (No. 9), on two assays gave no gold.

Aubert-Gallion. — On lot 30, range I., Aubert-Gallion, a vein of quartz from which a specimen was obtained and sent to Dr. Hunt, failed on two assays, (No. 10) to yield a trace of gold.

Linière. — A vein of white quartz, partially explored, occurs on lot 76, range I., township of Linière. It has a width of five feet, and runs with the strike of the slates north-north-east. Mr. Michel was told that visible gold had been observed in another small vein at the bottom of the pit, and that an assay of the quartz made at New York gave $54 worth of gold to the ton. Specimen (No. 11) from this vein, sent to Dr. Hunt, gave, on two assays, no gold.

A shaft to the depth of twenty-five feet was opened on lot 2, range I., Linière, very near the International Boundary, on an outcrop of quartz running with the strike of the slates. The quartz consists of several veins from four to six inches wide, and in one case a foot, with portions of slaty rock between each. Specimens from this mass of quartz (No. 12) gave Dr. Hunt on two assays a mean of 6 dwt. 13 grains of gold = $6.76 to the ton.

Dr. Hunt's remarks.

In regard to the foregoing, Dr. Hunt remarks:—"If we compare the results of these assays with those [the mechanical assays] mentioned by Mr. Michel, we shall see further proof of the irregularity with which gold is distributed in the gangue. The quartz from several of these veins has been examined by Dr. A. A. Hayes, of Boston, whose results, which are worthy of the highest confidence, are given by Mr. Michel, together with other assays by persons unknown to me, but probably reliable. The quartz of No. 1 had given in Boston $37, and in another assay made on the spot $106 of gold to the ton; the mechanical assay also yielded a portion of gold to Mr. Michel; while two assays of another sample from the same vein gave me no trace of the precious metal. Again, in the case of No. 2, Dr. Hayes obtained $77.56, and Mr. Colvin $54, while one assay of the same vein yielded me not less than $101.29; and four others, as seen above, a mean of only $6.76. No. 3, in like manner, is said to have furnished gold, though none was found in the specimen just assayed. Nos. 4 and 6 have yielded gold both to Dr. Hayes and myself; while of No. 8, which gave traces of gold by Mr. Michel's mechanical assay, and of No. 11, which is said to have yielded gold to an assayer in New York, the specimens furnished me yielded no traces."

Gold in rocks of Marlow.

Assays of specimens from Marlow, lot I., range VII., made by Prof. J. T. Donald, of Montreal, showed, in addition to silver and lead, small quantities of gold, in one case half an ounce to the ton. An assay of a sample from a vein in the same locality by Dr. Hoffmann in the laboratory of the Geological Survey, yielded traces of gold and forty-three ounces of silver to the ton. Specimens of quartz from the Bras du Sud Ouest, near the falls, having small quantities of felspathic rock associated therewith, and carrying some iron-pyrites, were likewise assayed by Dr. Hoffmann in the laboratory of the Survey, and gave ·117 of an ounce of gold to the ton. A mass of white garnetiferous rock occurring near this place has also been reported to contain gold.

O'Farrell vein.

The O'Farrell and other quartz veins at the Devils Rapids, Chaudière River, have yielded gold, and the occurrence of such veins led The DeLery Gold Mining Company to erect a crushing mill at this place in 1864, and attempt to work these and the quartz veins of the Gilbert valley. Crushing for gold here, however, proved unsuccessful and was soon abandoned.

Dr. Selwyn's observations.

In 1870, Dr. Selwyn, as Director of the Geological Survey of Canada, examined and reported on the gold-fields in Quebec and Nova Scotia, and makes the following observations concerning the quartz veins of Beauce county. "The quartz veins of this district have already been examined and reported on, and their auriferous character has been established. I examined the outcrops of several of these from which samples were taken by Mr. Michel and carefully asssayed by Dr. Hunt. No efforts appear to have been made since the date of the reports above referred to, for their further development. The result of Dr. Hunt's assays was certainly not very encouraging, but when compared with other assays made by Dr. Hayes, of Boston, they only serve as he remarks, to prove the irregularity with which the gold is distributed in the gangue.

"Some of the veins are well situated for working, and so far as can be judged from the very limited extent to which any of them have yet been opened, there would be no difficulty in raising large quantities of quartz. Considering the heavy and often nuggety character of much of the alluvial gold of the Chaudière district, it is in the highest degree improbable that none of the veins from the abraded portions of which this gold has without doubt been derived, should be sufficiently rich to yield a fair profit to well directed enterprise applied to their exploitation, and it seems extraordinary that so little has hitherto been done in this direction."*

Gold in Handkerchief settlement.

Gold is reported from the Handkerchief settlement, seigniory of St. Giles de Beaurivage, also from the copper lodes of Harvey Hill. Traces of gold have been met with at Thetford, and Mr. Michel reports finding gold by a mechanical assay from lot 8, range A, of Lambton. Assays of specimens of quartz from lot 6, range XI., Whitton, gave traces of gold.

Along Rivière du Loup.

Mr. Obalski, Inspector of Mines for Quebec, reports that according to assays made by Mr. H. Nagant, of Quebec, of specimens collected by him, gold occurs in quartz from the following localities along the upper part of Rivière du Loup, viz., lot 79, Kennebec Road range, Township of Marlow; range VIII. or IX., near Portage Lake; near Portage River, range II., section C. Gold has also been found on lot 2, range XV., of Risborough, in quartz veins, and a specimen from a quartz vein near Lake Megantic, gave traces of gold to Dr. Hoffmann in the laboratory of the Geological Survey.

*Report of Progress, Geol. Surv. Can., 1870-71, pp. 276-77.

The gold obtained in Beauce county is alloyed with silver, a small mass from St. François, containing 13·27 per cent according to Dr. Hunt. Other specimens gave 13·60, 12·87, 12·23, 10·76 per cent of silver.* Alloy.

About half a mile from the mouth of Rivière du Loup, on the south bank, Messrs. E. B. Haycock and Louis Gendreau erected a small mill with three stamps (Fraser and Chalmers) in 1893, in order to test the numerous quartz veins in the lower part of the valley of that river. The results of their operations are given in the report of the Inspector of Mines for Quebec, Mr. J. Obalski.† Eventually the mill passed into Mr. Haycock's hands, but as work was closed there in the autumn of 1895, it is feared that the enterprise has not met with success, although according to the tests made gold was found in several of the veins. Respecting these Mr. Obalski remarks: "It is true that only small quantities of quartz have yet been milled by Mr. Haycock, and that the question of the productiveness of the quartz in Beauce cannot as yet be considered settled. In other countries gold has been found in paying quantities in quartz, where it was quite invisible, and it may be hoped that these first assays will encourage others which will have a definite result." In the summer of 1895, Mr. John Blue, of Eustis, Que., and his son, prospected the Du Loup for several miles above its mouth, and still further tested and assayed considerable portions of the quartz from the veins above referred to as well as from others in the vicinity; but the quantities of gold obtained from the latter were reported to be very small. No attempts have been made to work these quartz veins since. Mill tests by Messrs. Haycock and Gendreau.

At Dudswell, in the Stoke Mountain range, visible gold has been found in the matrix on lot 1, range VI., township of Dudswell. It was first discovered in a thin quartz vein, from one and a half to two inches in thickness, traversing a mass of altered arkose, which consists principally of quartz, felspar and talc. Iron-pyrites and other sulphides are found in this arkose, which appears to form a wide band in the pre-Cambrian schists, cropping out as a low ridge or boss. Whether the pyritous minerals occur throughout the whole mass of this rock has not been ascertained; but specimen from that part inclosing the thin quartz vein carrying visible gold, assayed in the laboratory of the Geological Survey, yielded ·35 of an ounce of gold to the ton = $6.40. Some exploratory work was performed here by Messrs. Harrison, on whose land the gold occurs, and by Mr. John Armstrong, of Marlow, who leased the property. Gold in matrix at Dudswell.

* Geology of Canada (1863), p. 520.

† Report of the Commissioner of Crown Lands for Quebec, 1894, pp. 88-89.

Mill test from Dudswell.

Subsequently, as this matter appeared to be one of considerable interest, the writer was instructed to again visit this place, and obtained several hundred pounds weight of rock, consisting largely of small quartz stringers, but including the arkose matrix and representing material that might be obtained in quantity. By the kindness of Professor J. B. Porter, of McGill University, this was submitted to a mill test, with the following results :—

Weight of rock tested 387 lbs.			
Free gold recovered, 321 millegrammes or at the rate of..		$1.10	per ton.
Concentrates obtained from tailings by Frue vanner $1\frac{1}{4}$ p. c., value..................................		8.30	"
Tailings from vanner $98\frac{3}{4}$ p.c., value................		0.40	"
Total value of rock.	$1.62		"

Professor Porter also notes that, as assays of the rock gave from $4.00 to nothing to the ton, the gold must exist in particles of appreciable size scattered through it.

Previous to the discovery of gold in these rocks, pieces of quartz and conglomerate, generally yellowish in colour, and containing visible grains of gold, were found in the gravels of several of the small streams flowing off Dudswell Mountain. In 1892, a boulder of this rock, very little rolled, was found in Halls Stream. Numerous angular pebbles have recently been discovered containing specks of gold. Considering all the facts, it seems quite evident that the source of the alluvial gold obtained here is in the pre-Cambrian rocks of this mountain.

Near Sherbrooke.

In the Stoke Mountain range, near Sherbrooke, gold occurs in small quantities in association with the copper ores. Mr. John Blue, manager of the Eustis copper mine, informed me that traces of gold as well as silver were found on assay in the copper mines wrought by him, the value being about fifty or sixty cents to the ton of rock. In other places in these mountains, especially near Sherbrooke, and in the township of Ascot, gold has likewise been met with in the copper ores.

Massawippi Lake.

On the west side of Massawippi Lake, on lot 14, range VII., Hatley, gold is reported to have been found in the rocks in minute quantities, in the valley of a small stream in which alluvial gold occurs. The pre-Cambrian schists here carry a number of broken quartz seams, which in places, contain sulphide minerals, chiefly iron-pyrites. The quartz veins are irregularly interbedded in the talcose or chloritic schists and slates. It is quite evident that here also the pre-Cambrian rocks must be the source of the gold.

In the Ditton district, very little exploration for auriferous quartz veins has taken place. Mr. Obalski reports an assay of a specimen of quartz found there by Mr. Nagant, of Quebec, as showing an appreciable amount of gold. Ditton.

During the summer of 1895, the writer collected specimens of quartz from some of the veins crossing the Little Ditton valley, at different points above the Chartierville road bridge. These were assayed in the laboratory of the Geological Survey, and found to contain neither gold nor silver. Gold has, however, been reported to occur in a quartz vein near the source of the Little Ditton, but the writer was unable to verify this. Across the boundary line, in New Hampshire, it has been discovered at Plymouth and Bridgewater in rocks of pre-Cambrian age.

Observations on occurrence of gold in the rocks.

The foregoing facts serve to show that gold has been found in the gangue in a number of localities in the "Eastern Townships," and is not confined to rocks of one age, having been met with in the pre-Cambrian, Cambrian and the Cambro-Silurian, although in very minute quantities. Its occurrence in the districts mentioned, nevertheless, affords good grounds for supposing that the gold of the alluvial deposits has been derived from the rocks of the region, and is consequently of local origin. The comparative abundance of the precious metal in the alluviums of certain parts of the region where auriferous quartz veins occur, as, for example, in the Gilbert valley, at the Devils Rapids of the Chaudière River, and near the junction of the Du Loup with the last-mentioned river, would seem to indicate that it exists in some undiscovered portions of these rocks in greater quantities than have hitherto been met with, though whether in paying quantities is problematical.

As stated on a previous page, the view held by Logan and Hunt regarding the primary source of the gold in South-eastern Quebec, was, that it occurred in the crystalline schists, or pre-Cambrian rocks of the Nôtre Dame range. Since that time the quantity of alluvial gold found principally in districts occupied by Cambrian or later rocks, has led to a change or extension of the views of geologists regarding its source. The Gilbert, Famine, Mill, DesPlantes and other rivers traversing rocks of Cambrian age, in the valleys of which so much gold has been found, prove that its source is near, and is in these and their associated rocks. From the quartz veins, found in considerable number in the places mentioned, specimens were collected by Mr. Michel, and assayed by Dr. Hunt, as shown on a former page, and since that time additional samples have been obtained from various portions of the

Cambrian and Cambro-Silurian districts, some of which have been assayed in the laboratory of the Geological Survey. But although yielding traces of gold, in no instance have the results been such as to encourage the expenditure of capital in working these ruins.

The source of the gold met with in the alluviums in Ditton, Emberton, Chesham, and along the International boundary north-eastward to Lake Megantic, and beyond, may also have been in the pre-Cambrian rocks which extend along the watershed. Near the boundary, however, gold has been met with only in very small quantities. And although a considerable amount has been extracted from the alluviums of the Little Ditton valley, none appears to have been discovered in the rocks there, except that noted by Mr. Obalski, as already mentioned.

Difficulties in accounting for origin of gold.

In endeavouring to ascertain the origin of the gold of the "Eastern Townships" of Quebec, a region in which practically no quartz mining has yet been carried on, great difficulties presented themselves, owing to the almost entire absence of information regarding its mode of occurrence in the rocks. Indeed, it was found that very little progress had been made in our knowledge of its derivation since the time of Logan and Hunt. While the assays given above are doubtless in the main correct, the results it will be seen are meagre. Quartz veins are numerous and occur in rocks of all ages here, but few of them are found to be auriferous. Their origin is a problem requiring a much larger body of data than is yet available for its determination. Owing to the fact that the rocks are everywhere covered with a thick mantle of boulder-clay, it is not surprising that our knowledge concerning these veins is so limited. It seems probable, however, from the differences in their appearance and character, that they belong to different geological ages. The great majority are interbedded or parallel to the schistose or slaty cleavage. Those found in the pre-Cambrian schists are often broken, interrupted, or lenticular. In the Cambrian rocks they are thicker and more persistent. The larger number of quartz veins are entirely barren, these predominating in the districts occupied by Cambro-Silurian slates. The sulphide quartz veins are to be found chiefly in Cambrian and pre-Cambrian rocks. The results of the investigations so far carried out indicate that the gold occurs only in these quartz veins or associated with them, though seldom met with in visible form.

In regard to the original source of the gold as defined by Logan and Hunt* it would seem that the ancient pre-Cambrian rocks, having fur-

* Geology of Canada (1863), pp. 519 and 739.

nished much of the material constituting the Palæozoic sediments, it seems possible that they may likewise have yielded gold to the latter in a fine state of division as they were washed down into the ancient sea bottom. The materials composing the Cambrian and Cambro-Silurian having been thus derived, were probably carried both from the north-west and from the south-east pre-Cambrian ranges, as denudation and waste proceeded. There is a possibility, also, that the gold of these early Palæozoic rocks, if any existed in them, may have been concentrated to some extent in much the same way as in the alluviums of later geological ages, and, if so, it would be somewhat unequally distributed in the sediments. This may be one cause of its occurrence more abundantly in some areas than in others.

Probable Relation of Gold-bearing Rocks and Diorites.

Occurrence of gold in diorite areas.

The rocks of the "Eastern Townships" have undergone a great amount of shearing, plication and faulting, and the slates everywhere dip at a high angle. Besides the lateral pressure to which they have been subjected, eruptive masses have been thrust up through them, producing, in some localities, marked changes in their character and physical relations. These eruptive flows are dominant in the belts of Cambrian rocks to the south-east of the Sutton Mountain anticline, though also noted in local areas in pre-Cambrian and Cambro-Silurian districts, and seem to have been repeated at intervals throughout the geological history of the region. Dr. R. W. Ells states that "it is probable that the diorites of the several localities have come to the surface at widely different periods, for, while some have evidently exercised a metamorphosing action on the Cambro-Silurian strata, at other places the lower beds of the Cambrian are largely made up of their débris."* Although it is held that gold is more likely to occur in those portions of auriferous districts in which intrusive rocks prevail, nevertheless for the reasons stated above, no new facts bearing on this question have been elicited by our investigation. It is true, nevertheless, that the two districts in Beauce county which have yielded the most gold are those traversed by numerous diorite or diabase dykes. Intrusives also occur commonly in those portions of the Stoke Mountain range in which gold has been found. The Gilbert and Mill River districts are much intersected by dykes of these rocks, and considerable faulting and fissuring appear to have accompanied the

* Annual Report, Geol. Surv. Can., vol. II. (N.S.), 1886, p. 41 J.

outflows of igneous materials there. The basin drained by the Famine River also contains numerous diorite or diabase rocks. Similar eruptives extend along the mountain ranges, especially the Stoke and the Sutton mountain anticline throughout the greater part of the "Eastern Townships." Dr. Ells has thus described them :—"Dioritic rocks are found at many points throughout the Townships, sometimes in masses of large extent, as in the Big and Little Ham mountains, and in the peaks along the western side of Lake Memphremagog; at others, as bosses and dykes........The largest and most important areas are found in a belt which can be readily traced from the Vermont boundary, north-east for over one hundred miles, crossing the Chaudière River, and extending into the townships of Cranbourne and Ware.......

Dr. Ells's description of diorites.

"The course of the principal belt is generally north-east, following the prevailing trend of all the formations; but in Cleveland and Shipton it assumes a transverse twist which also affects the pre-Cambrian and other formations in the vicinity, and changes the strike for some miles in the townships of Wotton and Ham to an almost easterly course. The prolongation of the Melbourne and Shipton ridge, which apparently terminates at the Little Ham Mountain, after an interval of about five miles occupied by slates and sandstones, reappears in the Big Ham Mountain, which is on lot 2, range XI., Ham, and rises boldly from the somewhat flat country around its base, to a height of 1150 feet, forming a magnificent hill-feature in the landscape. Thence the diorites extend with a gradually curving outline to the north-east, crossing the road from South Ham to Garthby, and continuing through the latter township as well as the eastern part of Wolfestown, Coleraine and Thetford, where it is conspicuously marked by the large elevation of the Bull Mountain already noted.....As in the Brompton belt, diorites are more prominent at the extremities, while the central portion is characterized by the presence of serpentines, which in this direction have a great development, especially in Coleraine and Thetford, with some large areas in Wolfestown, now of great importance as the seat of the asbestus industry.....

"Smaller areas of dioritic rocks are numerous. Of these, probably the most important is seen in the township of Ascot, where it traverses the area of the copper-bearing schists, extending from lot 19, range V., of Ascot, south-westerly at intervals to lot 27, range IV., Hatley. This belt has a considerable development in the vicinity of some of the copper mines situated to the south of Sherbrooke. Diorites of more limited extent occur also on the line between Westbury and Stoke, but these are of comparatively recent age, since they have altered the slates with which they are in contact.

"In the Megantic area in Clinton, Chesham and Emberton, dioritic masses are also seen. Two prominent hills are noted, the one on lots 10 and 11, ranges I. and II., Clinton, the other on lot 25, and adjacent range VII., Clinton. They are apparently part of the chloritic slate series, and may belong to an earlier date than many of those of the central and western area."* The probable age of the diorites has also been referred to on page 149 I.

Extent of diorite masses

The superficial or areal dimensions of these dioritic masses is variable, dykes from only a few feet or yards in width to great masses, of the extent of Moose Mountain in Cranbourne (see Geological Survey map) being met with. In the Chaudière valley from the Colway River and Bras du Sud Ouest to the junction of the Du Loup, they are quite commom. The Devils Rapids, just above St. Francis, are caused by one or more bands of these eruptive rocks crossing the Chaudière valley. East of Jersey Mills, in Ste. Marguerite settlement, diorite bosses were observed.

Further west, along the upper waters of the St. Francis and in the vicinity of Dudswell, as stated, diorites occur, and here gold has been met with in the alluviums and also in the rocks. The great band of eruptives continuous with the serpentines and diorites of Coleraine and Thetford, passes to the north, as has been shown by Dr. Ells.

Coincidence of gold-bearing rocks and eruptives.

Gold-bearing rocks are thus found in a number of places associated with the great band of eruptives described. It seems to be also in rocks traversed by these that silver, iron and copper ores, chromic-iron, asbestus, etc., are met with, irregularly distributed in a broad mineralized zone. So far as known, nearly all the precious metals and ores lie within this irregular belt, except such as occur near the New Hampshire and Maine boundary.

Gold in rocks near International boundary.

Along the International boundary in the townships of Emberton, Chesham, Woburn, Clinton, Ditchfield, and as far as Risborough, gold seems also to have been furnished to the alluviums by the erosion and waste of the Cambrian and pre-Cambrian rocks. Diorites or diabases have also come up through these ancient rocks. Gold is reported to have been found in a quartz vein at or near the source of Little Ditton

* Annual Report, Geol. Surv. Can., vol. II. (N.S.), 1886, pp. 39, 40, 41, J.

River, also in Risborough and Marlow in association with the silver or galena ores met with in these localities. The pre-Cambrian source of the gold, and the conditions of its origin, especially in relation to the presence of dioritic intrusives, appear to be similar here to those of the great belt to the north-west described above.

Source of Ditton gold.

In the Little Ditton valley, which is almost wholly within the area of Cambrian rocks, the source of the alluvial gold is problematical, unless it is derived from the pre-Cambrian of the International boundary. Specimens from four of the quartz veins traversing Cambrian slates in this valley, assayed in the laboratory of the Survey, gave no traces of gold. As, however, the alluvial gold occurs most plentifully just above the bridge on the road which leads from La Patrie to Chartierville, it would seem as if its source must be local, in the Cambrian rocks. The country is densely wooded on both sides of the river, and no explorations could be made beyond the valley. Towards the sources of the Ditton River, in Emberton, Chesham and Clinton, alluvial gold has, however, been found in the gravels south of the limits of the Cambrian area.

Co-ordinating all the known facts respecting the conditions of occurrence of the gold-bearing veins and the diorite group, it would seem that they have a very close relation to each other. At Dudswell the gold was found in an arkose, possibly conglomeritic. In every other instance where it is known to occur, its invariable associates seem to be quartz and sulphides, and diorite rocks are met with in the vicinity. The coincidence between the belts of these eruptives and the districts in which traces of gold have been met with is, to say the least, remarkable.

Primary source of gold of "Eastern Townships."

The primary source of the gold of the "Eastern Townships" seems therefore, to be the crystalline schists of pre-Cambrian or Huronian age, which were invaded by diorites and other intrusives and yielded material to the basal Cambrian conglomerates, and were also probably traversed by quartz veins. These schists having furnished by their denudation a considerable portion, perhaps the chief portion of the materials constituting the Cambrian and later rocks, if they contained gold, it would be transported along with other minerals, and disseminated in a very fine state of division in the sediments of Cambrian and Cambro-Silurian age. After the consolidation of the rocks, upheaval, crumpling, faulting and metamorphism would seem to have taken place, and the gold would probably be brought up in solutions in these and concentrated along with silica and the metallic sulphides in the faults and fissures, thus forming auriferous veins.

In the latest geological ages, subaerial action has oxidized and changed the rocks into soil (rotten rock) to considerable depths. The quartz veins and their contents would also suffer similar decay with the slates, sandstones, etc., and a great reduction of the surface undoubtedly followed wherever there was sufficient slope to allow the materials to be affected by drainage waters. In the removal and transportation of this sedentary material, whatever gold was in the quartz veins and in the products of rock decay would be concentrated in channels or river-bottoms in the gravels in which it is found at the present day.

In the auriferous districts of south-eastern Quebec, there has thus been a prolonged concentration of the gold throughout several geological ages, by mechanical, chemical and other agencies, bringing it more and more into an available economic form, the latest being in the alluviums of the present river-valleys. The gold-content of these alluviums as it now exists, therefore, is really in the form of a residuum of the processes of denudation and waste, a large part of the metal having, doubtless, been entirely lost in a very fine state of comminution.

APPENDIX I.

The following statistics have been compiled from information furnished to Mr. E. D. Ingall, of this Survey, by Mr. Wm. P. Lockwood, of Montreal.

"Gold extracted by Wm. P. Lockwood from the first property acquired by him on the Chaudière, 1867-68, as shown on Robinson's map, while working to prove the continuity of the auriferous gravel, its course, width, depth, and average yield per acre. The yield was easily calculated at any point. The drives were 8 feet wide, and each set of timbers 10 feet long. Every 10 feet could be tried separately. The usual yield was from four to five ounces of gold for every eighty feet, say one dollar to one dollar and fifty cents per foot, or fully $50,000 per acre on this lead. In many places it was much above and in others much below the average. Comparing the total length of the drifts run at any time, and the total amount of gold obtained, Mr. Lockwood was enabled to make reliable estimates, many drifts run in to known barren ground not being taken into consideration.

		oz.	dwt.	grs.
1868 to 1871.	Lockwood & Co. from prospecting shafts on Miners Claims	1904	17	15
1868 to 1876.	Lockwood & Co. from Lot 15 De Lery and Lot 8 St. Charles	250	0	
1871 to 1877.	Lockwood, from two 100-foot shafts with two sets of imported machinery, heavy pumps and extensive buildings for permanent works (destroyed by fire the 13th of January, 1877—a total loss of $35,000)	1	10	0
1876 to 1877.	Lockwood & Co. opened three shafts, and drives for 150 men, complete and in perfect order, making large returns, when they were driven from their work. Thirty-five men in the month of October, took out	109	0	0
1878.	Lockwood & Co. opened three shafts on Lot 12 De Lery, with full working plant for Canada Gold Company, and obtained	970	13	17
1891-92-93.	Lockwood & Co. from two shafts, one inclined tunnel and tramway, obtained	428	15	20
		3664	7	4

"Copy of sworn returns of gold extracted from the property of the Canada Gold Co., from the 1st of July, 1880.

			oz.	dwt.	grs.
St. Charles,		McArthur Bros	458	16	0
"		La Santa Anna	29	10	
"	Lots 10 & 11.	Thos. Richards	1625	13	

				oz.	dwt.	grs.	
De Lery,	Lot	12.	Grenville Mg. Co. of Ontario..	41	7	10	
"	"	13.	Clarence Gold Mg. Co.........	1311	10	9	
St. Charles	"	12.	Geo. Therien & Co............	60	7	14	
De Lery,	"	13.	Cameron, Gibson & King.....	56	6	20	
"	"	"	McDonald, Powers & Potvin..	17	10	0	Tailings
"	"	14.	Chas. Lionais.............	27	6	20	
"	"	"	Beauce Mg. & Milling Co......	324	1	2	
"	"	15.	John McRae..............	45	7	11	
"	"	16.	East Branch Co............	12	16	12	
"	"	"	Béribe & Cie................	3	19	15	
"	"	17.	Chaudière Mg. Co............	0	17	10	
"	"	7 & 18.	Sands and Spaulding..........	4	4	23	
"	"	18.	Victoria Co................	2	9	19	
"	"	20.	Jas. Reed	3	8	14	
St. Charles,	"	12.	Onésime Dion	3	16	0	Tailings
"	"	13.	Hugh M. Gillis............	4	11	10	
"	"	"	Jean Lefebre....	1	4	12	
"	"	"	A. Walker....	3	4	22	
"	"	12 & 13.	E. Fenton..	24	7	0	Tailings
Devil's Rapids,			L. Blanchet....	1	1	0	
St. Charles,	"	11.	Jas. Forgie................	114	14	11	
"	"	"	Gilbert Tomlinson...........	118	0	5	
"	"	11 & 12.	St. Onge & Cie.............	1001	13	13	
"	"	"	Powers, Brack & Co	1	13	6	Tailings
De Lery,	"	13.	V. Coupal & Co............	10	3	20	
"	"	18.	L. Gendreau................	22	14	1	
1st Range,			John McNicholl.........	4	0	0	
Rivière des Plantes,			Billy Poulin & Co............	8	0	6	
St. Charles, Lot		12.	Canada Gold Co..............	3306	14	21	
Gold dust and nuggets bought by Renault, Potvin and others from parties working within limits........				284	5	0	

Certified 8th June, 1887,

(Signed) H. J. J. DUCHESNAY.

J. G. M. D.

(Copy.)

"Gold extracted ...... from the grounds of Wm. P. Lockwood & Co., from 1876 to July 1st, 1880, by the persons named as follows:—

		oz.	dwt.	grs.
1876 to 1877	Sands, Oldson & Miller, three of Mr. Lockwood's regular workmen, from lot 11, St. Charles, reported in the first five months	205	18	5
	Made no returns afterwards, but obtained at least...	200	0	0
	Total...........	405	18	5
	or			$7,290

1876 to 1877.	Gold obtained as above stated by Sands, Oldson and Miller, valued at...........	$ 7,290
1876 to July 1, 1880.	Jack St. Onge, one of Mr. Lockwood's foremen, who worked for him 8 years, joined his brother and six miners, and having made arrangements with farmers for land on Lot 11, St. Charles, obtained Government licenses and show a return of..	$ 75,000
1877 to July 1, 1880.	The St. Onges commenced working on Lot 12. They were holders of Government gold mining licenses, and stated that they won in gold	$190,000
	The ground worked was about four acres, which shows the average yield of gold, as reported by Mr. Lockwood, to be about $50,000 per acre for the main Gilbert lead.	
	The St. Onge Company stated that they took out, with forty men, about 8 ounces of gold per day, or an average of $3.60 per man.	
	In addition to the above the sworn Government returns from July 1st, 1880, to 1885, show a production of..............................	$160,516
	Total...	$ 432,806

"Before July 1st, 1880, many of those working on Mr. Lockwood's grounds made large returns, but it was not possible to arrive at the facts. The Beauce Mining and Milling Co., and C. W. Kempton, M.E., in their pamphlets state that, previous to 1881, $400,000 worth of gold was taken from three-fourths of an acre on lot 14, DeLery.

"A number of other companies wrought between lot 11, St. Charles, and lot 15 DeLery, but it was not possible to obtain any account of the gold they obtained, until Flynn's Mining Act of 1880, came into force, or ..... until the courts in December, 1883, declared the DeLery title valid.

In addition to the foregoing statement of the gold production of the Gilbert, Mr. Lockwood shows a receipt from the U. S. assay office, New York, for gold bullion of the value of $1,194.96, deposited there in 1892.

APPEN

LEVELS OF GOLD WORKINGS, GILBERT

The datum of these levels is the junction of the Gilbert and the

Heights of shafts above river.	No. of shafts—Lots—Concessions.	Depth of shaft.	Depth to pay gravel.	Depth to bed rock.	HEIGHTS River opposite shaft.	Top of shaft.
ft.		ft.	ft.	ft.	ft.	ft.
	St. Charles.					
	A Lot 8	12	11	12	206·5	130·6
	B Lot 8	12	11	12		
	1 Lot 8	44	44			
11	2 "	54	54		139·0	150·0
6	3 "	38	38			
5	4 "					
	St. Charles.					
	5 Lot 7	35	35			
	X "	64	64			
	6 "	33				
5	6A "	100	83	97	156·5	161·5
	6B "	83	83			
	St. Charles.					
	C Lot 9	12				
	D 10 A Lot 9	21				
8	7 "	70	none.	70		
	St. Charles.					
	Lot 11	63	56	63	201·5	239·5
	"					
St. Onge Sands & Co.	"	37	none.	37*		
	"	38			201·5	216·3
4	8 Lot 12	60	none.	60	208·0*	212
6	9 "	9		9	212·7*	218·7
10	10 "	25	none.	25	212·7	222·7
38	11 "	60	52	60	212·7	250·7
42	12 "	64	58	64	212·7	253·0
	13 "	40				
		67·6	56	65·6	201·5	
		78·6	66·6	76·6	218·5	273·0
8	14 Lot 13 A / " B	27	none.	27		
	"					
	"					
	"					
	DeLery.					
22	1 Lot 13	79	61	63	246	272
5	2 "	40	31·6	35·6	246	249
	Miners' Claims					
	Lot 12	69	56	69	278·7	322·7
	16	78	55	78	274·0	327·0
	18	78				
	23					
	24					

*Approximate elevations.

DIX II.

RIVER, CHAUDIÈRE DISTRICT, QUE.

Chaudière rivers, approximately 515 feet above sea-level.

ABOVE DATUM.			
Top of pay gravel.	Bed rock.	River at nearest point levelled.	Remarks.
ft.	ft.	ft.	
117·6	118·6	....	These shafts 4 to 5 ft. above river, on sma
....	....	....	
....	....	....	Not bottomed, struck water and filled.
96·0	....	....	do do do
....	....	....	
....	....	....	
....	....	....	do do do
....	....	....	do do do
....	....	....	
88·5	64·5	....	Overflowed.
....	....	....	Not bottomed, works destroyed by fire.
....	....	....	
....	....	....	
....	....	....	
183·5	176·5	....	A. Lockwood & Co., No. 1.
....	....	....	" " No. 2, about same as No. 1.
....	....	....	Drifted from shaft into the hill to the lead.
....	178·3	....	Tunnelled into hillside above the ditch, about 15 ft. above river, and sank shaft to bed-rock.
none.	152	....	
....	209·7	....	
none.	197·7	....	
198·7	190·7	....	
195·0	189·7	....	
....	....	....	4 ft. Test shaft.
....	....	....	A L. & Co. No. 3, near line of 11 & 12 about same as 1 & 2.
206·6	196·6	....	W. P. L., near line of 12 & 13.
....	....	218·5	
....	....	....	No particulars.
....	....	....	
....	....	....	
211·0	209	246	Depth of shafts from top of timbers 82 ft.
218·4	214·4	246	do do do 43 ft., chainage 202·37 to here.
266·7*	253 7*	....	N. B. Line of 15 & 16.
272·0*	249·0*	....	
....	....	....	
....	....	....	
....	....	....	

The foregoing table is incomplete, the data for some of the shafts not having been furnished. There are also some discrepancies, noted by Mr. Ingall on the MS. in his possession. Taken along with Mr. Wm. P. Lockwood's report quoted in previous pages, however, it gives a number of valuable details regarding the old workings of the Gilbert valley, now all filled in and closed.

APPENDIX III.

Notes on the chainage and levels of the Gilbert River, St. Francois, Beauce county, Quebec, by Arthur Lockwood.

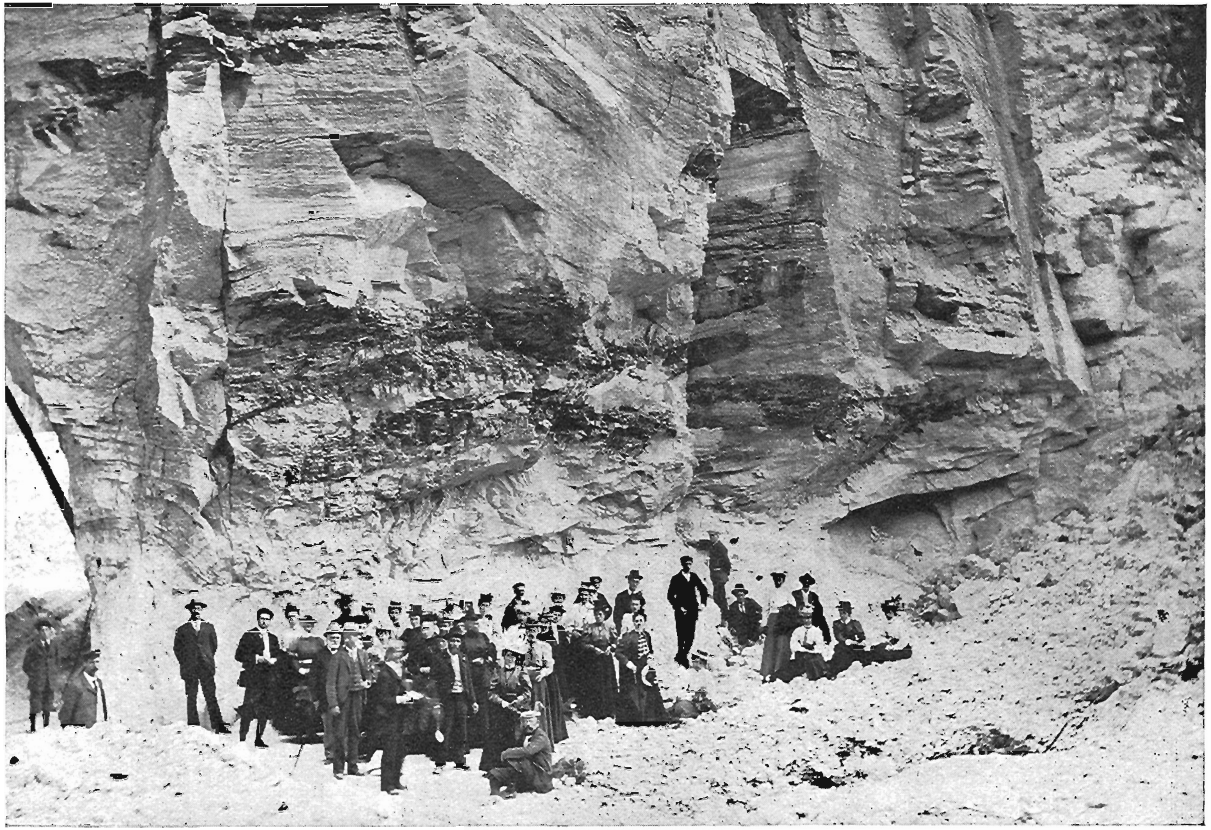
The datum is the junction of the Gilbert River and the Chaudière 515 feet above sea by aneroid, based on the height of St. Francois station, Quebec Central railway. From this point also the chainage was reckoned, following the sinuosities of the river.

Chainage and Levels from the mouth of Gilbert River to Lot 15, DeLery Concession :—

——	Chainage.	Levels.
	ft.	ft.
East line of 1st range, N.E.	8,142	130·6
Lot 7, St. Charles concession	11,415	151·2
Just below mouth of Caron Creek	11,540	156·5
Lot 10, St. Charles, concession	14,297	181·2
" 11, " "	16,346	201·3
" 13, DeLery "	19,713	224·0
" 15, " "	22,462	278·7

From Lot 15, DeLery Concession, to the Cranbourne line :—

——	Chainage.	Levels.
	ft.	ft.
Mouth of N.E. Branch, Lot 16, DeLery	22,669	281·0
Line of Lots 16 and 17, DeLery	23,067	....
Foot of American Gold Mining Co.'s works, F. Wadsworth & Co., Lot 18	23,992	307·1
Line of Lots 18 and 19, DeLery	24,529	314·5
At line of Lots 20 and 21, DeLery, Foot of dam	25,819	349·5
At line of Lots 20 and 21, DeLery, Top " "	25,819	353·0
Line of Lots 21 and 22, DeLery	26,752	363·3
Foot of falls	27,091	366·5
Top of falls	....	372·1
Foot of falls and rapids at saw-mill, about line of Lots 22 and 23, DeLery	28,326	387·5
Top of falls and rapids above mentioned	28,400	399·2
Foot of small falls, Lot 25, DeLery	29,425	415·8
Lower side of bridge at road between Lots 25 and 26, DeLery	29,926	423·5
About line of Concession Chaussegros	32,121	445·9
" " " St. Gustave	37,586	534·2
Lower side of Lot 31, Fraser, S.E.	40,572	616·2
On hill at Atkinson's dam, Lot 43, Fraser, S.E.	46,911	709·9
Head of swamp at Cranbourne line	....	720·0



INTERIOR VIEW OF GYPSUM QUARRY, HILLSBOROUGH, ALBERT COUNTY, N.B.

GEOLOGICAL SURVEY OF CANADA
G. M. DAWSON, C.M.G., LL.D., F.R.S., DIRECTOR

THE

MINERAL RESOURCES

OF THE

PROVINCE OF NEW BRUNSWICK

BY

L. W. BAILEY, PH.D., LL.D., F.R.S.C.

OTTAWA
PRINTED BY S. E. DAWSON, PRINTER TO THE QUEEN'S MOST
EXCELLENT MAJESTY
1898

No. 661.

ERRATA—PART M.

Page 13, line 23—" north-east" read " north-west."
" 14, " 17—" were" read " the furnace was."
" 17, " 29—" south" read " east."
" 19, " 14—" Borestown" read " Boiestown.'
" 27, " 27—" showing" read " showed."
" 28, " 32—" east" read " north."
" 55, " 5—" north-east" read " west."
" 115, " 12—" Tattagouche" read " Tête à Gauche.

To

DR. GEO. M. DAWSON, C.M.G., F.R.S.,

Director Geological Survey of Canada.

SIR,—I have the honour to submit the following Report upon the Mineral Resources of New Brunswick, made in compliance with your instructions received May 26th, 1897.

The data upon which the report is based have been derived in part from the published reports of members of the Survey staff and others, from information furnished by persons engaged or interested in mining operations, and finally from observations made by myself during the past season with a view to obtain the latest facts bearing upon the subjects discussed.

I would desire here to return my thanks to the many persons by whom aid has been rendered, more particularly to Hon. A. T. Dunn, Surveyor General of New Brunswick, and the officials of the Crown Lands and Mining Departments at Fredericton, for lists of mining licenses issued, and other information; to C. J. Osman, Esq., M.P.P., manager of the Albert Manufacturing Co., for an historical and descriptive sketch of the extensive operations in the manufacture of gypsum at Hillsborough, Albert county; to Major Alfred Markham, for valuable information relative to the mining of manganese; to Messrs. Milne, Coutts & Co., St. George, for information relative to the growth and conditions of the red granite industry; to Mr. R. P. Hoyt, of Hillsborough, for particulars of the deposits of bog-manganese recently opened at Dawson Settlement, Albert county, and the conversion of this material into briquettes for use in steel manufacture; to Mr. C. E. Fish, of Newcastle, Northumberland county, for data regarding the manufacture of building-stone, grindstones, etc.; to Robt. McMahon, of Grand Lake, for information respecting the working of the coal mines of Queens county; to Mr. Charles Boardman, of Calais, Maine, for data and other assistance in connection with the nickeliferous pyrrhotite deposits of St. Stephen, Charlotte county; and to Prof. W. F. Ganong, of Smith College, Northampton, Mass., for facts relating to peat-bogs and siliceous deposits in different parts of the province.

I have the honour to be, Sir,

Your obedient servant,

March, 1898. L. W. BAILEY.

NOTE.—Some further data, obtained during the summer of 1898, have been added by Professor Bailey to his Report as presented in March of that year.

NOTE.—*Unless otherwise stated, the bearings in this report are all referred to the true meridian.*

THE

MINERAL RESOURCES OF THE PROVINCE OF NEW BRUNSWICK.

INTRODUCTION.

If the past history of mineral production in New Brunswick be alone considered, this province certainly can not be claimed with truth to be a country of great mineral wealth. Indeed, if we except building stones and other materials applicable to construction, such as gypsum, limestone, brick-clays, etc., there are but four substances that, in the whole history of the province, have been the basis of anything like extended or successful mining operations, viz., coal, iron, manganese and albertite, and of these one only, namely, coal, is at the present time actually being worked. New Brunswick as a mineral producer.

Is the conclusion, then, to be drawn that New Brunswick is without useful minerals, or that, its limited supply being already exhausted, there is no reason to hope for anything further in this direction in the future?

The question would under any circumstances be an important one, but is specially so in view of the fact that, while the products of the forest, upon which the province in its earlier history depended so largely for support, are rapidly becoming reduced in quantity and value, the tracts which are being deforested are to a large extent unsuited for agriculture, and hence, unless something can be found beneath the surface to replace the deficiency, the revenues of the province must suffer considerably. The importance of the subject.

In endeavouring to answer the question proposed, everything which either directly or indirectly bears upon it, is deserving of consideration; and viewed thus comprehensively, a number of facts are brought to light which go far to give a much more favourable view of the situation than would at first seem possible. Among these the following are the most important:— Favourable facts.

1. *The variety of useful products actually observed in New Brunswick.*—These include:—among metallic ores; iron, in the forms of Variety of minerals found.

hæmatite, limonite and magnetite, besides pyrite and pyrrhotite manganese, as pyrolusite, mangantite and wad; copper, as native copper, and various sulphides; lead, as galena, usually with a small percentage of silver; zinc, as blende; antimony, as native antimony and stibnite; nickel sulphide, in pyrrhotite and serpentine; bismuth as a sulphide; and gold. To these must be added, among substances affording combustible products, bituminous coal, anthracite, bituminous shale, cannelite, albertite, petroleum and peat; among materials for construction, granite (gray, black and red) freestone, slate, limestone and marble, gypsum, clays and sands; besides graphite, salt, infusorial earth, silica, fire-clay, mineral water, etc. It is true that many of these substances, especially in the case of metallic ores, are not known to occur in other than small amounts; but the fact of their occurrence at all is important, in rendering it at least possible that any one of the substances enumerated may hereafter be found in profitable quantities.

Variety of geological formations.

2. *The number and character of the geological formations represented in the province.*—These include all the subdivisions of the geological scale, from the earliest Archæan to the Trias; while those formations, such as the Laurentian, Huronian and Cambrian, which elsewhere are usually most productive of metallic ores, and the Carboniferous formation yielding coal and related products, are among those which occupy the largest areas. As regards the former, it is also important to notice that the beds representing them have very generally been subjected to profound disturbance with its accompanying metamorphism; or, in other words, to the conditions most favourable to the occurrence in them of useful minerals and ore-bodies. The general resemblance and probable equivalency of some of the most important of these groups of strata to those of the bordering provinces of Quebec and Nova Scotia, as well as the state of Maine, all of which have proved more or less productive, is not without significance in the same direction.

Disturbances.

Distribution.

3. *The distribution of useful products.*—The occurrence of many of the mineral products above enumerated, not at one or two points only, but over large areas, is worthy of notice. Thus the iron ores of Woodstock extend through the greater part of Carleton county; copper ores characterize the Archæan rocks of the southern coast along the whole length of the Bay of Fundy; bituminous shales, with more or less of albertite, extend from Apohaqui, Kings county, almost to Dorchester, Westmorland county; the coal of the Newcastle basin, Queens county, though thin, covers an area of about 100 square miles, and outcrops, which may represent the same seam, are found over almost all parts of

the Carboniferous area, or a tract equal to one-third the entire superficies of the province; manganese is found at not less than six widely separated points, and antimony in at least two localities quite remote from each other.

4. The possible concealment of economic minerals by soil and forests, together with the absence of systematic prospecting.—While the facts above enumerated are, as stated, distinctly favourable to the existence within the province of useful minerals, the circumstances here alluded to go far to explain why such possible existence has not, except in a few cases, been definitely confirmed or disproved. It is only necessary to examine a good map of the province to see that large portions of its extent, including just those districts whose geological age and character would point them out as most likely to be productive of useful minerals, are still covered with unbroken forest, and hence are rarely visited except by those whose training and occupations would be little likely to make them close observers in this direction. These tracts have, indeed, been traversed by the members of the Geological Survey staff in various directions, and attention has been continually given by these gentlemen to the possible occurrence of useful products along such lines of traverse; but the main work of the explorers has been the determination of the age and character of the formations represented and the delimitation of their boundaries, rather than that of systematic prospecting, for which they have only paved the way. It is still true that very little of such prospecting has been done, and in its absence it would be wrong to assume too hastily that nothing worthy of discovery exists because so little has yet been found. The probabilities point strongly to an opposite conclusion, and one of the main objects of this report will be to suggest methods and directions through which, it is hoped, the present uncertainty may be removed, and the province may attain, to a much greater extent than at present, the position of a mineral producing country.

Concealmen by forests.

Absence of systematic prospecting.

The considerations above given afford a basis for the method of treatment adopted in the Report. A short account will first be given of the general geological structure of the province, and of the areas likely to be productive respectively of metallic ores, of carbonaceous materials, of granites, of freestones, of limestone, salt and gypsum. In a second division of the Report, full details will be given of the extent and mode of occurrence of all useful products so far observed, with particulars as to the history, development and output of all such as have been or are now being profitably worked; and in a third division some suggestions will be made, which, it is hoped, may help to

Subdivision of report.

awaken new interest in the subject on the part both of the government and the people of the province, and possibly lead to results of which the outcome cannot now be anticipated.

Economic Geology of New Brunswick.

The following is a summary of the geological formations represented in New Brunswick, with a brief statement of their distinctive features, their distribution and the minerals which they afford :*—

Laurentian system.

1. *Laurentian.*—The rocks referred to in this system are, so far as known, confined to the area of the southern counties, where they form a belt of land intersected by the St. John River between Fairville and the Kings county line, stretching thence westward to Musquash Harbour and Lepreaux, and eastwardly along the southern side of the Kennebecasis River, and near the line of the Intercolonial Railway, to and a little beyond the mouth of the Hammond River.

Rocks.

The rocks included under this system are all highly crystalline, the lower portion, of unknown thickness, consisting chiefly of coarse gneiss and granite, while the upper, estimated as having a thickness of over 1000 feet, exhibits a succession of quartzites, slates, limestones and dolomites. These beds are greatly folded and faulted.

Economic products.

The economic products afforded by the Laurentian rocks include granite, limestone (extensively quarried and calcined), graphite and magnetite. Serpentine occurs, and in places carries small veins of asbestus. There are also veins of argentiferous galena, apparently small, but which have not yet been fully proven.

Huronian.

2. *Huronian.*—The rocks distinctly referable to this system are also confined to southern New Brunswick, where they occupy extensive areas in the counties of St. John, Kings, Queens, Albert and Charlotte. With the exception, indeed, of the small Laurentian tract already noticed, and belts of intrusive granite such as constitute the axis of the Nerepis Hills, all the prominent ridges of the counties named are composed of Huronian rocks. In the northern part of the province, about the head-waters of the Tobique, Miramichi and Nipisiguit rivers, are other considerable areas which are almost certainly Archæan, and probably Huronian, but of which the age has not yet been indisputably fixed.

Distribution.

*New Brunswick has been geologically mapped on a scale of four miles to one inch. The areas covered by the respective sheets is shown on the index map accompanying this Report. The surface geology and extent of forest are shown on a second series of sheets, of which ten have already been issued. These are also indicated on the index map. The price of the above map-sheets is ten cents each.

The Huronian rocks of the southern counties consist very largely of volcanic materials, in the form of amygdaloid, felsite, ash-rocks and breccias, variously mingled with aqueous sediments such as conglomerates, sandstones, slates and some limestones, all metamorphic, and all showing evidence of profound disturbance. The thickness of the formation is very variable, but at its maximum cannot fall far short of 10,000 feet. In the northern counties, the lithological aspects are somewhat similar, but the strata embrace a larger proportion of schists and felsites, with less of the more obviously volcanic materials. Character.

The rocks of the Huronian system, are here, as elsewhere, very generally characterized by the presence of useful minerals. Veins of magnetic iron are a common feature in certain members of the system, while in others are found considerable deposits of specular ore, hæmatite and siderite. The nickel-bearing pyrrhotites of St. Stephen are in rocks which are probably of this age. To the same system also belong the numerous veins of copper ore found at various points along the north shore of the Bay of Fundy as well as in the interior, the Huronian being in fact the copper-bearing series of New Brunswick, recalling in this, as in many other respects, the copper-bearing rocks of the "Eastern Townships" of Quebec. Minerals.

3. *Cambrian and Cambro-Silurian.*—For the purposes of this Report the rocks of these two systems may well be considered together, for although in southern New Brunswick the existence of both has been clearly shown upon the evidence of fossils, the areas known to be occupied by the Cambro-Silurian rocks are quite insignificant; while in the northern part of the province, though the districts referred to this latter system in the reports and maps of the Survey are large, distinctive fossils have been found at a few points only, and it is now thought probable, that the larger part of the region so referred is in reality Cambrian. In subsequent references therefore the latter term alone will be used.

The Cambrian rocks of southern New Brunswick, occupy relatively but a small area, being confined essentially to three parallel troughs, of which the first crosses St. John harbour, and thence extends eastward by Coldbrook and Loch Lomond to the Hammond River in Upham, the second is represented in isolated patches in the valley of the Kennebecasis, and the third is confined to the valley of the Long Reach, chiefly along its northern side. The strata are mainly dark-coloured slates and sandstones, with some coarse red sediments beneath, but as far as known, contain no minerals or rocks of economic importance. Distribution in southern New Brunswick.

Distribution in northern New Brunswick.

The supposed Cambrian (possibly Cambro-Silurian) rocks of the northern counties, have a much wider distribution, being found in two principal belts which, upon either side of an extensive granitic axis, stretch completely across the province from the Maine frontier to the Gulf of St. Lawrence. The width of these belts, as fully indicated in the published maps of the Survey, is subject to considerable variation (ranging from three to twelve miles) but the nature of the strata is much more uniform, the rocks of the system consisting, as in the southern counties, mainly of slates and hard sandstones or quartzites which are very much alike wherever found, except that in approaching the granite they become more highly metamorphic, taking the character of fine gneisses and mica-schists, in this as in other respects bearing a very close resemblance to the rocks of the gold-bearing system of Nova Scotia, which are in like manner doubtfully referred to a Cambrian horizon.

From an economic point of view, the strata in question are among the most important to be found in the province. Long since compared by Sir Wm. Logan with the rocks of his Quebec group (now known to contain both Cambrian and Cambro-Silurian strata), they are, like that group, largely metalliferous, and constitute areas that, already to some extent productive, are those in which future developments of importance are chiefly to be looked for. In these rocks are included ores of iron, copper, manganese and lead, in Gloucester county; of copper in Carleton county, and of antimony in York county; while it is also in the area which they occupy that many of the reported discoveries of gold have been made. The rocks are throughout highly disturbed and in places abound in quartz veins, many of which contain mispickel or other metallic sulphides.

Economic minerals.

Silurian.—The rocks of this system have a wide distribution in New Brunswick, but are relatively unimportant from an economic standpoint.

Distribution in southern New Brunswick.

In the southern part of the province they are found skirting the borders of Passamaquoddy Bay and portions of the valley of the St. Croix River, whence they extend eastward in two main belts, one on either side of the Nerepis granite range, to the St. John River. The strata are chiefly slates and sandstones, largely associated with volcanic products, but with the exception of some rocks available for construction or for decorative purposes (slates and porphyries) afford few if any materials of a useful character.

Distribution in northern New Brunswick.

In northern New Brunswick the Silurian rocks are widely spread, covering most of the area included in the counties of Victoria, Mada–

waska and Restigouche, with portions of York and Gloucester, and determining a district of remarkable fertility and valuable forest growth. They are interesting economically chiefly as containing the iron ores of Carleton county. Small veins of galena are occasionally met with, as well as beds of limestone, and drift gold has been reported from localities within the district.

Devonian.—The Devonian rocks are confined to small areas in St. John county, such as the Mispeck valley and Lepreau basin, and (probably) to a somewhat larger tract lying just south of the central coal-fields in Queens and Charlotte counties. The impure anthracites of Lepreau, together with slates and flags in the county last named, are the only mineral substances of interest. Devonian

Lower Carboniferous.—Though geologically but a subdivision of the Carboniferous system, the formation designated as Lower Carboniferous is in New Brunswick, as in Nova Scotia, strongly differentiated from the proper Carboniferous or Coal Measure rocks, by dissimilarity of character and origin, by difference of fossils, and by at least a partial unconformity. The contrast as regards economic minerals is equally marked and important.

In the southern counties, the Lower Carboniferous rocks, usually readily recognized as consisting of coarse red sediments, which are more or less calcareous and contain marine fossils, occupy large areas in Kings, Albert and Westmorland counties, with smaller areas in Charlotte. In central New Brunswick they are mostly concealed from view by overlying Coal Measures, but appear as a rim or margin to the latter around almost the entire extent of the large triangular tract which these Coal Measures cover, beside occasionally protruding through them. In northern New Brunswick they cover a considerable tract in the valley of the Tobique River, with smaller areas on the Beccaguimec River in Carleton county, and on the shores of Bay of Chaleurs. Distribution.

The useful minerals of this formation are numerous and important, including bituminous shale, cannelite and albertite, with some petroleum, in Albert county ; the extensive gypsum (plaster) deposits of the same county and of Kings, with associated bituminous limestone ; the manganese deposits of Markhamville and Jordan mountain, (Kings county) ; Shepody Mountain, (Albert county), and Quaco, (St. John county) ; the salt and other mineral springs of Kings county ; the gypsum deposits of the Tobique River in Victoria county. Useful minerals.

Carboniferous.—The rocks of the Coal Measures cover nearly one-third of the entire area of the province, but owing to their generally Distribution.

horizontal attitude have, with large surface extent, apparently but little thickness and but little coal. The principal tract is in the centre of the province, in the form of a triangle, of which the apex is at Oromocto Lake, and the base along the so-called "North Shore," between Bathurst and Cape Tormentine, there becoming continuous with the coal formation of Nova Scotia. Smaller areas occur in Kings, Albert and Westmorland counties, as well as along the shore of the Bay of Fundy in St. John county. In the last-named instances the beds are, as a rule, more highly disturbed, but still usually without evidence of much thickness or of workable coal-beds.

The subject of the occurrence of coal will be more fully considered later in this report.

Economic products.

Besides bituminous coal, the Carboniferous rocks afford valuable building materials, such as freestones of gray, purple and olive colours, also grindstones, stones for pulp-mills, fire-clays, etc.

Triassic.—The rocks of this age, in the form of soft, red, friable sandstones, as occurring on the mainland of New Brunswick, are confined to small tracts along the Bay of Fundy shore, chiefly in the vicinity of Quaco. They are without economic interest.

On the island of Grand Manan, the volcanic beds of the same system are largely displayed, and may in the future become useful for road-making; but, with the exception of nodules of native copper, too small and infrequent to admit of profitable removal, they contain no minerals of value.

Granite.

Granite.—Very large areas in New Brunswick are occupied by this rock. Two main belts may be distinguished, of which the more northerly and larger crosses the central part of the province from the St. Croix River, north of Vanceboro, to the Nipisiguit River, but with much irregularity in detail, while the second, or southern belt, also somewhat irregular in outline, forms the axis of the Nerepis Hills, and extends from the St. Croix River, below St. Stephen, to the St. John River, at Spoon Island. Smaller areas are met with in the Quaco Hills in eastern St. John and Albert counties.

These granites present much variety of colour and texture, the red granite of St. George being especially noteworthy. They do not carry ores of any kind.

Surface deposits.

Pleistocene.—Under this name are comprised the superficial deposits of sand, gravel and clay distributed over the preceding formations as the result of glacial, marine or sub-aerial action in post-Tertiary and recent times. In the same connection occur deposits of so-called infusorial earth or "tripolite", deposits of silica, not of organic origin, and beds of peat. The clays are available for the manufacture of bricks and pottery, the silica and tripolite as abrasive material and in the manufacture of dynamite, the peat for use as fuel and the manufacture of moss-litter. The materials employed in the macadamizing of streets and highways are also largely drawn from this source.

Iron.

Iron. The ores of iron found in New Brunswick include the hæmatites and limonites of Carleton county; hæmatites and specular ores of Black River and West Beach, St. John county; magnetites found in western St. John and Charlotte counties; with deposits of bog-iron from various localities.

Ores of Carleton county.—As these have been very fully described, in previous reports of the Survey, only a brief summary of the facts, with references, will be given here.

Woodstock ores. What are commonly known as the Woodstock hæmatite beds, were first brought to public notice in the year 1836, by Dr. C. T. Jackson, of Boston, in connection with a geological survey of portions of the State of Maine, then being made by him. Subsequent explorations, made by the officers of the Canadian Geological Survey and others, showed that these beds, probably in more than one belt, extend across the principal part of the county of Carleton,* but have their greatest thickness and are most readily accessible in Jacksontown, about three miles north-east of the town of Woodstock. They are here, as elsewhere, associated with a series of slates, usually bluish or grayish in colour and highly calcareous, but, when in connection with the iron ores, commonly becoming more or less reddish or greenish. At various points, though not at Jacksontown, the slates are associated with beds of limestone, and in both are contained fossils showing them to be members of the Silurian system. Their exact horizon has not yet been certainly fixed, but it is probable that they are of about the same age as that of many of the iron-bearing beds of Nova Scotia, *i. e.* near the summit of the Silurian.

Distribution. Age.

Nature of ore-beds. As seen at Jacksontown and vicinity, the ore-beds are quite numerous, having a thickness ranging from one foot to sixteen feet, and are conformable to the inclosing slates which usually dip north-westerly at an angle of 85°, although in places much contorted. Individual beds, however, when followed, are found to exhibit notable variation in width. In places they contain considerable quantities of manganese,

*Annual Report, Geol. Surv. Can., vol. I. (N.S.), 1885, p. 20 G.

which also often gives a black colour to the slates, while occasionally green stainings indicate the presence of copper. Slickensided surfaces, indicative of shearing and vertical displacements, are not uncommon. The ores also vary in composition, usually yielding water when heated, and consisting of admixtures of limonite and hæmatite. The average of six analyses* of ore from Iron Ore Hill, made by Mr. John Mitchell, of London, and quoted by Dr. Ells gave† :—

Analysis.

Metallic iron	35·593 %
Sulphuric acid	·723
Phosphoric acid	1·298

Production.

The first attempts to utilize the Jacksontown ores were made in 1848, when a blast-furnace was erected by the Woodstock Charcoal Iron Company upon the bank of the St. John River, a short distance above Upper Woodstock, and about two miles and a half from the ore-beds. Ore was obtained by the ordinary process of quarrying, and, according to information supplied to the writer by the manager, Mr. Norris Best, were charged as follows :—

Ore	1,350 lbs.
Limestone	70 "
Charcoal	20 bush.

According to statements quoted by Dr. Harrington,‡ 3·33 tons of ore and 126 bushels of charcoal were required to make a ton of pig-iron, the charcoal (in 1865) costing 7 cents a bushel. "There were 10 charcoal kilns, having an average capacity of 75 cords of wood and a production of 2800 to 3200 bushels of coal. The quantity of ore used was, on an average, three tons to the ton of pig, and the cost at the furnace, $1.20 per ton." The cost of pig produced was $20 to $22 per ton.

urnaces.

The first furnace, erected in 1848, was 39 feet high, 33 feet square at the base and 9¾ feet at the boshes, with three tuyere arches and a capacity of about seven tons a day; while a later and smaller one built in 1863, was inclosed in boiler-plate, had a circumference of 40 feet, and a capacity of 5½ tons per day.§ Both were lined with Stourbridge bricks, a sandstone from the Gulquac, one of the tributaries of the Tobique, being used as a hearth. The "hot blast" was used, the steam necessary for the purpose being obtained from suitable boilers,

*The numerous assays, analyses, etc., of ores and minerals quoted throughout this Report, are given on the authority of the authors only, except in the case of examinations made in the laboratory of the Survey.

†Report of Progress, Geol. Surv. Can., 1874-75, p. 104.

‡Report of Progress, Geol. Surv. Can., 1873-74, p. 252.

§R. W. Ells.

which were in turn heated by combustion of waste gas from the furnace head. The average duration of each crucible and hearth was about 24 weeks, during which time an average production of 50 tons per week was attained. The limestone employed as a flux, was obtained from the Beccaguimec River, seven miles distant from the furnaces. The operations were subject to numerous interruptions, made necessary for repairs, and it is stated that the whole time during which the principal furnace was in blast was only about eight years.*

Iron smelting at Woodstock is now, however, a thing of the past. Is it possible to look forward to a resumption of operations? Possible future.

In attempting to answer this question many considerations arise, the main one being, of course, the cost of manufacture and transportation to market. The figures as to the former, already given, are based upon the conditions at the time of working, or about thirty years ago. Since then a much larger proportion of Carleton county has been denuded of forest, especially in the vicinity of Jacksontown, and the cost of fuel has been considerably increased. It is not, however, probable that this alone would prevent the ores being worked, more especially as their position, on the bank of the St. John River, is in every way favourable to the easy and cheap removal of the product. A more serious difficulty is to be found in the nature of the product itself, which owing to the high percentage of phosphorus, was often found to be brittle or cold-short to a degree which detracted very materially from its value. On the other hand, it is difficult to reconcile this deficiency with the statements given as to experiments made in England with armour-plates constructed of Woodstock iron, which, according to a paper by Mr. Wm. Fairbairn, F.R.S., published in the *Artizan*, had a resistance in excess of that of any other plates then tested, or a tensile strength in tons per square inch of 24·80. It is also to be observed that the presence of phosphorus is not now the serious objection to the use of iron ores that it formerly was, the introduction of the basic process of Thomas and Gilchrist, making it possible to reduce such ores effectively. It is also not impossible that processes may be introduced whereby the extensive deposits of nickeliferous pyrrhotite occurring near St. Stephen, may be used in connection with the Woodstock ores, the combination, after the removal of sulphur, affording an iron suited for the manufacture of armour-plate.

Cost of fuel.

Presence of phosphorus.

Tensile strength.

While, then, it is doubtful whether, in the present condition of the iron industry and in the face of adverse tariffs, the Woodstock ores

* Dr. B. J. Harrington.

could be worked with profit, they must still be looked upon as valuable assets, which changed methods of treatment and changed commercial conditions may at any time bring again into prominence.

The following lists of publications referring in various ways to the Woodstock ores, may be of service to those seeking further information upon the subject :—

Bibliography.

Abraham Gesner. Geological Report, 1842. This author asserts that the ore had been sent abroad and examined as early as 1820.

Chas. T. Jackson. Reports on the Geology of Maine, 1836.

Geo. L. Goodale. Seventh Annual Report Maine Board of Agriculture.

Wm. Fairbairn. London *Artizan*. This paper gives accounts of experiments illustrating the tensile strength of armour-plates in the making of which Woodstock ore was used. This tensile strength is quoted in tons per square inch as 24·80.

L. W. Bailey. Report on Mines and Minerals of New Brunswick, Fredericton, 1864, pp. 55–59.

H. Y. Hind. Preliminary Report on Geology of New Brunswick, 1864.

B. J. Harrington. Report of Progress, Geological Survey of Canada, 1873-74. p. 251.

R. W. Ells. Report of Progress, Geological Survey of Canada. 1874-75.

West Beach hæmatite.

West Beach.—This locality is twelve miles east of the city of St. John, and not far from the shore of the Bay of Fundy. The ore is mainly a dark reddish-brown hæmatite, contained in the upper part of a large bed of coarse reddish gray conglomerate, but associated with quartz veins containing more or less micaceous or specular iron. The deposit is probably of pre-Cambrian (Huronian) age. Only a small quantity of this ore has been removed, and that many years ago.

Black River ores

Black River.—The ore-beds at this point, which is two or three miles eastward of those of West Beach, are somewhat similarly situated, and probably mark the same geological horizon, but yet differ both in their character and associations. The ore is chiefly the specular variety, and is contained in beds of trap-ash and hydromica schists, attaining in one instance a thickness of twenty feet. Though known for many years, and frequently made the subject of examination, no serious attempts have been made to carry on mining operations.

Magnetite.—Magnetic oxide of iron, in the form of scattered crystals, is a very common mineral in connection with the probably intrusive rocks of the pre-Cambrian systems, and in one of these, the Huronian, is also often found in the form of beds or veins, though none of great thickness have yet been observed.

Lepreau magnetites.

Among localities at which such veins have been found, one of the most notable is in the vicinity of the village of Lepreau, near the boundary between the counties of St. John and Charlotte. About two miles west of the village, and a quarter of a mile north of the post-road to St. George, on the farm of John A. Wright, a series of dark hornblendic schists, representing that portion of the Huronian system which has locally been designated as the "Kingston group," contains a number of these veins, varying from a quarter of an inch to eight inches in thickness. Though termed veins, the deposits are strictly conformable to the inclosing schists, and may be traced with little variation for considerable distances, the dip being at a very high angle and the strike quite regular. Ore from these deposits was analysed by Dr. Hoffmann (Dec. 5th, 1895) with the following results :

Metallic iron	66·71 per cent.
Insoluble matter	4·36 " "
Nickel and cobalt	Traces
Titanic acid	None.

The beds are massive, granular and generally very free from admixtures of any kind, but, owing to the large proportion of very hard rock to be removed to get the ore, cannot, unless thicker beds are found, be mined with profit. As yet nothing has been done beyond a small amount of exploratory work.

Deer Island.

Veins similar to the above have been observed at New River, on the south shore of Deer Island, (from 2 to 3 feet thick) and at other points. They may indeed be looked for in almost any part of the Kingston group ; and, as much of the country occupied by the rocks of this group is still uncleared and has been only imperfectly explored, it is quite possible that beds large enough to be mined may exist.

Cranberry Head specular hæmatite.

In addition to such occurrences in the rocks of the Kingston group, that portion of the Huronian which in the reports of the Survey has been designated the "Coastal group" also contains ores of iron to some extent. One locality of this kind was visited in 1897 near Cranberry Head, on the coast of Charlotte county, on the farm of one Murray, now owned by Hon. A. T. Dunn, Surveyor General of New Brunswick. The ore is a specular hæmatite, and occurs in veins in silico-felspathic rocks, often exhibiting a purple tint, but usually white-weathering, and varying in texture from slates to conglomerates. The veins are somewhat numerous, but rarely exceed two inches in width, besides being very irregularly distributed. Several pits have been opened, but at the time of examination these were all filled with water. No well-defined bed or vein was seen.

Bog-iron.

Bog-iron Ores.—These have been noticed in many parts of the province and by various observers, but in the presence of better and more available ores are of little present importance. In the reports of Dr. A. Gesner, reference is made to their occurrence in Sussex Vale and Bull Moose Hill, Kings county; at Liverpool, Kent county, and in the Tobique valley, Victoria county; but few details are given. Similar deposits have been observed in connection with the work of the Geological Survey on the Tracadie River, North-west Miramichi; Queensbury, York county; Beaver-dam settlement, York county; at Maugerville and Burton, Sunbury county; but the two latter are the only ones which have as yet been used for practical purposes. The deposit at Maugerville is thus described by Mr. Robert Chalmers:* "The ore-bed consists of a mixture of loamy and boggy or peaty materials of the depth of from one to three feet below the surface, underneath which is a clayey hard-pan. The ore is found in the form of cakes, or loose flattened aggregations, few of them more than six to twelve inches in diameter, although sometimes two to three feet. An intervale or alluvial terrace of considerable extent occurs here at a height of about ten to twelve feet above the level of the St. John River, and the ore-bed occupies a longitudinal belt in it, parallel to the river, about 50 yards in width and three to four miles in length."

Bog ores of Burton, Sunbury county.

During the latter years of the operations at Woodstock, bog-ores from Sunbury county were carried to that place to be used in connection with the hæmatites and limonites of Jacksontown.

Some of these bog-iron ores might, no doubt, be employed as pigments, either as raw ochres or after grinding and calcination.

Vivianite.

A blue phosphate of iron (vivianite) has been observed upon the bank of the St. John River, four miles above Grand River, in the parish of Madawaska, associated with or contained in heavy beds of clay. The quantity, however, is not large.

To the above observations on the occurrence of iron, the following notes may be added as bearing some degree of interest, though in no case, probably, of economic importance:—

*Report of Progress, Geol. Surv. Can., 1882-84, p. 46 GG.

Veins in the granite about St. George and Lake Utopia in Charlotte county are in some instances filled with scales of micaceous specular iron. Occurrences of iron ores.

On Coal Creek, in Queens county, where a series of slates protrude through the Carboniferous strata, nodules of hæmatite, several inches in diameter, are frequently met with.

At Spraggs Cove, on the island of Grand Manan, veins of siderite, (iron carbonate) have been observed in connection with rocks of presumably Huronian age. Rocks of similar age on the Nerepis River, in Kings county, also hold veins of like composition.

Beds of bog-iron, as indicated by specimens in the museum of the University of New Brunswick, occur on the South-west Miramichi River, one mile below the Clearwater Stream, and nineteen miles above Borestown.

On the Clarendon road, in Queens county, and at a point about six miles west of Gaspereau station, small veins of magnetite have been observed in connection with massive dark-gray quartzites, and dark argillites, associated with dioritic and hornblendic beds, of uncertain age. As exposed in a pit, about twenty feet deep, dug here, the vein has a width of about eighteen inches, but is much mixed with quartz and rock. It does not invite further expenditure.

On the western side of Oak Mountain, about a mile distant from the line of the New Brunswick railway, and three miles distant from Benton, beds of hæmatite have been observed in rocks, probably of Cambro-Silurian age, but have not been sufficiently laid bare to make evident their extent or value.

On the Peabody farm, two miles south of Woodstock, and in a position corresponding geologically to that of Oak Mountain, loose blocks of hæmatite are scattered over the land, but whether derived from beds *in situ* near by, or driftage from the Jacksontown beds to the north, has not yet been ascertained.

COPPER.

This metal has been found in the province in the forms of native copper, oxide of copper (cuprite), sulphides of copper (copper-pyrites, erubescite or bornite), and the carbonates of copper (malachite and azurite.) Copper.

Native Copper.—In the Triassic traps of the Island of Grand Manan, scattered nodules or irregular strings or bunches of pure Native copper

copper have been frequently met with, especially in the vicinity of the South-west Head. They are, however, of small size, have none of the characteristics of true veins, and even fail to show any tendency to concentration at particular points. From an economic point of view, therefore, they are wholly without interest. The red sandstones of the same formation which may be seen, but only at very low tides, to underlie the traps at various points between South-west Head and Dark Harbour, are also said to hold the same mineral.

Cuprite.

Oxide of Copper or Cuprite is said to have been found in connection with the sulphides of the metal during the course of mining operations on the Albert county coast, to be presently noticed, but not in quantities requiring special mention.

Sulphides.

Sulphides of Copper.—These have been reported from many different localities, and from rocks of various ages.

Copper ores of southern coast

The rocks of the Coastal group, (Huronian ?) are specially characterized by the occurrence of copper sulphides. These rocks, though not confined to the southern seaboard, are there very prominently developed, including a large part of the coast of Charlotte county, much of that of St. John, and portions of that of Albert. They embrace granitoid gneisses, talcose or hydromica schists, chloritic schists, gray and purple slates and conglomerates, felsites, etc., with numerous masses of diorite, all highly tilted and folded. To the west of the St. John River they have an average width of four miles, forming a country which, though rugged, is of moderate elevation; but, eastward of the same stream, they rise into much greater prominence, having in eastern St. John county a breadth of at least ten miles, and an elevation of six hundred feet or more.

Comparison with copper-bearing rocks of Quebec.

This series has been compared lithologically to the rocks of the "Eastern Townships" of Quebec (formerly known as the Quebec group), and like the latter, is generally cupriferous. The ores, which are usually the sulphides, especially erubescite or bornite (gray and peacock ores), have been observed at a great many points, but (as is also the case in Quebec), are rarely sufficiently concentrated to offer any attractions to the miner. Still, attempts have in several instances been made to develop them, of which the most important are the following :—

Adams and Simpson Islands.—These are small islands lying to the east of Deer Island, on the Charlotte county coast, and not far from the entrance of La Tête Passage. Attention was first drawn to them through the occurrence upon the shore of Simpson Island of a quantity of pale-green powdery malachite, in which, upon examination, were found numerous nodules or irregular lumps of black or dark-gray copper sulphide, the malachite being evidently a secondary product resulting from the action of the sea on the original and solid ore. Some sixty or seventy barrels of this green carbonate were removed by a local company (Messrs. Lord and Dakin) about the year 1863, but, owing to the influx of water, the underlying vein could not be worked. An attempt was then made to strike the latter farther from the shore and upon higher ground, but owing probably to some displacement, the effort was without success. Other veins, however, (Nos. 2 and 3) were thus discovered, leading to more or less prospecting, but for a time to no further underground work. Work of all kinds was then dropped for a period of about twenty years, when (about the year 1890) Messrs. Crow and Welter, associated with James Lord, of Lords Cove, Deer Island, sunk a shaft on vein No. 2 to a depth of 52 feet, finding a vein of about two inches of copper glance, inclosed in a veinstone, chiefly of quartz, with a thickness of eight inches. Another vein (No. 4) was also prospected, while on No. 3 a shaft was sunk to a depth of 110 feet, showing strings and veins, of which the largest was about five inches. A cross cut having been made from this for a short distance, a further descent of 26 feet was made, but without result. Since then no further operations have been undertaken. The vein on the beach (No. 1) showed four feet wide of the green carbonate, with a core of about eight inches of copper glance. It is said to have yielded, upon analysis, 27 per cent of copper, and nearly four ounces of silver to the ton.

Discovery of copper.

Development.

Adams Island is separated from Simpson Island by a narrow channel only, and their position is such as to show that the rock formations and veins of the one are a direct continuation of those of the other. Upon Adams Island two companies have worked at different times, and several shafts have been sunk, the results being, however, unsatisfactory. An examination made during the summer of 1897, of a pile of ore, lying near one of these openings, showed this to consist almost entirely of a dark-gray felspathic ash-rock, through which were scattered irregularly large numbers of blebs, consisting chiefly of erubescite (peacock copper), but sometimes of quartz or of mixtures of both minerals. No appearance of a well-defined lode was observed. This shaft was sunk to a depth of 80 feet.

Adams Island

At about the same time that mining operations were first in progress on Adams and Simpson islands, work of a similar character was being undertaken upon the mainland on the eastern side of La Tête

La Tête Passage.

Passage and Passamaquoddy Bay (Mascarene Peninsula). The rocks here, however, belong to a somewhat different geological horizon from that of the localities first named, while the character of the ores is also not the same.

Wheal Louisiana mine.

One of the points upon the peninsula referred to at which a considerable amount of work was done was that known as the Wheal Louisiana mine, opened by the Messrs. Johnson, of Liverpool, under direction of Mr. J. B. Key. This is about ten miles from the town of St. George, and not far north of the promontory known as La Tête, the rock being chloritic and talcose slates of Huronian age. The ore was mostly copper-pyrites, but with this were large quantities of pyrite and pyrrhotite, the latter forming a large proportion of the material raised. This pyrrhotite is now known to be, like that of St. Stephen, nickeliferous. A shaft was sunk to a depth of nearly one hundred feet, but the returns were not commensurate with the cost, and the mine was soon abandoned.

La Tête mine.

One mile north or north-west of the Wheal Louisiana mine was the La Tête copper mine, consisting of a shaft sunk about 100 feet on a lode of mixed quartz and calcspar included between clay-slates and trap. Several other shafts were also sunk, but, as in the case of the Wheal Louisiana mine, the ore obtained bore but an inconsiderable proportion to the associated rock, and operations were soon suspended.

Coast of eastern St. John and Albert counties. This is another region in which attempts at copper mining have been repeatedly undertaken, but so far with but little success.

The rocks of this district, consisting of gray and purple micaceous slates and conglomerates, with granitoid or gneissic beds and much intrusive diorite, are essentially the same as those of the Charlotte county coast, and the ores are also similar.

Vernon mine.

The principal works undertaken were those of the so-called Vernon mine, situated directly upon the coast about two miles east of the mouth of Goose Creek, in St. John county, where for a time (about 1865) not less than forty men were employed, and a considerable quantity of ore was extracted. The latter consisted essentially of copper glance or bornite, but copper-pyrites was also met with, and as a secondary product more or less malachite—the veins being of quartz, with some calcspar and chlorite. Several veins were traced, two of them being described as five feet and one as twelve feet in width, but the relative proportion of ore and of veinstone is not now known.

Assays.

Assays of samples sent to Boston and to Swansea gave returns varying from 18 to 25 per cent of copper, but how far these were representative of the general average is only matter of conjecture.

Apart from the quality of the ore, the situation of this mine was also such as to make its development a doubtful venture; for this part of the coast is not only high (500 to 600 ft.) but rises from the waters of the bay with great abruptness, making it impossible to secure safe wharfage, while communication by any other means than water is both long and difficult. At the time of the visit by the writer to these mines (in 1863) the boarding-house of the workmen was actually supported against the side of the cliff by being let into the nearly vertical face of the rock, while much of the ore previously mined and piled at the foot of the cliff for shipment had been washed away by a storm. It is now many years since the works were abandoned. Unfavourable position of mine

At about the same time that work was being undertaken at the Vernon mine, several other openings, known as the Alma, Gordon and Williams mines, were made a few miles farther east, in the neighbourhood of Upper Salmon River in Albert county. From one of these, the Williams mine, about 100 tons is said to have been taken, yielding according to the prospectus of the company from 28 to 30 per cent of copper, but in a recent visit to the locality no indications of anything like a distinct vein could be found, while such specimens of ore as were still to be got in the vicinity certainly did not seem to hold out much inducement for the expenditure of capital. Williams mine.

For further particulars regarding the copper mines of Charlotte, St. John and Albert counties, reference may be made to a report on the Mines and Minerals of New Brunswick by the writer, published by the legislature of the province in 1863. Other places.

Westmorland County.—About three miles and a half north-east of the town of Dorchester, in this county, are some beds of copper-bearing rock which, a few years since, attracted attention, and upon which a considerable expenditure was made, but of which the real interest is rather scientific than economic. Dorchester mine.

The rocks in question are gray sandstones and conglomerates, belonging to the base of the Millstone Grit division of the Carboniferous system, and resting unconformably upon red marly shales of Lower Carboniferous age. In the sandstones are contained numerous stems of plants, and about these were found deposits of copper glance mingled with more or less of the green carbonate. The remainder of the rock, though showing no visible ore, was stated by the manager of the property to carry from four to five per cent of copper glance. Indications of ore were found at intervals for a distance of a mile and a half. For the purpose of developing the property, commodious buildings were erected and mining and hoisting machinery was introduced. A shaft was also sunk to a depth of 100 feet, reaching the underlying red beds, but no considerable body of ore was discovered; and little return being found for the heavy expenditure made, the works were after some months' trial, finally abandoned.

List of localities in southern New Brunswick.

The following list of localities in the southern counties, at which veins of copper ore, of greater or less size, have been observed, is reproduced from the Report of Progress of the Geological Survey for 1870-71 (p. 225), as indicating the wide distribution of such ores, and as possibly affording aid towards further exploration :—

CHARLOTTE COUNTY.

Seely Cove.—Quartz veins holding small quantities of copper-pyrites in a chlorito-felspathic rock.

Seely Head (on the shore west of).—Copper-pyrites in small quantities in red syenite.

Seely Creek.—Copper-pyrites in a quartz vein intersecting felspathic rocks.

Shore west of Crow Harbour Island.—Copper-pyrites and copper glance in a quartz-vein about 2 feet wide, running through greenish-gray chlorito-felspathic rocks.

Cove of Red Head.—Copper-pyrites and iron-pyrites disseminated through schistose talco-micaceous rocks. No distinct lode was seen.

McLean's Mills on Lockes Brook near New River.—Copper-pyrites in quartz veins. Quantity small.

Negro Harbour.—Copper-pyrites.

Beaver Harbour.—Copper-pyrites in quartz veins and disseminated in schistose diorite of Kingston group: also with galena, in a quartz lode (3 feet and a half wide) in chlorito-felspathic rocks of Coastal group.

Clark Point, Mascarene shore.—Native copper and gray copper ore in strings and pockets, in trap associated with red argillites of Silurian age.

Wheal Louisiana Mine.	*La Tête.*—Described	above.	
Woodward's Mine.	*Mascarene shore.*	do	do
Hardwood Island.	*Bay of Fundy.*	do	do
Adams Island.	do do	do	do

Simpson Island. Bay of Fundy.—Described above.
Campobello Island. do do do do
Grand Manan. do do do do

ST. JOHN COUNTY.

Black River Settlement.—Copper-pyrites and malachite in hard clay-slate, containing remains of plants; also copper glance in limestone.

Little Salmon River (near mouth).—Copper-pyrites, in small quantity, with much iron-pyrites, in slates.

Martin Head.—Erubescite, in rocks of Coastal group.

Goose Creek (Vernon Mine).—Described above.

ALBERT COUNTY.

Point Wolf. do do
Upper Salmon River. do do
Blackwood Block, (N. E. angle, Alma parish).—Malachite.

WESTMORLAND COUNTY.

Beech Hill.—Copper glance in veins of quartz, with fluorite.

KINGS COUNTY.

Quispamsis.—Copper-pyrites with galena and blende in gray chloritic Laurentian gneiss.

Norton.—On north side of Dickie Mountain, copper glance encrusting gray quartzite of Kingston group, and overlain by Lower Carboniferous limestone with galena.

Springfield.—In Scotch Settlement, north of Bull Moose Hill, copper-pyrites and copper glance in gray argillites; also on southern slope of Kierstead Mountain.

London Settlement, parish of Kars.—Copper-pyrites in rusty-weathering felspathic sandstones.

Nerepis station, parish of Westfield.—Copper-pyrites, with galena and iron-pyrites, in purple slates of Coastal group.

Northern New Brunswick.

In northern New Brunswick copper ores have been observed in the vicinity of Woodstock, Carleton county, and Bathurst, Gloucester county.

Bull Creek.

(*a*). *Woodstock.*—About three miles below this town, the St. John River receives, on its right bank, a small tributary known as Bull Creek. At the point of junction and for some distance up the creek, the rocks consist of coarse gray syenite, in which are contained veins of quartz carrying sulphides of iron and copper. The latter is mostly in the form of copper-pyrites, and is in sufficient quantity to have led, on more than one occasion, to the formation of a company to work it but without remunerative results.

In the town of Woodstock itself, the underlying rocks appear to be metalliferous. In digging a sewer, about the year 1896, a quantity of ore, embracing several metallic sulphides, including copper sulphide and galena, was obtained to the amount, it is said, of 500 or 600 lbs. The exact composition of the ore, however, and its extent, have not been ascertained.

Bathurst copper mine.

(*b*). *Bathurst.*—At the falls of the Tête à Gauche River, eight miles from this town, the metamorphic slates of this region, described as manganiferous, carry also certain quantities of copper. This is in the form of the yellow sulphide, associated with iron-pyrites, and is contained in well defined lodes, of which not less than seven occur within a space of sixty feet, and have in some instances a width of five or six feet. A number of openings were made on these latter about the year 1859 or 1860, the product, in connection with that of the manganese beds near by, being shipped to England, but soon after all further operations were abandoned and have not since been renewed. According to analysis made by the late Dr. James Robb, the copper ore, when dressed, would be worth about £35 per ton.

Nipisiguit.

At the mouth of the Nipisiguit River, about three miles from Bathurst and about ten miles from the locality on the Tête à Gauche last described, the strata which form the basal beds of the Carboniferous formation, consisting of conglomerate, sandstone and shale, hold small irregular seams of bituminous coal, intimately mixed with which occur irregular masses and veins of sulphide of copper and malachite. They thus resemble the copper-bearing strata near Dorchester, in Westmorland county, described above, and like them have been supposed to afford indications of sufficient promise to justify expenditure for their extraction. It is stated that about the year 1859 some 20 or 30 tons of ore was shipped from these deposits. The anticipations, however, as to their productiveness were not realized, and work thereon was soon abandoned. At present, like the beds at Dorchester, they are only interesting as helping to indicate the metalliferous character of the underlying systems from which these conglomerates and ores were derived, and as illustrating one of the methods—that of the reduction by vegetable matter of soluble metallic salts and their consequent conversion into sulphides,—by which this class of ores may have been formed.

NICKEL.

In the Report of Progress of the Geological Survey of Canada for the years 1870-71, an account is given of the geology of Charlotte county, in connection with which reference is made to a group of dioritic rocks, presumably of Huronian age, as occurring a short distance to the eastward of the town of St. Stephen. These same rocks are further described as being traversed by fine veins of dark-green serpentine, which, as shown by an analysis of Dr. T. Sterry Hunt, carried a certain percentage of chromic oxide and of nickel. This was the first intimation of the existence of nickel in New Brunswick. Original discovery.

A few years later, in consequence probably of the discoveries then being made at Sudbury, Ontario, attention began to be directed to the existence, in connection with the St. Stephen rocks, of considerable deposits of pyrrhotite, some of which, upon analysis, also showed a small percentage of nickel. The first deposit of this mineral was observed on the bank of the St. Croix River at the Union mills, about 100 yards below the bridge at that point. A second deposit was struck soon after in sinking a well on the property of Mr. Stephen Hitchings about half way between the Union mills and cotton mills in Milltown. The Union mills deposit was, as exposed on the bank of the river, about 30 feet wide, and was at first pronounced to be an arsenical iron of no value. A later analysis showed it to contain $\frac{1}{4}$ of 1 per cent of nickel. In 1880 a similar deposit was found on the Basswood Ridge road, on the property of Mr. Ed. Hall, and was also considered of no value. Mineral rights were, however, leased from Mr. Hall by Messrs. Gilbert Ganong and James Bixby, and subsequently by Mr. Jerry Carrell, while about the same time the examination of the surrounding country having been made by Mr. C. A. Boardman, showing a wide distribution of the pyrrhotite. The last-named gentleman and Mr. W. F. Todd, both of St. Stephen, secured mineral rights on a number of other lots, and steps were at once taken to determine their value. On a lot known as the Rogers lot, a cut of 175 feet was made through the mineral without any indication of a break in the ore. In 1893, a dozen holes were made, over an extent of country about two miles square, and ore was found in most of them. In the fall of 1896, Mr. Jerry Carroll sunk a shaft about 20 feet deep on the Hall lot, and in 1891 a shaft was sunk to about the same depth on the Rogers lot. The ore on the surface assayed only about eight-tenths of 1 per cent, but further down was found to be better, running from 1·25 to 3·10 per cent of nickel. Most of the analyses ranged from 1·75 to 2 per cent, but some ore from the Carroll shaft had no nickel in it, and

Analysis.

Exploitation.

Carroll property.

some on one lot showed over 4 per cent. The ores contain small portions of copper as well as nickel, and in several of them small percentages of gold and silver are said to have been found.

Conclusions.

From the above data, for the most part kindly furnished by Mr. C. A. Boardman, two conclusions may be drawn, first, that the ore is spread over a large area and in considerable quantity, and, second, that the nickel contents are subject to considerable variation. The first of these conclusions has been fully confirmed by the personal observations of the writer. During the summer of 1897, a visit was made to the district in question, and a somewhat careful examination made of the more important of the localities referred to above. The exposures on the Rogers lot were particularly noticeable, the trench of 175 feet showing for the greater part of this distance a nearly solid bed of pure pyrrhotite. Towards the southern end, however, is a mass of dark diorite, into which the pyrrhotite seems to graduate and which itself contains considerable quantities of the latter; while resting on both, and forming a capping of indefinite extent on either side, is a mass of ferruginous conglomerate, doubtless of comparatively recent origin, and resulting from the oxidation of the pyrrhotite through exposure to air and water. Particles of copper-pyrites could be seen here and there through the mass of rock. A shaft sunk to the depth of 17 feet failed to pass through the pyrrhotite, though irregular masses of diorite were found to be contained in it. In the fields around, low ledges of similar rock outcrop at no great distance from the trench, and are distinctly but not coarsely crystalline, and without evident stratification. At the Carroll mines on the Hall farm, about a furlong east from the last, the beds exposed are, as before, nearly all pyrrhotite, and have been penetrated to a depth of 22 feet.

Later observations.

Observations of H. P. Brumell.

In the year 1890, an examination of the nickel deposits about St. Stephen was made by Mr. H. P. Brumell, with results essentially the same as those above given.* In addition to the localities described above, reference is made to beds at Moore Lake, eight miles east of St. Stephen, where a shaft has been sunk on one of two parallel veins, respectively 12 and 7 inches wide, and only a few inches apart. In this shaft, at the depth of about 15 feet, the two small veins were found to come together and to show a strong and highly mineralized ore-body. An assay of this ore by W. French Smith, of Boston, gave:—

Copper, to the ton	8·00 lbs.
Nickel do	12·46 do

*Annual Report, Geol. Surv. Can., vol. V. (N.S.), 1890-91, p. 112 ss.

Compared with the well known deposits of Sudbury, Ontario, the nickel-bearing rocks of St. Stephen show many features of close resemblance.

1. The St. Stephen beds, like those of Sudbury, consist of basic intrusive rocks, such as diorite and diabase, with probably gabbro and norite, associated with heavy beds of quartzite. Comparison with Sudbury ores.

2. As at Sudbury, the pyrrhotite would seem to be a normal constituent of the dioritic rock and not an intrusion in the latter. The rock has not yet been subjected to petrographical examination, but it is highly probable that on the one hand the felspars and iron-magnesian silicates of which the rocks consist and the nickel-bearing pyrrhotites on the other, represent successive separations by cooling from the same fluid or semi-fluid magma, thus accounting for the graduations between them and their intimate interblending.

The association of the St. Stephen nickel ores with serpentine, diallage, bronzite, actinolite and picrolite is also interesting, such association having been observed not only at Sudbury but in New Caledonia, Oregon, the Urals, North Carolina and Silesia.

3. The St. Stephen rocks, like those of Sudbury, are referable to the Huronian system, and were probably formed under like conditions.

4. The heavy capping of gossan covering the St. Stephen pyrrhotites has its counterpart at Sudbury, and is in each case indicative of the large bodies of mineral below.

On the other hand.

5. While portions of the St. Stephen ore show little more than a trace of nickel and the maximum so far attained does not exceed 4 per cent, the pyrrhotite of Sudbury rarely carries less than $2\frac{1}{2}$ per cent, and frequently averages 4 per cent.

From the above it would appear that while the general similarity of the St. Stephen and Sudbury deposits in geological age, lithological characteristics, mineral associations and probable origin, favour the belief that the former, like the latter, may be a profitable source of nickel-supply, the relatively low percentage of this metal as found at St. Stephen is adverse to this conclusion. But the variability of the nickel-contents of pyrrhotite deposits, not only at the localities named, but at others from which considerable quantities of this metal are derived, make it at least possible that portions of the deposit may be much richer than any yet recognized. Considering the large extent and thickness of the deposit this is quite possible, and could probably Possible future.

be determined at no great cost by the selection and analysis of samples from many different parts of the field. As a contribution in this direction a number of such samples have been collected by the writer, but have not yet been submitted to analysis. A series of borings with the diamond drill now under the control of the Provincial Government, would doubtless also give much valuable information in the same direction.

It may be mentioned in this connection that during the working of the so-called Woodward Mine at La Tête, elsewhere described in this Report, large quantities of pyrrhotite were removed in connection with chalcopyrite, and it has been stated that these ores, like those at St. Stephen, are nickeliferous, but to what extent the writer has not been informed.

Antimony.

First discovery.

Prince William, York county.—The existence of ores of this metal in New Brunswick was first made known about the year 1863, through the discovery of a deposit of stibnite, or sulphide of antimony, in the parish of Prince William, York county. The locality is about twenty-five miles from the city of Fredericton and about three miles from the St. John River, being very near the summit of a somewhat elevated tract overlooking Lake George and the valley of the Pokiok River.

Geological horizon.

The rocks exposed in the vicinity consist of alternating beds of slate and quartzite, being part of a wide belt of such rocks traversing the central counties, and supposed to be of either Cambrian or Cambro-Silurian age, though, so far as at present known, without recognizable fossils. The beds are very highly disturbed, and show abundant evidence of metamorphism, connected, no doubt, with the close association of the strata with masses of intrusive granite, which may be seen *in situ* within a mile of the principal deposits of ore. These latter occur in connection with veins of milky quartz, some of which appear to be coincident with the bedding, though more commonly intersecting this at various angles. The total area over which lodes bearing antimony were found was about 350 acres, the quartz veins varying from a few inches to six feet, in which those of stibnite occurred partly in a network of fine veinlets and partly in more considerable masses, sometimes attaining a thickness of twelve or fifteen inches. In some parts of the workings very fine specimens of native antimony were met with.

Area of antimony deposits.

Native antimony.

Development.

The first company to undertake active operations at Prince William was the Lake George Mining and Smelting Company, their location being that of the old "Hibbard property," adjoining the road to Lake George, and about three miles from Prince William. At this place a considerable quantity of ore was raised, followed by the erection of a somewhat extensive plant including crushers, rolls, jiggs, etc., and, somewhat later, works for desulphurization and smelting. When in full operation these works yielded fifteen tons of metal every six weeks, the charges (of 500 cwt.) affording from 45 to 55 per cent of regulus. The product was partly exported in cubes or ingots to the United States, and was partly employed on the ground in the manufacture of babbit metal, by admixture with lead, copper and tin. The value of the regulus was quoted on the ground at 12 to 14 cts. per pound; that of the babbit metal, according to quality, from 20 to 50 cts. per pound. Manufacture of babbit metal.

The manufacture of the above products was continued for several years, but a continued decrease in the demand for the metal, with increased protective duties imposed by the government of the United States, soon made it difficult to carry on the work with profit. At the same time, discoveries having been made of antimony lodes upon adjacent properties, the competition of rival companies, with more or less litigation arising out of disputed claims, tended still further to hinder progress. It was then determined to export the ore in the raw state, this being hauled to Magaguadavic station on the Canadian Pacific Railway for shipment. At the same time an entire change in the destination and use of the material was made, almost the whole product being sent to the town of Medford, Mass., and there used in connection with processes for the vulcanization of rubber. To supply this demand, about eighty men were, in the year 1883, employed in the Brunswick mines, and during five months of that year about 29 tons of ore was exported, a shaft being sunk to the depth of about 300 feet. This business also appears to have been short-lived, as about the year 1890 all work was suspended. The property of the Brunswick company, originally known as the Hibbard property is now in the hands of trustees, resident in Haverhill, Mass. The other properties are a portion of the Lawrence estate owned in St. John, N.B. Difficulties. Change of application.

As to the quantity or quality of the antimony ores of Prince William there can be but little question. The distance from the Hibbard shafts to those opened later by the Messrs. Lawrence, is nearly half a mile, and at many points in the interval, as well as about each of these centres, which apparently occupy different sides of an anticlinal fold, quartz veins are numerous and generally metalliferous. There was also no sign of diminution in the quantity of the ore as followed in depth, but on the contrary, a tendency to greater concentration, with Quantity of ore.

a replacement to some extent of stibnite by native antimony. The question of the future working of the deposits is therefore mainly one of demand.

Demand.

From statements contained in *The Mineral Industry*, it appears that the domestic production of antimony ore in the United States in 1897 amounted to 500 short tons, averaging 45 per cent of antimony. The production of the metal, amounting to 750 tons was, therefore chiefly derived from imported ore. A great part of the antimony employed there is, however, imported in the refined state. There should, therefore, be a good market for antimony in the United States, but the prices are lower than those ruling some years ago.

Proposed resumption of work.

It has been recently stated in the public press that the mines at Prince William are to be reopened by a company, and that preparations for that purpose are now in progress, under direction of Messrs. Hammond and Adriance.

Analyses.

The following are analyses of the Prince William ores :—

1. Sample sent to England.

Sulphide of antimony	50·70	per cent.
" iron	1·87	"
Silica	47·43	"
	100·00	"

2. Sample analysed by Dr. A. A. Hayes, Boston, Mass.

Antimony	59·00	per cent.
Sulphur and rock	41·00	"

3. Sample analysed by Dr. Hayes (Silliman's Journ. Jan., 1863).

Sulphide of antimony	36·00	per cent.

This sample contained some silver.

4. Analysis by James R. Chilton & Co., New York.

Antimony	66·00	per cent
Iron	·60	"
Sulphur	23·40	"
Silica	10·00	"

5. Three analyses by W. W. Bailey.

	1. per cent.	2. per cent.	3. per cent
Antimony	68·98	70·1	69·00
Sulphur	28·86	28·4	27·28
Iron	·85	·0	·85
Gangue	·81	1·5	1·50
	99·50	100·00	98·63

Springfield, Kings county :—" Small quantities of stibnite or sulphide of antimony have been found in connection with dioritic rocks which are either intrusive or of Laurentian age near Sunnyside Lake in the

Scotch Settlement, parish of Springfield, Kings county. A small portion only of the vein has been disclosed by the removal of the soil, and little is known of its extent or value."

Antimony veins at Scotch settlement, Kings county.

The above extract is from the Report of Progress for 1870-71. No further developments in the locality, so far as known to the writer, have since been made.

TIN.

Discovery.

A specimen of oxide of tin, labelled "Pokiok," was some years ago noticed as occurring in a collection of New Brunswick minerals made by Dr. Abraham Gesner, in connection with his geological explorations of the province in 1839 and subsequent years. The specimen, which is quite small, is now in possession of the writer.

Doubts regarding locality.

Though the locality given above is very indefinite, the more so as there are several Pokiok rivers and settlements in the province, there would seem to be little doubt that the place from which the specimen came was in the vicinity of the Pokiok River in York county; for this is the best known of the localities bearing that appellation, while the geological age and structure of the region are such as to render the occurrence of this metal there very probable. The river referred to traverses a district partly occupied by metamorphic slates and sandstones and partly by granites, for portions of its length running along the line of contact of the two. It is in just such situations that the tin of Cornwall and other countries is found to occur. It is also to be noticed that it is in this same district that antimony, a mineral often associated with tin, is abundantly met with, as at the Prince William mines. Finally, at the town of Waterville, Maine, in rocks which appear to be the equivalents, if not the direct extension of those of Prince William, in New Brunswick, small quantities of tin have been found.

There is, therefore, some possibility that this important ore may yet be found in available quantities. Unfortunately the aspect of the ore, when not crystallized, is of such a character as to attract little attention from the ordinary observer, and hence it may readily be overlooked. So far all search for the precise locality from which Dr. Gesner's specimen was derived has proved fruitless.

Lead and Silver.

Occurrence of veins of argentiferous galena.

No pure or native silver is known to occur in New Brunswick, but veins of galena or sulphide of lead, met with at various points, usually carry a certain percentage of silver, making it necessary that the two metals should be considered together.

Geological formations.

The geological formations in which galena has been observed, include the Laurentian, the Huronian, the Cambrian and Cambro-Silurian, the Silurian and the Lower Carboniferous. In most instances the amount is small. In the following descriptions the localities are taken by counties.

CHARLOTTE COUNTY.

Frye Island lodes.

Frye Island.—The geology of this island, also known as L'Etang Island, and situated near the mouth of L'Etang Harbour, is complicated, and is fully described in the Geological Survey Report for 1870-71 (p. 86). Of the rocks met with, the most important in the present connection is a series of limestones, in part dolomitic, and associated with quartzites, that form the shore of that portion of the island which overlooks the "Back Bay." They are quite similar to rocks to be presently noticed both on the mainland of Charlotte county and in St. John county, and, with the latter, have been referred to the Laurentian system. Intersecting these limestones, which also carry more or less serpentine, are a number of well-defined lodes consisting mainly of quartz, but containing also considerable quantities of barite and fluor-spar, besides veins of galena. One of these lodes, when stripped, showed a width of from six to eight feet, with a course about east-north-east, while two other lodes, each about six feet, and approximately parallel, approached the first with a course about north-east or nearly that of the inclosing strata. Portions of these lodes contain numerous small veins of galena, sometimes associated with blende or pyrite, but no considerable body of ore was visible. Beyond stripping the lodes and the firing of a few blasts, no attempt has been made to mine the ore.

Character and associations.

Campobello.—At several points on this island, veins of galena, usually in association with sphalerite or zinc blende have been observed, but at one point only have they been found large enough to lead to any expenditure of capital. This point is near the eastern extremity of the harbour of Welchpool, not far from the former residence of Admiral Owen, where, nearly forty years ago, a quantity of the above ores, chiefly galena, was found to occur in connection with a series of chloritic and hornblendic strata, probably of Huronian age. A level being opened in the bank, not far above high-water mark, several tons of very good ore were extracted, but while the vein, as first exposed, was several feet wide, consisting of galena with associated barite

Welchpool.

and pyrite, at the distance of twenty feet or so it dwindled down to a thickness of only a couple of inches. It was then abandoned.

In this connection, it is of some importance to notice that ores of lead have been observed at a number of localities in the neighbouring district of Washington county, Maine, some of which, as near Lubec, have at times been the basis of more or less extended mining operations. Lead ores of Lubec, etc.

On the Magaguadavic River, half a mile below the village of St. George, is a small island upon which, it is said, a vein of galena occurs, yielding masses of pure ore as large as a barrel.

St. John County.

Frenchman Creek, Parish of Lancaster.—The rocks of this locality bear much resemblance to those of Frye Island, Charlotte county, and are almost certainly of Laurentian age. The principal rock is a whitish or cream-coloured, more or less siliceous limestone, becoming in parts dolomitic ; but with this are dark-gray to black rubbly slates, while a little to the north, and covering a space of many acres, are very heavy beds of dark-gray quartzite. In visiting the locality in 1897, a trench was found to be in process of excavation on a bed of dolomite, disclosing a series of small veins, from one to three inches in width, in which, besides quartz, was contained a quantity of galena associated with honey-yellow sphalerite or zinc blende and some tetrahedrite. Stainings of green and blue copper carbonates were also noticeable. Lancaster.

The locality is on the farm of Mr. Jno. Burchell, and was being prospected by Mr. C. J. Weldon, of St. John. The amount of work, however, so far done, has been too small to afford any data for an estimate of its value. Samples having been sent for analysis to the office of the Survey, and there, freed from all gangue, the metallic sulphides were found by Dr. Hoffmann to contain no gold, but to carry silver to the extent of 25·08 ounces to the ton of 2000 lbs.

Musquash Harbour, West side.—The Laurentian syenites which occur here, carry veins of white quartz holding sulphides of copper and lead. A specimen of the pure galena, assayed by Dr. B. J. Harrington, in the laboratory of the Geological Survey, yielded 14·219 ounces to the ton.* The extreme hardness of the country-rock, as compared with that of Frenchman Creek, is against its profitable working. Musquash Harbour.

*Report of Progress, Geol. Surv. Can., 1877-78, p. 52 G.

KINGS COUNTY.

The following localities are quoted in the reports of the Geological Survey as showing small veins of galena :—

Norton.

Norton.—The veins are in Lower Carboniferous limestone resting upon the Huronion rocks of Dickie Mountain. They were observed as early as 1863, but have not been considered sufficiently important to warrant exploration.

Hammond River.

Hammond River, near Wanamake's Inn, parish of Upham. Galena, with copper-pyrites, in quartz veins penetrating dioritic and petrosiliceous rocks of Huronian age. The veins are small but carry a little silver. An assay by Dr. F. D. Adams gave, silver 3·099 ounces to the ton.

Quispamsis.—Galena with pyrites and blende, in Laurentian gneiss.

GLOUCESTER COUNTY.

The localities in this county at which ores of lead have been observed are three in number, viz., the Nigadoo River, the north branch of Elm-tree River and Rocky Brook, a tributary of the Nipisiguit. All are within moderate distance of the town of Bathurst, and not far from the line of the Intercolonial Railway, but in tracts which are still wooded, and somewhat difficult of access.

Nigadoo River.

At each of the localities named, some little work, chiefly of a prospecting character, has been done, but at the time of the visit of the writer to the vicinity this had been suspended, the trenches and shafts were filled with water, and nothing could be learned by personal inspection. The locality upon the Nigadoo River, however, was visited by Dr. Ells in 1879, and again in 1881, after mining operations had been commenced, and the ore was described by him as being of good quality.* That of Rocky Brook was similarly examined by the late Edward Jack, C.E., of Fredericton, on behalf of the Provincial Government, and was described as showing a vein of quartz carrying more or less galena and pyrite, with a total width of twenty feet. An assay of the ore by Prof. H. O. Hoffman, of the Massachusetts Institute of Technology, is also quoted, as yielding 11 ounces of silver and 0·24 ounces of gold to the ton. Another analysis (by Prof. Ricketts, of New York) yielded 14·20 ounces of silver per 2000 pounds of the ore, as submitted.

Elm-tree mine.

In the printed prospectus of the Elm-tree Silver Mining Company, it is stated that about 800 pounds of ore were taken out from a

* Report of Progress, Geol. Surv. Can., 1879-80, p. 45 D.

six-foot lode upon their property, an assay of which (by J. D. Marsh, New York), gave silver to the value of $182 to the ton, lead $72 and a trace of gold. Another assay (by Frank L. Bartlett, State Assayer of Maine) gave silver 9 ounces, gold 2 penny-weights, lead 73 per cent.

The prospectus of the Nigadoo Silver Mining Company quotes the following analyses of ore from their property :— Asseys of Nigadoo ores.

SACKVILLE, June 22nd, 1881.

Assay of Galena.

(1). Lead 613 lbs. to ton of 2,000 lbs.
Silver 31 oz. to ton of lead.
Gold, slight traces.

(Signed), J. BURWASH,

August 8th, 1881.

(2). Lead 71 per cent or 1,420 lbs. to ton.
Silver 36·3 oz. troy to ton of ore.
Nearly 50 oz. to ton of lead.
Value about $119 per ton.

(Signed), JOHN BURWASH.

(3). Metallic contents per ton of 2,000 lbs.

Gold, at present value U. S. cy.		$ 0·51
Silver in troy oz	72·67	81·39
Lead per cent	60·75	60·75
Total assay value		$142·65

(Signed and sealed), F. L. BARTLETT
State Assayer.

Portland, Maine, Aug. 15th, 1881.

GOLD.

The consideration of the occurrence of this metal in New Brunswick must, with our present information, be rather a discussion of probabilities than a statement of facts. It is true that numerous reports of its discovery have from time to time appeared in the public prints, but in the very few instances in which it has been possible to trace them back to authentic sources, they have proved to be the product of alluvial washings, and of very small amount. Assays of ores from different parts of the province have also shown traces of gold, but these again go but a little way towards establishing the auriferous character of the rock formations represented. On the other hand, it is easy to adduce many considerations which favour the belief—fully entertained by the writer—that New Brunswick will yet be found to yield gold in economic quantities. Reported discoveries.

Among these reasons are the following :—

Reasons favouring a belief in occurrence of gold.

I. The occurrence in the province, over extensive tracts, of rocks in all probability of the same geological age as those of regions elsewhere generally auriferous. These rocks are mainly the slates and quartzites, with their metamorphic equivalents, which traverse New Brunswick a little north of its centre, on either side of the great band of intrusive granite extending from the Chiputneticook lakes, on the western frontier, to the neighbourhood of Bathurst. Though holding at one point (Rocky Brook upon the Nashwaak River,) fossils referable to the base of the Devonian, the larger portion is non-fossiliferous, and in the case of the northern belt this is unquestionably overlapped, unconformably by rocks of Silurian age. Both belts have accordingly been coloured in the Survey maps as Cambro-Silurian (the Rocky Brook beds being regarded as an infolded outlier of more recent strata), but it is quite as probable that they include Cambrian strata also, being thus brought into parallelism with the gold bearing belt of the south coast of Nova Scotia, about the geological age of which a similar doubt exists.

Probable equivalence with gold-bearing strata of Nova Scotia

It may also be added that a third belt of similar strata, like that of Nova Scotia auriferous, exists in the Chaudière region of Quebec, coming up on the northern side from beneath the same basin of Silurian slates as that which directly overlaps the supposed Cambrian rocks of central New Brunswick. Sir William Logan long since expressed the belief that the rocks of the Quebec group as understood by him, (and now known to include in that province both Cambrian and Cambro-Silurian strata), were repeated in New Brunswick on either side of the granite axis referred to above, and finally, by another anticlinal undulation on the Atlantic coast of Nova Scotia*. It seems, therefore but reasonable, in view of the auriferous character of the rocks of the Chaudière district and of Nova Scotia, that the probably equivalent rocks of New Brunswick should be alike productive of the precious metal.

Comparison of lithological character.

II. The lithological characters of the supposed Cambrian or Cambro-Silurian rocks of New Brunswick, though not identical with, bear much resemblance to those of the Nova Scotia gold series, the likeness being seen not only in the system as a whole and in individual members, but also in the order of succession, and the results of metamorphism. In both, the lower and greater portion of the series consists of fine-grained sandstones or quartzites (in New Brunswick usually felspathic) alter-

*See letter to Prof. H. Y. Hind in Preliminary Report on Geology of New Brunswick.—H. Y. Hind. Fredericton, 1865. p. 15.

nating with gray argillites, while above there are simple argillites, mostly dark-coloured, but sometimes green or red. In both, these rocks are more or less invaded by granite, in approaching which they assume, to some extent, the character of fine gneisses and mica-schists, more or less charged with such minerals as garnet, staurolite, tourmaline, etc. In both places the higher rocks or argillites are markedly pyritiferous and with the pyrite other metallic sulphides, as those of antimony, arsenic, lead and zinc occur. In the New Brunswick rocks hornblendic strata, closely similar to those of Yarmouth, N. S., are met with.

III. A considerable proportion of all the reported "finds" of alluvial gold have been from districts in or closely adjacent to the belts, which, on other grounds, would seem to afford the most favourable indications of the presence of this metal. Among them may be especially mentioned the tributaries of the Tobique and Little Southwest Miramichi rivers. Prof. H. Y. Hind, in connection with a survey for the Provincial Government in 1865, reported alluvial gold from both of these streams, and exhibited specimens at the Provincial Exhibition of the same year, which are now in the cabinet of the University of New Brunswick. Other observers report like results, and upon the strength of these, or possibly independent observations, certain parties have gone so far as to erect on the Serpentine River, a branch of the Tobique, at a point at least fifteen miles from the nearest settlement, a small stamp-mill whereby to test more thoroughly the nature of the ground. Under instructions of the Director of the Survey, this point was visited by the writer during the summer of 1897, with results which, though negative as regards the actual finding of gold, nevertheless go far, in his opinion, to confirm the views already expressed as to its probable future discovery.

Record of finds.

The Serpentine River joins the Campbell River, or Right Hand branch of the Tobique, about eight miles above the Forks of the Tobique, and, according to the published map of the Survey, very nearly in the middle of a band of supposed Cambro-Silurian rocks, extending thence south-westerly to the head-waters of the Gulquac, and north-easterly nearly to Sagamook Mountain at the head of the Nictor or Little Tobique. About four miles above the mouth of Serpentine River, the Cambro-Silurian rocks, according to the map referred to, give place to an extensive tract regarded as pre-Cambrian, within which the remainder of this stream lies, together with the lakes at its head. The ground for such a separation upon the Serpentine, whatever may be the case elsewhere, does not seem to be very obvious, and the writer would rather be disposed to regard all

Supposed occurrence on Serpentine River.

Rocks of Serpentine River.

the strata between the lower and the upper fall as being of similar age, and that age probably Cambrian. Excepting a band of crystalline felsite, which, like the granite of the main fall, is probably intrusive, all the other rocks are quartzites and slates; and except that those nearer the granite are more glossy and unctuous, it is difficult to see wherein they differ from those below. It is, however, in these more glossy slates or schists that quartz veins especially abound, and it is here that the stamp-mill to which reference has been made, has been placed. Immediately beneath the latter is a vein of milky quartz, from six to twelve inches in width, much stained with iron and holding irregular masses of dark-green chlorite, while numerous similar veins are exposed in the banks of the stream for several miles above and below. A considerable quantity of broken quartz was lying about, and from this samples were selected for analysis. The slate was in aspect very similar to the auriferous schists of North Carolina, and the appearance alike of the veins and the country-rock, appeared favourable to the occurrence of gold. The occasional occurrence of mispickel or arsenopyrite was another favourable indication. Several veins examined were found to be, like many of those in Nova Scotia, conformable to the bedding, and in some instances to be lenticular. Boulders of white or of ferruginous quartz are common in the bed of the stream for a mile or more below the mill.

Stamp-mill.

Frequency of quartz veins.

No work was in progress at the time of our visit, nor were we subsequently able to obtain any definite information as to the reason for the erection of the mill or the returns therefrom. We were ourselves unable to find any gold, and heard that the parties operating the mill had also failed to obtain any, except by washing in a neighbouring brook; but of this we are unable to speak with certainty. We can only add that the assays referred to above, made in the laboratory of the Geological Survey, also failed to give satisfactory results. Samples from various veins found at and near the mill, and aggregating twelve pounds and a half in weight, were submitted to trial, but were found to contain neither gold nor silver.

Result of analysis.

If the information as to the Tobique is indefinite, that relating to the Miramichi and its tributaries is even more so. Positive statements as to the occurrence of gold have indeed been made, and by apparently reliable persons, but until the discoveries are followed up by applications for mining licenses, they can hardly be regarded as worthy of serious attention.

Absence of exploration.

IV. The regions most likely to be gold producing have been very imperfectly explored. It is true that all have been examined, more or less, by the members of the Survey staff and by others, but the purpose of these explorations was mainly the determination of the age, character and limits of the formations represented, not that of systematic prospecting. This has yet to be done. It is to be remembered also, that the larger part of the districts in question is still unsettled and for the most part densely covered with forest, and such observations as have been made have been chiefly confined to the larger streams or such as are navigable by canoes. Even in countries which, like Nova Scotia, are known to be auriferous, and where the conditions of the occurrence of gold are now well understood, the discovery of new veins is to a great degree a matter of chance, and a similar chance may at any time alter the view now generally entertained as to the non-productive character of the New Brunswick rocks.

Possible gold area in Charlotte county.

In addition to the two great belts to which the above remarks mainly apply, some other districts also deserve notice as possible gold producers. One of these is the tract lying to the north and north-east of the town of St. Stephen, in Charlotte county. Here again the rocks may, both in character and succession, be closely paralleled with those of the Nova Scotia gold series, and their age also is in all probability the same. A series of massive gray quartzites is overlain by black pyritous argillites, and both are invaded by masses of granite, becoming thereby altered, the one into imperfect gneisses and the other into micaceous, garnetiferous and hornblendic schists. Quartz veins also abound, in some instances of very large size, and some of these, upon the authority of Prof. C. H. Hitchcock,* formerly State Geologist of Maine, yielded, at more than one locality, small quantities of gold. On the other hand, assays made by Dr. T. Sterry Hunt, of samples obtained from one of these localities (that of the Bolton property) failed to show any gold, while a similar negative result has been obtained in the case of specimens since collected from other points by the writer and submitted to assay in the laboratory of the Survey. These were partly from Bailey Settlement and partly from the Grimmer farm, between Basswood Ridge road and Getchell Settlement road.

In view of this conflicting testimony the question in this instance, must be regarded as being still an open one, to be decided by further exploration.

Albert county

The last region to which reference may be made, is that of the hilly country comprising the eastern part of St. John county with the adjoining portions of Kings and Albert. Small quantities of drift gold were found by the writer, as early as 1864, in the hills south of the

* Report on Mines and Minerals of New Brunswick. Bailey. 1864.

Coverdale River; and Prof. H. Y. Hind speaks of the country between Hopewell and Golden Mountain, examined by him, as being also slightly auriferous. The existence of small percentages of gold in the copper ores of the southern coast of Albert county has also been noticed by Prof. Hind.

The following are other localities in which alluvial gold has been reported :—

1. Upsalquitch Lake. Reported by Prof. Hind as slightly auriferous.
2. Nipisiguit River, near the Grand Falls. Hind.
3. Right-hand Branch Tobique River and Long Lake. Hind.
4. Blue Mountain Brook. Hind.
5. Springfield, seven miles north-west of Norton station. Hind.
6. Dutch Valley road. Traces of gold in pyrite. Hind.
7. Muniac River, Carleton county.
8. Nashwaak River, York county.
9. Frye Island, Charlotte county. Reported by Dr. A. A. Hayes, of Boston, as occurring in quartzites to the extent of $10 to the ton.

MANGANESE.

Deposits of manganese.

The deposits of manganese found in New Brunswick occur in three different formations, of widely differing character.

Tête à Gauche River.

The deposits which are the oldest geologically, as they were also the first to attract notice, are found in the county of Gloucester, in the vicinity of the falls of the Tête à Gauche River, about eight miles from Bathurst. Veins of copper-pyrites having been found in the same neighbourhood, a company was formed about the year 1860 for their development, and a small stamp-mill was erected, but the results proving unsatisfactory, operations were soon suspended and have not since been renewed.

Recent observations.

During the summer of 1897, a visit to this vicinity was made by the author of this report, with the result of showing that the manganese veins of the region are, in all probability, much more numerous than had previously been supposed, and that the metal may possibly occur in quantities which will admit of profitable working. Thus, at points nearly a quarter of a mile from the place of their first discovery at the Falls, the red slates of the district, (probably of Cambrian age), were found to carry numerous small veins

Preliminary Report on Geology of New Brunswick, Fredericton, 1865.

of pyrolusite; while I was assured by resident farmers that, in road making, they had exposed similar veins, attaining in some instances a width of eight inches. Masses of pure ore, usually highly crystalline, are also found scattered over the neighbouring fields. Unfortunately, the whole district, which is nearly flat, is covered deeply with a clayey soil, that completely conceals the underlying rocks, and with them any ores they may contain; but in consideration of what has been stated above, and the further fact that indications of manganese are found in the same belt of rocks in their extension to the Nepisiquit River, it would certainly seem that the district is worthy of closer investigation than it has as yet received. As the veins observed are of the nature of "stringers" rather than well characterized lodes, a tracing of them to their points of origin might reveal deposits of considerable extent and value.

The second class of manganese ores in New Brunswick, is that found in connection with the rocks of the Lower Carboniferous formation; and includes the deposits of Markhamville, Jordan Mountain and other points in Kings county; those of Shepody Mountain, in Albert county and those of Quaco, in St. John county.

Markhamville deposits.

Markhamville.—The deposits at this place are by far the most interesting which have been yet found in New Brunswick, whether they be regarded from a scientific or from an economic standpoint. Thus not only did they for years form the basis of an extensive and profitable industry, but in the course of their development they afforded admirable illustrations of the conditions under which most of the manganese deposits of the Maritime Provinces are found. A review of the operations undertaken at this point and of the facts then revealed, will therefore be of value with reference to any future undertakings of a like character.

Situation.

The Markhamville mines are situated near the head of the Hammond River, at a point about forty miles north-east of the city of St. John, and about eight miles south of Sussex station on the line of the Intercolonial Railway. The district in which they occur is an elevated one, and though the ore-beds are found on the sides and towards the bottom of a considerable valley, drained by the river, the necessity of surmounting the high ridges which border the latter, in order to reach, within reasonable distance, a suitable place of shipment, was, during the operation of the mines, at all times a serious difficulty. The more recent construction of the St. Martins and Upham (now Central of New Brunswick) Railway, would, were the mines at any time reopened, afford a much more easy and less expensive outlet.

Associated rocks.

As described in the report of the Geological Survey for 1870-71, the rocks which on either side border the valley of Hammond River, at Markhamville, are of Huronian age, consisting of dark-gray to black diorites and felsitic beds, that in places are more or less brecciated, and are probably of volcanic origin. They are themselves to some extent manganiferous, and are probably the source from which the more considerable deposits have been derived, but these are wholly confined to beds of more recent age, viz., to Lower Carboniferous limestones and associated strata resting upon the Huronian beds, and to deposits of clay and gravel connected therewith. A deep covering of drift makes it impossible to determine with accuracy the order of succession of the Lower Carboniferous sediments, but from what data are available, it is probable that the limestones represent the base of the Carboniferous system at this point, the higher beds being represented by red conglomerates and sandstones.

First discoveries.

The earliest discoveries of manganese in this vicinity are said to have been made by Mr. G. F. Matthew, the property being subsequently leased by Mr. Wm. Davidson, of St. John. The first systematic operations, for the extraction of the ore, were, however, undertaken by Colonel Alfred Markham, on behalf of the Victoria Manganese Company, about the year 1864, and to his energy and perseverance is to be credited the large development which they subsequently underwent.

Development.

The deposits first removed were superficial ones, consisting of ore inclosed, in the manner of pockets, in beds of clay, mingled more or less with gravel, and holding boulders of limestone. These deposits had a depth of twelve feet or more. Somewhat later, operations were extended to the underlying limestones, but in these also the distribution of the ore was found to be most irregular, thus leading to great fluctuations in the output of successive years, as well as in the profits derived therefrom. In more than one instance an entire season would be occupied in profitless search, and operations would be upon the point of abandonment, when new and possibly richer deposits would be struck, thus prolonging, for a greater or less time, the life of the mine. Such finds, however, eventually became too rare to admit of continued expensive search, and about the year 1893 the mines were finally closed, though the extensive plant used in connection therewith has never been removed. The output, during the first twenty-three years of operation, varied from 500 to 1500 tons per year, and the value, as delivered at Sussex, from $15 to $50 per ton. The total output appears to have exceeded about 23,000 tons.

Irregularity of occurrence.

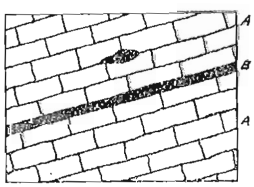
Stoppage.

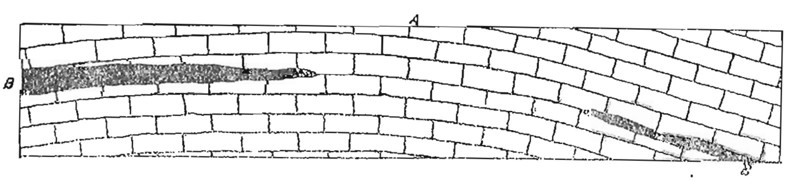
Output.

During the period of their greatest activity, the deposits at Markhamville were visited and very carefully examined by Dr. R. A. F. Penrose, in connection with a similar examination then being made by him of all known deposits of this metal in North America, and the results of his observations were published in a volume wholly devoted to this subject, forming a part of the Annual Report of the Geological Survey of Arkansas for 1890. As, owing to the closing of the mines, such observations are not now possible, and those referred to, the work of a recognized authority, are not only a remarkably full and clear account of these mines, but of their probable origin and their relations to manganese mines elsewhere, it has been thought well to reproduce here, from the volume referred to, some of the more important statements.— Observations of Dr. Penrose

"The ore occurs either as crystalline pyrolusite and manganite, or in a compact, massive, nodular or bedded form, sometimes containing psilomelane. Nature of ore.

"The ore-bearing limestone is generally of a gray colour, but at times is pink or buff, and is associated with shaly strata. It contains veins of crystalline calcite, in which masses of pyrolusite are frequently found, but the principal ore-deposits are lenticular bodies interstratified with the limestone. These occur either as irregular pockets, or as flat layers, more or less continuous for considerable distances, and Mode of occurrence.





SCALE 8 feet to 1 inch.

FIG. 1. SECTIONS IN OPENINGS AT THE MARKHAMVILLE MINE, NEW BRUNSWICK, SHOWING THE MODE OF OCCURRENCE OF THE MANGANESE ORE.

A. Limestone.
B. Manganese ore.

becoming thin and thick at intervals. In some places such deposits widen out into pockets from which several hundred tons of ore have been taken, and in one opening 3000 tons are said to have been mined. Though in places the pockets do not always adhere strictly to the bedding of the rock, yet in a general way they follow it. Sometimes veins and pockets cut directly across the bedding, but these are generally smaller than the others and are probably due to a secondary chemical action by which they have been derived from the bedded ores.

Explanation of sections.

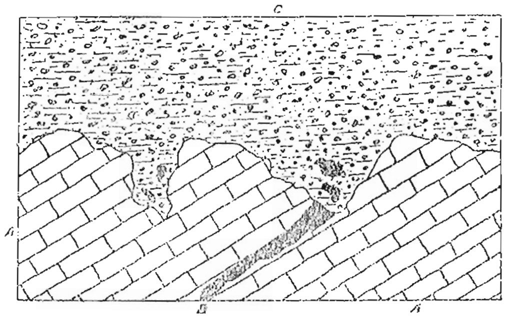
"The two sections [Fig. 1] represent exposures of ore in openings on the property, and illustrate on a small scale the characteristic modes of occurrence, though very much larger bodies of ore than those here shown have been worked. The smaller section shows an interstratified lenticular layer of ore through the centre and an irregular, isolated pocket lying in another plane of stratification above. The larger section shows two lenticular pockets following the same line of stratification in the limestone, but separated by a barren area.

Decomposition of limestone.

"The surface of the limestone has often been decomposed and a red residual clay, frequently mixed with surface gravel, has collected in considerable quantities. The ore that was originally in the part of the limestone which has decayed, is now found buried in the clay; and therefore deposits of ore-bearing clay or gravel, overlying the partly decomposed surface of the limestone, are of frequent occurrence. Such deposits are rarely more than from eight to twenty feet in thickness, but the ore in them is cheaply worked, and they have supplied a large part of the output of the Markhamville mine. Frequently the decomposition of the limestone has spread downward more rapidly along the outcrop of a body of ore than elsewhere, causing somewhat abrupt hollows filled with residual clay and manganese ore, and containing in the bottom, the outcrop of the ore *in situ* in the rock.

"Not only has decomposition taken place on the surface, but it has also gone on to a considerable extent underground, frequently causing subterranean cavities and passages. When these have intersected bodies of manganese the floors are covered with loose fragments of ore, brought there in the same way as that in the residual clay on the surface. Kidney-shaped masses of glossy, black limonite are frequently found with the cave deposits, and these also have doubtless come from the limestone.

"The figure [Fig. 2] represents a section exposed in a surface pit. It shows the decayed surface of the limestone and the overlying residual material, with fragments of ore that have weathered out of the rock. It will be observed that the body of ore in the limestone has been partly freed from the rock by decay, and that the fragments have become enveloped in the overlying clay. It will also be noticed that the decay of the rock has reached deeper where there is ore than where there is none. Surface pit.



SCALE 10 feet to 1 inch.

FIG. 2. SECTION AT THE MARKHAMVILLE MINE, NEW BRUNSWICK, SHOWING THE DECAY OF THE ORE-BEARING LIMESTONE AND THE FORMATION OF RESIDUAL ORE-BEARING CLAY.

A. Limestone.
B. Manganese ore.
C. Manganese-bearing clay.

"Though a large amount of manganese has been taken from the surface clay beds and the caves, yet the deposits of ore in the limestone have also been extensively worked, and in many places the rock is honeycombed with a network of shafts and drifts, following the erratic courses of the ore-bodies in all their intricacies. Workings.

"The thickness of the limestone varies considerably; in one of the pits a depth of twelve feet was found, and a diamond drill boring in another part of the property showed a thickness of fifty-five feet. Probably a greater thickness will be found elsewhere. The bed is much disturbed and is folded into small anticlines and synclines, but at Markhamville it has a general dip to the north-west and a strike of north-east and south-west. In many places it contains fossils, and sometimes the carbonate of lime of these has been partly replaced by manganese, which has subsequently been oxydized, and now exists as a black, more or less calcareous, mass." The limestone.

Annual output.

The following table affords more exact information of the annual output of manganese in New Brunswick between the years 1868 and 1894, almost the whole of which was furnished by the Markhamville mines.

Exports of Manganese ores from New Brunswick, 1868-1894:—

	Tons.	Value.
1868	861	$ 19,019
1869	332	6,174
1870	146	3,580
1871	954	8,180
1872	1,075	24,495
1873	1,031	20,192
1874	776	16,961
1875	194	5,314
1876	391	7,316
1877	785	12,210
1878	520	5,971
1879	1,732	20,016
1880	2,100	31,707
1881	1,504	22,532
1882	771	14,227
1883	1,013	16,708
1884	469	9,635
1885	1,607	29,595
1886	1,377	27,484
1887	839	20,572
1888	1,094	16,073
1889	1,377	26,326
1890	1,729	34,248
1891	233	6,131
1892	59	2,025
1893	10	112
1894	45	2,400
Total	23,024	409,203

In the year 1894, the export practically ceased. The mines at Markhamville yielded over one half of the whole Canadian product up to the time at which work was suspended.

High grade of ore.

As indicated by the preceding table, the manganese ores of Markhamville are largely high-grade ores, and derive their value not so much from their manganese contents as from their being in a condition to readily part with their oxygen, and hence to be of service in such chemical processes as demand the free use of the latter. Among these are the manufacture of chlorine, the decolorization of glass and the making of varnishes and cements, and for these purposes the Markhamville product was chiefly used. Other uses to which they are adapted are the construction of Leclanche batteries, the manufacture of disinfectants, such as manganate and permanganate of potash, as colouring materials in the printing of calicoes, the staining of glass, pottery, brick, etc., and the making of paints. For the manufacture of spiegeleisen and ferro-manganese, alloys of the metal used in the manufacture of steel, the "available oxygen" has no importance, and much cheaper ores may be employed. But little of the Markhamville ore was, accordingly, used for this purpose. Applications.

In preparation for market, the better class of ores, known locally as high-class ores, were first crushed, then washed and finally sized in screens, to be afterwards loaded in old petroleum barrels, containing something over 1000 pounds each. These were usually estimated by their appearance, but sometimes by analysis, the very best ranging as high as ninety-six per cent of pure manganese ore, worth about five cents per pound. The lower grades, under the name of "furnace ore" or "metallic ore" were shipped without special treatment, the price being based upon analysis, fifty per cent of manganese being employed as the standard. In the year 1888, the price in England of this latter ore was $15 per ton. Estimation of values.

The Markhamville mine is said to have produced some of the highest grade manganese found in the world.

The following are three analyses of high-class ore from Markhamville, taken from The Mineral Resources of the United States, 1888:— Analyses.

—	No. 1.	No. 2.	No. 3.
Manganese binoxide	98·78	......	......
Manganese peroxide	......	97·25	96·62
Silica	·55	......	......
Iron	·75	......	......
Iron peroxide	......	·85	·78
Barium	Trace.	......	......
Baryta and Silica	......	·95	·85
Water	......	Trace.	Trace.
Loss	......	·95	1·75
Total	100·00	100·00	100·00

An analysis of furnace ore (No. 3) as quoted in The Mineral Resources of the United States, 1885, gave:—

	Per cent.
Peroxide of iron	3·75
Peroxide of manganese	52·74
Carbonate of lime	13·40
Silica	9·50
Sulphur	·02

Glebe mine.

Glebe Mine.—This mine was situated three miles north-east of Markhamville, and about seven miles from the I. C. R. at Sussex.

According to Dr. Penrose, the ore was found in a limestone resembling that at Markhamville, though much less disturbed than at that place, and dipping gently to the west. The ore occurs in the limestone in nodules and thin layers, frequently associated with calcite, and following the general direction of the stratification. Several shafts and tunnels were opened, the deepest being eighty-five feet.

Operations at this point were carried on for a short time only, and no particulars are now available.

ordan Mountain ines.

Jordan Mountain.—This mine, discovered in 1882, is situated on the south-eastern side of Jordan Mountain, and near the head of a brook forming one of the tributaries of Smith Creek, itself a branch of the Kennebecasis River. It is distant about seven miles from Sussex station on the Intercolonial Railway, and about seventeen miles from Markhamville, being connected with the former (with the exception of about a mile near the mine) by a well built and easily travelled thoroughfare.

Geological ondition.

The general geological relations at Jordan Mountain are similar to those of Markhamville, *i. e.* the ores are similarly found in Lower Carboniferous strata near the contact of the latter with older metamorphic rocks (gneisses, felsites, etc.) presumably of pre-Cambrian age. But instead of occurring, as at the locality last named, chiefly in limestones, or in clayey deposits which have been formed by the decomposition of the limestone, they are here found in connection with shales and shaly conglomerates, made up largely of fragments of the older rocks on which they rest, which are distant from the mine only about 200 yards. The mine, so called, is merely a trench, which at the time of examination, several years ago, was found to be about seventy feet in length, with a depth of from ten to twelve feet. The sides of this trench show the shaly conglomerates dipping in each case to the south-east at an angle of 70°, while the base of the trench was chiefly occupied by the deposit of manganese, extending for a distance of about sixty-five feet, with an average thickness of about six feet.

Ores.

In approaching the ends of the cutting, the ore-deposit was found to thin out rapidly and to alternate with the conglomerates; but the trench had not been opened sufficiently far to enable one to form a very accurate idea, either as to its extent or character. Its appearance was that of a lenticular mass conformable to the bedding rather than that of a vein, but such mode of occurrence has already been referred to as common in manganese deposits, and has little bearing upon the total quantity of ore which the beds may contain. About 250 tons are said to have been removed. Removal of ore.

In addition to the main vein, small veins and stringers of manganese oxide were observed penetrating the surrounding rocks for a distance of twenty or thirty feet, while in some instances angular fragments of conglomerate were apparently cemented by the ore into a sort of breccia.

This brecciated character of the Jordan Mountain deposits, in contrast with those of Markhamville, is interesting, as being, according to Dr. Penrose, a common feature in connection with manganese ore-beds both in Canada and the United States. Thus at Tenny Cape, in Nova Scotia, this feature is very conspicuously seen, as it is also in the great deposits of the Batesville region in Arkansas. In discussing its probable origin, the author referred to, points out that the brecciation is confined to the manganese-bearing strata, and therefore can hardly be the result of folding, especially as the associated beds are of a character which would make them equally susceptible to the effects of shearing; and is inclined to ascribe the result to chemical action, this action being possibly connected, in some instances at least, with the association of gypsum beds. None of the latter, however, have as yet been observed in immediate proximity to the Jordan Mountain deposits. Brecciation of manganese beds.

The ore of the main vein at Jordan Mountain is mostly a fine-grained pyrolusite, of a massive character and iron-black or steel-gray colour and dull lustre, but exhibiting also crystalline veins and masses. Probably with the pyrolusite is more or less manganite and other oxides. The rocks in the vicinity are everywhere stained brown from the presence of the same ores, and trial-pits opened upon other portions of the same property at considerable distances from, but on the same general line as that of the vein already opened, have been found to contain manganese in greater or less abundance. Of specimens collected at random, some were found to be quite pure, while others contained a considerable admixture of quartz. Limonite, hæmatite, barite and calcite, all of which occur at Markhamville, were not observed at Jordan Mountain. The absence of clay deposits here is probably connected with the absence of limestones. Character of ores.

The following are several analyses of the Jordan Mountain ore :—

4

Analyses.

1. Analysis by Prof. P. B. Wilson, Baltimore, Md., Nov. 7, 1887

	Per cent.
Manganese binoxide	86·08
(Equal to metallic manganese 54·57).	
Iron oxide	0·87
Silica	2·86

2. Analysis by Dr. Olto Wirth, Pittsburgh, Pa., Nov. 22, 1887 :

	Per cent.
Metallic manganese	52·88
Iron	1·18
Silica	9·70
Phosphorus	·014

3. Analysis by Pennsylvania Steel Company, Dec. 12, 1887 :

	Per cent.
Manganese	57·37
Silica	0·23
Phosphorus	0·015
Sulphur	0·61

Quaco mines.

Quaco Head Mine.—This mine was also examined by Dr Penrose, whose description of its features could not well be improved. It is as follows: "The Quaco Head mine is situated on Quaco Head, on the north shore of the Bay of Fundy, one mile south of the town of St. Martins, about thirty miles east of St. John, and twenty-four miles south of Markhamville. It forms a bold headland protruding into the bay for almost a mile and forming the southern barrier of Quaco Harbour. A branch railway connects St. Martins with Hampton, on the Intercolonial Railway, which runs thence to St. John, making the total distance from Quaco Head to St. John, by rail, fifty-one miles. The mine has been worked at several different times, and up to April, 1889, several hundred tons of ore are said to have been taken out. The property was acquired in 1889 by the Brunswick Manganese Company.

Situation.

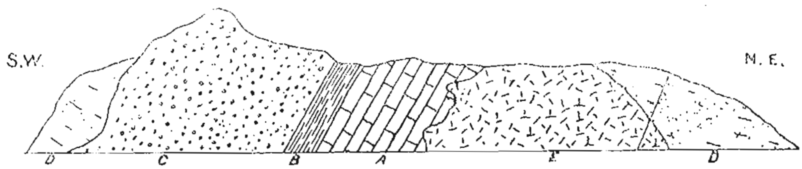
Nature of ore.

"The manganese is sometimes crystalline, representing pyrolusite and possibly also manganite, while at other times it is hard and massive, possibly representing psilomelane, and still again it is in porous, honeycombed form. These ores are found in Lower Carboniferous shales and limestones, associated with a large conglomerate bed.

Associated rocks.

"The rocks are greatly disturbed and have been much shattered and broken by igneous intrusions. They now stand at steep angles, sometimes almost vertically, exposing, in different parts of the headland, areas of limestone, shale and coarse conglomerate. Masses of igneous material protrude into these beds at different points, and on either side of the headland are beds of Triassic sandstone and fine conglomerate lying unconformably on the upturned edges of the older rocks.

"The general section [here reproduced] shows the relation of the different rocks. It will be seen that the conglomerate forms the highest part of the headland, that to the north-east of it are successively the shale, limestone and an igneous intrusion, and that the Triassic sandstone occupies both sides of the headland. Geological section.



Horizontal scale 660 feet to 1 inch. Vertical scale 100 feet to 1 inch.

FIG. 3. SECTION ON QUACO HEAD, NEW BRUNSWICK.

A. Limestone.
B. Shale.
C. Conglomerate.
D. Triassic sandstone.

"The manganese occurs as nodules and irregular, discontinuous veins, in both the shale and the limestone, though the larger quantities are in the former. The nodules vary from the fraction of an inch to several inches in diameter, and the thickness of the veins is equally variable. The disturbed character of the rocks renders it somewhat difficult to determine the thickness of the main ore-bearing bed, but it is probably not over thirty feet, though smaller quantities of manganese are found in the rocks on either side. The ore is scattered through this thickness in very variable quantities. The amount of commercially available ore at Quaco Head is small. Mode of occurrence.

"The igneous rock is a hard, light-gray, close-grained material of a texture somewhat like trap. The limestone is like that of Markhamville, though it is much reddened at the contact with the igneous rock. The conglomerate bed is composed of coarse pebbles of metamorphic rocks. It dips steeply to the south, and forms a bold bluff, on which the lighthouse of Quaco Head is situated. The sandstones and conglomerates at each end of the section are of a brick-red colour, and vary from coarse sandstone to a fine conglomerate, with pebbles from a quarter of an inch to one inch in diameter, both sand and pebbles being composed of white quartz stained by a ferruginous cement.

Sometimes these beds contain small irregular seams or nodules of manganese ore, which, however, are in very limited quantity, and have doubtless been derived, during the deposition of the beds, from the erosion of the Lower Carboniferous rocks."

The accompanying analyses by Dr. A. M. Comey, show the composition of the better grades of ore from Quaco Head,

Analyses.

Analyses of Manganese ore from Quaco Head, New Brunswick.

Constituents.	Compact variety.	Porous variety.
Manganese peroxide	71·54	65·00
Ferric oxide	2·19	1·75
Calcium	trace.	trace.
Phosphorus	0·02	0·04
Sulphur	0·00	0·00
Insoluble silicates	8·37	6·66
Manganese	58·20	57·15
Iron	1·53	1·23

" The ore-bearing rocks can be traced back on the promontory at intervals for almost a mile, to a place where an opening has been made on the farm of Mr. Molaskey. On the north side of the Head, small scattered nodules of manganese ore are found in the gravel drift that lines that part of Quaco Harbour and extends inland over the Lower Carboniferous rocks. They have doubtless been derived from the latter rocks during deposition of the gravel, in the same way that the red sandstone just mentioned obtained its manganese contents at an earlier date."

Salisbury Bay

On the east side of Salisbury Bay, in Albert county, a small deposit of manganese ore occurs near a contact of Lower Carboniferous and Triassic sandstones, but is not of economic importance.

In the vicinity of Elgin, in the same county, large pieces of good ore are scattered over the surface, but when seen (1878) their source had not been ascertained.*

Shepody Mountain mines.

Shepody Mountain.—This eminence, one of the highest in southern New Brunswick, having an elevation of about 1000 feet, has a composite structure, its lower half being composed of chloritic hydromica-

*Report of Progress, Geol. Surv. Can., 1878-79, p. 18 D.

schists and related rocks, forming a portion of a long ridge of such sediments extending along the St. John and Albert county coasts; while the upper half consists of Lower Carboniferous strata, including the usual association of gray, more or less bituminous limestones, red conglomerates, red and gray sandstones and shales. On the north-east side of the mountain, near the road leading from Hopewell Corner to the Albert mines, the contact of the two sets of rocks may be seen, and in the limestones occurring here are the old excavations of the Hopewell Manganese Mines.

These mines were opened about the year 1860, by Mr. Steadman, of Hopewell, an adit being driven horizontally into the limestones for a distance of about five hundred feet. From the latter a considerable quantity, at least 500 tons, was removed and shipped partly to England and partly to the United States, bringing, it is said, about $50 per ton, though exact returns of the product are not now available. The ore was a compact black oxide, less crystallized than the ores of Markhamville, but said to be of very high grade. It was found to occur both in veins and beds, of which the latter attained in places a thickness of five feet. Owing to various causes, however, of which little is now known, work was abandoned many years ago, and the works have long been in ruins. It is thought by many that the deposits of manganese are by no means exhausted.

History.

Nature of ore.

The third class of manganese ores to which reference has been made are the superficial, impure and more or less earthy ores, commonly known as wad or bog manganese. These are found in beds of greater or less extent, and with varying proportions of manganese oxide, in many parts of the province, but with one exception have been considered as being without value. This exception will now be more particularly noticed.

Bog Manganese or Wad of Dawson Settlement, Albert county.—This very remarkable deposit is located about five miles and a half from the town of Hillsborough, on the slope of a hill inclining north-easterly at a low angle towards a small brook, flowing thence to the Petitcodiac River, and whose opposite slope is occupied by the settlement above named. The upper part of the first ridge is wooded, but between the edge of the latter and the brook the ground is cleared, and upon removal of a thin coating of vegetable matter, usually not more than two inches in depth, is found to be everywhere covered with a very fine black powdery deposit, consisting essentially of manganese oxide.

Dawson settlement deposits.

Extent.

The property, as leased, embraces an area of about 150 acres, and upon about eighteen or twenty acres, or as far as searched for, the ore has been found, the deposit varying in depth from a few inches to thirty feet. In a survey recently made by a Crown Land surveyor, seventy-three borings were made, in squares of one hundred feet, over a space of seventeen acres, showing an average depth of six feet seven and three-quarter inches, equal to 1900 pounds to the cubic yard. There is, accordingly, already in sight and available for use :—

	Tons.
In situ on hillside, 17 acres	173,176
In drying-house and sheds	400
Total	173,576

Depth.

According to the statements of the manager of the property, Mr. R. P. Hoyt, to whom I am indebted for assistance and valuable information, the iron rods used in the above borings, in many of the deepest places, failed to go down over twenty-five or thirty feet, and then struck what was apparently hard manganese ore, so that the above results indicate the minimum quantity. The general aspect of the ground is shown in an accompanying photograph, representing one of the numerous trenches dug in the course of development.

Analyses.

Twelve analyses of the ore have been made by competent chemists, including Prof. E. P. Dunnington, University of Virginia, William White, jr., Pittsburgh, Pa., the chemists of the Cambria Iron Works, Johnstown, Pa., the Carnegie Steel Co, Pittsburgh, Pa., and the Illinois Steel Co., Chicago, Ill., the average of these giving :—

	Per cent.
Metallic manganese	45·81
Metallic iron	9·95
Sulphur	·03
Phosphorus	·05
Silica	5·36

Uses.

These ores are thus, in comparison with those of Markhamville, low-grade ores, and would be of little or no value for the uses to which the latter are chiefly put. Nor in their natural condition would they have commercial value of any kind. It is, however, proposed to subject them to a bricquetting process whereby the pulverulent and absorbent mass shall be rendered solid, non-absorbent and capable of easy handling, in which condition it may be advantageously used in the manufacture of spiegeleisen and ferro-manganese. For this purpose an extensive plant, embracing drying furnaces, compressors, bricquetting machines, etc., has been erected close by the manganese deposits,

Proposed application to manufacture of spiegeleisen

TRENCH IN BOG MANGANESE DEPOSIT, DAWSON SETTLEMENT, ALBERT COUNTY, N.B.

and also near to the track of a branch railway, one mile and a half in length, built by the company, and connecting with the Harvey and Salisbury Railway at a point eleven miles from Salisbury, whence, over the Intercolonial Railway the product may be readily shipped to all Canadian and United States points, the freight rate being on a basis of about $5.20 per ton to Chicago. The shipping point by sea is five miles and a half by rail from the mine to Hillsborough, with direct landing at wharf for vessels of 800 to 1000 tons capacity. The rail rate to Hillsborough is about twenty-five cents per ton, the vessel rate to Atlantic ports of the United States, and others at a greater distance, is about $1.00 per ton. Shipping.

On Sawmill Creek, which traverses a valley along the western base of Shepody Mountain, manganese ore has been observed, and is now being exploited by Mr. R. P. Hoyt, of Hillsborough. Other localities.

The following additional localities of bog manganese are indicated by specimens in the Museum of the University of New Brunswick, but of which particulars are not now available:—Richibucto, (Kent county): Bull Moose Hill, (Kings county); Queensbury, (York county); Elgin, (Albert county); Moores Mills, (Charlotte county); and the vicinity of Woodstock, (Carleton county). One of the Fredericton cemeteries, just above the old Government House in Fredericton, is underlain by a bed of impure wad.

According to the scale of valuation in use among consumers of manganese ores (multiplying the percentage of manganese by the price per unit, and forty-five per cent ores being worth twenty-eight cents a unit), the Dawson Settlement ore would have, allowing sixty cents for iron value, a total average value of $13 to $14, though portions of it would range much higher than this. At present it is the intention of the company to use the material solely in the manufacture of steel, and with that object in view it has bought the plant of the Pictou Charcoal Iron Company, at Bridgeville, N. S., to which the ore is to be sent. In the latter place the company is in possession of 4000 acres of woodland and twenty-two charcoal kilns, while the plant at Dawson Settlement, with railway, has an estimated value of about $30,000. The company is known as the Mineral Products Company, the head-quarters being in New York, with Mr. Russel P. Hoyt, of Hillsborough, as general manager. Valuation.

The process of manufacture now in operation at Dawson Settlement may be briefly summarized as follows:— Process of manufacture.

The ore is brought in tram-cars from the deposits near by, and on reaching the works is dumped on a platform on a level with the feed-hopper of a large revolving "drier," the latter being a cylinder of half-inch iron, five feet in diameter, and twenty-eight feet long, inclosed in a brick chamber 10 x 44 feet, and thirty feet high. By the revolution of the drier, which is heated by wood or coal fires beneath, the material now deprived of a large part of its water, is carried to the end of the brick chamber, and there dropped into a special conveyor, by which it is carried to the foot of a bucket elevator, and by this to the top of the building. Here it is made to pass through a revolving screen with the effect that the finer part passes into and is retained by the "dry ore bin," while the coarser part is carried off to be subjected to the action of a grinder, after which it also comes back to be again passed through the revolving screen as before. Above the drier is a dust chamber with a V-shaped bottom, and provided with a spiral conveyor. By this any fine ore which may be passing along with the steam or gases from the drier is made to settle, and thence passes to the foot of the elevator to be carried to the revolving screen and dry ore bin.

Bricquetting. From the "dry ore bin" the material is removed to a mixer, there to be mixed with a suitable "binder," the nature of which is not made public. The mixed material is then ready for the bricquetting machine, into which it enters at the top, issuing from below in the form of very compact cylinders, each about three inches in diameter, and about two and a half inches long. These are at once transferred, on the same level, to cars for removal.

Probable origin of bog manganese deposits. An interesting question, in connection with these deposits, is that of their probable origin. Upon this point the locality throws very little light, there being absolutely no exposures of rocks anywhere in the vicinity, or any visible source from which the manganese may have come. The nearest rocks are indeed those of the Millstone Grit, though these are doubtless underlain, as at Hillsborough and about the Albert mines, by Lower Carboniferous rocks, including limestones. None of these, however, are markedly manganiferous. It is also a little singular that the deposit should have such a decided slope, instead of being, as usual with bog-ores, nearly horizontal. Finally, the abruptness with which the deposit ends along the line of the brook referred to above, towards which it inclines, while no such material is to be found on the opposite slope, is also remarkable, and seems to suggest that the ores are the result of deposition from springs originating on the one slope but wanting on the other, while the brook has carried off the excess of the solvent water. In support of this view it may be observed that the hillside on which the ore-beds rest is remarkable for the number of springs which issue from its surface, in the waters of which both iron and manganese may be readily detected.

In connection with the subject of the origin of the bog-ores of Dawson Settlement, a few words relative to the formation of the older and purer manganese deposits, such as those of Markhamville, Jordan Mountain, Quaco, etc., may not be out of place.

It has been suggested by Sir J. Wm. Dawson that the manganese deposits in the marine Lower Carboniferous limestones of Nova Scotia may have been derived from the decomposition of trappean débris, not unfrequently associated with these limestones and of contemporaneous origin; and a like view is taken by Mr. E. Gilpin, Deputy Commissioner of Mines for Nova Scotia, except that he regards the older strata bordering the Carboniferous tracts as being also a possible source from which the metal may have been originally derived. Both explanations would be equally applicable to the deposits of New Brunswick, for igneous ejections, in the form of dolerite, diabase, etc., are, as at Quaco, a common accompaniment of the Lower Carboniferous limestones; while in the rocks of the Huronian system, such as underlie the manganese-bearing strata at Markhamville and Jordan Mountain, are also contained much material of volcanic or semi-volcanic origin, these in the latter instances having been found to be actual carriers of this metal. On the other hand, the observations made by various exploring expeditions, and especially that of H. M. S. *Challenger*, have made it certain that manganese deposits, much like those under discussion, may be in process of formation over many portions of the sea-floor. Other view to origin.

BITUMINOUS COAL.

There can be but little doubt that among the minerals of New Brunswick, bituminous coal was one of the first to attract attention, its mode of occurrence, ready recognition and obvious utility alike contributing to that result. It is probable that the first discoveries were made at Grand Lake, and from the beds in that vicinity, coal would appear to have been obtained in small quantities as early as 1782;* but it was not until nearly sixty years later, through the explorations of Dr. Abraham Gesner, that the full extent of the areas occupied by coal-bearing rocks was made known. Between the years 1839 and 1841, Dr. Gesner, in addition to the recognition of limited areas of such rocks near the coast, styled by him the "Chignecto Bay First discoveries. Explorations of Dr. Gesner.

*Rev. W. O. Raymond, in a paper read before the Historical Society of St. John, Dec. 1897.

Coal formation" and the "Westmorland Coal-field" ascertained that a large part of the central counties, including the whole of Sunbury and Kent, with large portions of Queens, York, Northumberland and Gloucester were underlain by rocks of the same age. These general conclusions were subsequently fully verified, especially by the work of the Geological Survey,* with the recognition, however, of the fact that, with a large superficies, owing to the approximate horizontality of the beds, the formation had in all probability but little thickness, and, in direct contrast to the extravagant views of Dr. Gesner, coal-seams of inconsiderable amount. As the facts bearing upon this question have been largely derived from explorations in the Grand Lake region, a brief history of the operations there will be of interest.

Exaggerated views.

Grand Lake deposits.

The coal mines of Grand Lake are situated on its northern side and about its eastern extremity, mainly in the vicinity of the Newcastle River, on the Salmon River, in Chipman, and about the lower part of Coal Creek, the entire extent of the Newcastle basin being estimated at about 100 square miles. The country has an average elevation of not more than fifty feet above the lake, while the surface of the latter is not far from sea-level. The country, except where cut by water-courses, is also nearly flat, with a drift covering varying from a few inches to thirty or forty feet. The lake is navigated by steamboats and small sailing vessels, the distance from Newcastle to St. John by water being forty-five miles, and from Chipman to the same port about fifty-two miles. Chipman is now connected by the Central Railway with the Intercolonial Railway at Norton, a distance of forty-four miles, and it has been proposed that this line be extended, a distance of thirty-five miles, to Fredericton. The means for removal of the product of the mines to market are therefore ample.

Means of access.

Development.

The development of the mines has been very slow. Indeed, through their entire history there has been almost a total lack of combined and persistent effort. For many years the removal of coal was effected in a most desultory way, each farmer upon whose land the seam was exposed devoting a portion of his winter's leisure to getting out what was needed for his own use, or occasionally hauling a load on sleds to Fredericton. A considerable quantity was also sent to the same place or to St. John, mostly the former, by wood-boats, obtaining a ready sale. Little or no care was, however, taken in the handling of the coal. Screening, if undertaken at all, was very imperfectly done, and no attempt whatever was made in the direction of system or economy. To a considerable extent the same state of things still prevails,

Careless working.

*Report of Progress, Geol. Surv. Can., 1872-73.

all tending to give the coal a reputation considerably below its real value. There being only one seam of coal, but twenty-two inches in thickness, and this occurring often so near the surface as to be obtained by the simple process of stripping and quarrying, the coal was liable to considerable deterioration from exposure, dirt, etc., detracting still further from its value. Even at the present time, so slight is the attention paid to preserving the quality of the coal, that it is often loaded and unloaded several times in surmounting the low swells of the surface which intervene between the pits and the wharf, while at the latter it is not even dumped upon a platform, but thrown upon the ground, to be further mixed with earth or crushed by the wheels of passing vehicles.

Thickness of seam.

It has been said that practically only one seam of coal, twenty-two inches in thickness, exists at Grand Lake. The idea that other and thicker seams might be found at greater depths was long entertained, and was favoured by what was known of coal-development in Nova Scotia. Accordingly, in 1837, a company was formed to test this point by boring. As a result, at a point about two miles above the mouth of Salmon River, a bore-hole was sunk to a depth of a little over 400 feet, the return of the borings embracing, at a depth of about 250 feet, "eight feet of shale and coal." The relative amount of each was not stated, and prominence is given to the shale; still the result was regarded as affording some encouragement towards more systematic and extensive mining. Nothing, however, beyond the continual removal of the "surface seam" was actually done, and it was not until 1866 that further borings were undertaken, in this case at Coal Creek. A depth of ninety-six feet was attained, but showed no coal. In 1870 still another boring, but equally without result, was made on Salmon River to a depth of 217 feet.

Result of borings in 1837

Borings 1866.

Results.

Of the above borings the first was certainly unreliable and inconclusive, while the two last were decidedly unfavourable. Still the impression continued to prevail that the question had not been finally settled, and with a view to its determination, the assistance of the Geological Survey was invoked for the purpose of making a more thorough and systematic investigation of the whole subject, the sum of $4,000 being at the same time appropriated by the local legislature for the purpose of assisting the investigation through the use of a diamond drill. In pursuance of these undertakings, the whole field was very thoroughly examined, the position and nature of all outcrops determined, and the geological structure carefully studied; the general conclusion being that the area of the Grand Lake coal-field proper, embracing about 112 square miles, was evidently that of a shallow basin, with a maximun depth not exceeding 600 feet, and of this fully 200 feet belonging to the lower or barren measures. This conclusion was in a measure confirmed by the results of the borings, which at a depth of 217 feet were found to have passed entirely through the coal formation, bringing up characteristic cores from underlying and older rocks, and showing no trace of any beds other than those near the surface. Notwithstanding, however, the removal, which would thus seem to be conclusive, of any reason for belief in deeply seated beds, the same observations sufficed to show that the surface seam, if, as is probable, the latter underlies the entire area, must contain a large quantity of coal, and that this, from the ease with which it is worked must possess a considerable aggregate value. Taking only the Newcastle area proper into account, the estimated amount of coal contained therein is 22,135,449 tons, or, if the associated areas of Salmon River and Coal Creek be included, (about which the information is less conclusive,) the total will be nearly 155 million tons. Of this it is probable that from 100,000 to 125,000 tons have already been removed.

Borings 1873.

Estimated capacity of Newcastle coal-fields.

Annual output.

The output of the Grand Lake coal mines in 1863 was about 3000 chaldrons, and since that time has averaged about 4000 chaldrons annually, the chaldron being about one and a half tons or 3200 lbs. Of this about 1000 chaldrons go to Fredericton, where the coal is used in the electric light works and water-works, as well as in factories, mostly for steam-making purposes. Its selling price in Fredericton is now about $3.50 per chaldron, though in some cases as high as $4. It is sent by water, at a cost of eighty cents per chaldron. From Newcastle all the coal now goes by water, either to Fredericton or St. John, the price being about the same. From Chipman none has been shipped by water either to Fredericton or St. John, but what is here raised (the amount being small,) is used on the Central Railway.

Markets.

Manufacture of coke.

In 1891 an attempt was made to manufacture coke ; and again, two years later, by Messrs. Geo. King and Silas McMahon, but the work was not pushed beyond a test. The coke was pronounced good, but for some reason not ascertained the work was abandoned.

Methods of mining.

The average work of one man at the mines is about one chaldron per day, of good coal, at a cost of $1.50. With a thicker seam coal could be readily extracted at a cost of fifty cents.

The soil covering varies from three feet to thirty feet. If not more than seven or eight feet in depth the soil is "stripped." Beyond that depth it is usual to go under. The seam lies nearly at the level of the lake, and much difficulty is experienced in connection with drainage. No pumps have been used, except in one instance, by Mr. MacFarlane, of Fredericton, the small size of the seam not making the inducement sufficient for the introduction of steam pumps.

In the Geological Survey Report for 1873, full descriptions are given of all the openings made up to that time. During the visit of the writer in 1897, an interesting opening had just been made on the farm of Robt. Cox, now leased to the Central Railway on the Emigrant Settlement road, about four miles from Newcastle Landing. It is fairly representative of all. A stripping has been here made showing a surface of coal for about fifty feet in length by ten feet in width, and having a gentle slope west-northwest of about one foot in twenty. The soil covering, which at one end is about five feet deep, increases to about ten feet at the other, and is largely clayey, with many imbedded blocks of sandstone and shale. The following is a section of the exposure :— **Recent examinations.**

Soil....	5 to 10 feet
Good coal....	22 inches.
Shale and clay....	6 "
Coal....	11 "
Fire-clay, at least 4 feet deep, but of which the bottom has not been reached.	

The coal is firmer and can be mined in larger lumps here than at many of the openings in the vicinity. The seam is doubtless the same as at other localities in the Newcastle field, differing only in the fact that the clay and shale parting found here between the upper and lower part of the seam, is elsewhere usually shale only, locally known as "bone". The lower coals are usually not removed, as affording a good solid foundation on which to work, in preference to the soft clay beneath.

It may here be noted that a tramway down the valley of Newcastle River would pass near most of the important openings, and by doing away with the loading, dumping and reloading already alluded to, (which tends to reduce the coal to very small fragments, if not to dust), would serve to bring the coal to market in a much more satisfactory condition. **Transport.**

As to other parts of the New Brunswick coal-field, it would be out of place to describe here in detail all the localities at which outcrops of coal have been observed. In most instances the seams are small and of no economic value; but as bearing upon the general question **Other areas.**

*Report of Progress, Geol. Surv. Can., 1878-79, p. 20 D.

of the character of the field and its possible supply, it may be well to enumerate them briefly.* They are as follows :—

QUEENS COUNTY.

Coal occurrences.

Clones Settlement.—According to explorations made here by Dr. G. F. Matthew, there are two seams, with thicknesses respectively of one and two feet. The quality of the coal is good, and some attempts to work it were made in 1872, but the situation of the mine being unfavourable, these were soon abandoned.*

Otnabog and Mersereau Brooks. Report of Progress, 1872-73, p. 219.

SUNBURY COUNTY.

Near Tracey.

North-west Oromocto, below mouth of Hardwood Creek.—Seam of five inches.

Three-tree Creek. Borings made here reached a depth of 600 feet, but failed to show seams of coal.

North-west Branch of Oromocto River, one and a half miles above the mouth of the Yoho stream. Coal seams four and five inches.

YORK COUNTY.

Nashwaaksis River.

Taxis River.

Cork Settlement.

Prince William.

KENT COUNTY.

Coal Creek.

GLOUCESTER COUNTY.

New Bandon or Stonehaven.—The stone quarries opened at this locality, as well as at Clifton, near by, upon the southern shore of the Bay Chaleurs, besides affording a fine exposure of Carboniferous strata, lying probably near the base of the system, show also a seam of coal about eight inches in thickness, while other seams are said to show at low water, one of them with a thickness of eighteen inches. The strata

Bay Chaleurs.

*Report of Progress, Geol. Surv. Can., 1872-73, p. 219.

exposed in the nearly vertical bluffs which form the shore for several miles, consist below of massive sandstones, often of pale-greenish colour, with thin intercalated beds of shale (the latter often replete with fossil ferns admirably preserved), and above of gray, green and red crumbling shale, the whole series showing a very gradual south-east dip. As representative of the probable structure of a large part of the coal-field in this county, this coast-section is very instructive. The total thickness of exposed beds is about seventy-five feet.

KINGS COUNTY.

Dunsinane.—At this locality, which is a few miles east of Sussex and close to the track of the Intercolonial Railway, a seam of bituminous coal occurs, with a thickness of about twenty inches, the associated rocks being gray sandstones with blue, gray and reddish shales. In the latter are typical Carboniferous plants. A number of excavations have been made, in one instance to a depth of sixty feet, but without further result than that stated. Dunsinane, Kings county.

During the year 1897, boring operations were undertaken with the drill belonging to the provincial government, and a depth of nearly 1300 feet has since been reached. All the rocks passed through are such as belong to the coal formation, most of them being fine bluish-gray sandstones, associated with grit and fine conglomerates, but without red rocks. The unexpected thickness of the Coal Measures at this point is very remarkable, and must have an important bearing upon the possible thickness elsewhere.

Longs Creek, (near mouth.)—Seam ten to twelve inches, but very impure. Longs Creek, Queens county.

In regard to the question of the probable productive capacity of the New Brunswick coal-field, the facts afforded by the Newcastle or Grand Lake basin are of the utmost importance. Considering the results of the careful surveys of this district (fully detailed in the Geological Survey Report for 1873), together with the results of borings and mining operations, no reasonable doubt can be entertained that, in this particular basin, the coal formation is very shallow (probably not exceeding 500 feet), and that the twenty-four inch seam which has there been so long worked is practically the only one present. The structure of the district at the same time shows that this seam, occupying a low position in the Carboniferous formation, rests upon a floor of older rocks, including red sediments and trappean overflows of the Lower Carboniferous formation, in such a way as to clearly indicate not only unconformity but also extensive erosion between the two. It Discussion on coal supply.

Thicker seams possible.

is, therefore, possible that while the Coal Measure rocks over certain tracts, as over prominent ridges of the underlying beds, may be very thin, (or, as at Newcastle Forks and Coal Creek, may allow these to protrude through them), at other points, where underlying pre-existing valleys or depressions exist, they may have a thickness corresponding to these depressions. In these latter cases it is also possible that, with greater bulk of strata, they may include more seams of coal.

This condition of things is really typical of the entire central coal-field of the province. The strata are everywhere in an attitude varying but little from horizontality; the seams of coal approximate in thickness to that of Grand Lake; the associated fossil plants indicate about the same horizon; and the thickness of beds exposed in river-sections are too inconsiderable to admit of any conclusion being drawn as to what the total thickness is, or the extent to which it may vary. The only possible way, therefore, by which to test its productive capacity, is that of instituting systematic borings, along several parallel lines, at such intervals as may clearly indicate the varying thickness of the formation, and reveal the presence of additional seams of coal, if any such exist. Even should the results be negative, the information obtained would be of value as substituting certainty for conjecture, and thereby tending to save the useless expenditure of money.

Three-tree Creek, York county, 1897.

In addition to the borings at Newcastle, Salmon River and Coal Creek, previously referred to, borings have already been made at several other points with negative results. One of these was at Three-tree Creek, near Fredericton Junction, where, in the year 1873, a diamond drill penetrated to a depth of 600 feet, but found no coal.

Borings at Moncton, 1897.

Another locality is the vicinity of Moncton, where during the summer of 1897, with a diamond drill leased from the local government, a number of bore-holes were made, in some instances to considerable depths. A visit to one of these was made by the author of this report, the locality being the farm of Peter Wilson, about nine miles north-west of Moncton and near the base of the southern slope of Lutes Mountain. This latter is a ridge of coarse red conglomerate, of Lower Carboniferous age, associated with reddish felsites, boulders of which strew its sides. The bore-hole is close to Wilson's house, and less than a furlong from the conglomerate ridge. At the time a depth of 120 feet had been reached, about two-thirds of this being in a very fine rather dark-gray sandstone, while the beds below were generally reddish, though less markedly so than is usually the case with Lower Carboniferous strata. No beds of coal were passed through and this notwithstanding the fact that an eighteen inch seam was said to have been exposed, some fourteen years ago, within a few feet of where the present boring has been made. No rock is visible at the surface, the beds being covered with about eighteen feet of clay, in which some small fragments of coal were seen. Two miles west of the above, another boring obtained a depth of 737 feet. It is proposed that the cores obtained from these several borings, together with those derived from the operations at Dunsinane, shall be sent to Fredericton for critical examination. The results there obtained, with additional data derived during the past summer (1898) from examinations over various parts of the coal-field, will be embodied in another report now in course of preparation.

ANTHRACITE.

The occurrence of anthracite coal, in limited quantities, in the Devonian rocks of St. John county, was first brought to notice by the observations of Dr. A. Gesner,* in the year 1839, small seams of such coal having been noticed by him in the neighbourhood of the Lepreau River, and subsequently, in the form of trunks of trees converted into anthracitic matter, in the vicinity of Little River, east of the city of St. John. Later observations showed that such coal was not of uncommon occurrence in the rocks referred to, but at two points only, both in the Lepreau basin, and not far apart, did the quantity of coal appear to be such as to warrant any attempt to work it. First discovery.

The locality in which mining operations was first undertaken, in 1877, was that of Lepreau Basin, a short distance west of the line between St. John and Charlotte counties, on the land of Mr. G. K. Hanson.† Several shafts were here sunk, one of them reaching a depth of 140 feet, the strata penetrated consisting largely of gray sandstone, but with alternating beds of shale, both of which carry, somewhat abundantly, characteristic Devonian plants. At a depth of 125 feet a seam of mixed coal and shale was found, having a total thickness of fifteen feet; but the shale was irregularly distributed through the coal, of which not over four feet could be found at any one point, and this much mixed with earthy matter. An analysis of samples from the outcrop, made by Dr. B. J. Harrington, gave 36·88 per cent of ash; though two other analyses, of selected samples from lower levels, reduced the proportion of impurities to twenty-one and fourteen per cent respectively. When tested on a large scale for steam Location at Lepreau Basin. Result of boring operations.

* First Report on Geology of New Brunswick, pp. 51-53.

† Report of Progress, Geol. Surv. Can., 1876-77, p. 345.

producing purposes, the coal is said to have ignited readily, and to have had good heating capacity, but, as might be expected, burned imperfectly, leaving a considerable quantity of clinker. Work was carried on at this locality, more or less continuously, for four or five years and then abandoned. Considering the nature and age of the associated rocks, the impurity of the larger part of the product and the difficulties attendant upon its removal, it does not seem probable that mining operations of a profitable character are ever likely to be prosecuted here.

Development.

ALBERTITE.

No mineral found in New Brunswick has awakened more interest than this. None is so peculiar in its nature and associations, none has been the subject of greater controversy, both scientific and legal; upon none has more capital been expended, and from none has a larger return been obtained.

Geological horizon.

The mineral is essentially confined to the Lower Carboniferous formation, though in very limited quantities it has also been observed in underlying metamorphic slates and in overlying Coal Measures. By far the larger part is confined to heavy beds of very fine-grained dark-gray to black bituminous shales which occur near, if not at, the base of the Lower Carboniferous, penetrating these shales in the form of veins.

Physical character.

Albertite is soft and brittle, jet black, brilliantly lustrous and breaks with a marked conchoidal fracture. In its physical characters it bears much resemblance to asphaltum, but is less friable, is differently affected by solvents and has a different chemical constitution. Though for a long time regarded as unique, it is now thought to be identical or nearly so with the mineral gilsonite, found in small quantities in Utah as well as with the grahamite of Western Virginia. Its hardness is 3, nearly, of Moh's scale, its specific gravity being from 1·08 to 11·1. It may be readily ignited in the flame of a spirit lamp, and may be melted, though less readily than asphalt. It is of uniform quality, and under the microscope reveals no trace of structure. The conditions of its occurrence and its characteristics, both physical and chemical, favour the idea that it is an oxidized hydrocarbon, related to petroleum, and originally in a condition of partial or complete fluidity.*

Probable origin.

*Albertite has been recently found in small quantities forming veins and irregular masses in the pure white and stratified gypsum of the Hillsborough quarries. No stronger evidence of its character as injected hydrocarbon could be desired.

A full description of the history of the Albert mines, involving a protracted dispute as to the nature of the deposit and its consequent ownership, would be too lengthy for the present Report, and reference may therefore be made to the Report of Progress of the Geological Survey for 1876-77 (pp. 351-401) in which the subject is very fully treated, and which is accompanied by a map showing the geographical distribution of the albertite-bearing shales. A brief summary of the more important facts is all that can be given here. Reference to Reports of the Geological Survey.

The vein was originally discovered in the year 1849, on Frederick Brook, about four miles south-west from the town of Hillsborough, and showed at the surface a thickness of sixteen feet. The title to the property having been determined, on the supposition that the albertite was a variety of coal, and therefore reserved to the Crown, a company was at once formed for its development, and operations actively entered upon. These were continued for a period of fourteen years, the greatest output being in the years 1865 and 1866, in each of which the shipments were 20,500 tons, while the total from 1863 to 1874 was 154,800 tons. The royalty paid to the Government up to January, 1866, was $8,089.29. The exportation was principally to the United States, where the mineral was partly employed as an enricher in the manufacture of coal gas and partly in the making of oil. The yield of the latter was said to be about 100 gallons to the ton, while the gas-product was 14,500 cubic feet per ton, of a superior illuminating power. The price at which it sold varied at different periods from $15 to $20 per ton on the wharf at Hillsborough, but its present value, owing to the competition of petroleum, would be greatly reduced. In the course of the operations, it was found to occupy an irregular and nearly vertical fissure, to have a thickness varying from one inch to seventeen feet, to have numerous branch veins, in places cementing innumerable fragments of the shattered strata and even crystals of selenite into a sort of breccia, and finally to show, through much of its extent, complete discordance with the associated strata. The depth attained was over 1100 feet. The width of the vein in the lower workings was greatly diminished, and as a consequence gave a greatly lessened output. Between 1869 and 1870 there was a falling off from 17,000 tons to 6000 tons, and from this time little was done beyond exploratory work and the removal of reserves. These having finally become exhausted and all efforts to find new veins or enlargements of old ones having been ineffectual, the works were closed down. Discovery. Development. Value. Mode of occurrence.

Both before and since the stoppage of the Albert mines, many attempts have been made to discover deposits of a similar nature at Later attempts to discover similar eposits.

different points in Albert and Westmorland counties, where the occurrence of the characteristic bituminous shale seemed to render its presence possible. In several instances these attempts led to the discovery of veins of albertite, but in no case of such a size as to warrant the expenditure of capital in working them.

Geological range.

The facts relating to the possible occurrence of workable deposits of albertite are fully detailed in the report to which reference has already been made. The circumstance that the mineral has been found at points so distant as Norton station in Kings county and Beliveau in Westmorland county, the one fifty miles west and the other ten miles east of the Albert mines, is interesting as indicating the extent of the area over which the conditions resulting in the formation of albertite must have prevailed; but apart from the mine referred to, no facts at present known warrant a belief in its occurrence in other than small veins. At Beliveau, a shaft was sunk to a depth of 500 feet, and large sums of money were spent in exploratory work, but without favourable results.

Bituminous Shales.

The only development of these shales which is of economic importance, is that already referred to as being, in Kings, Albert and Westmorland counties, holding veins of albertite. Apart, however, from this fact, these shales are capable of yielding products which, even if not immediately available, are likely in the future to become of considerable value.

Geological position.

The position of the shales, geographically and geologically, has already been referred to. Lying for the most part along the northern side of the ridge of pre-Cambrian metamorphic rocks that occupy the larger part of St. John and Kings counties, they occur at intervals all the way from Norton station on the west to the vicinity of Dorchester on the east; while their stratigraphical relations and contained fossils indicate that they occupy a position near or at the base of the Lower Carboniferous formation. Full particulars as to both of these points are given in a special report contained, with accompanying map, in the Report of Progress of the Geological Survey for 1876-77.

Exposures at Baltimore, Albert county.

The best exhibition of these rocks, viewed from an economic standpoint, is to be seen in the settlement of Baltimore, Albert county, at which point operations for their working and treatment were undertaken about the year 1862. As seen at this point they consist, for the most part, of heavy beds of a very dense, tough and fine-grained character, from dark-gray to black in colour, effervescing readily upon the addition of an acid, and when rubbed emitting a strongly bituminous odour. Subjected to heat in furnaces erected for the purpose, the shales readily yielded oil to the amount, in the case of the best bed, known as the "black band," of sixty-three gallons to the ton; while the gas-yielding capacity per ton was 7500 cubic feet. In fact, the rock of this band may fairly be regarded as a true cannelite, closely resembling some varieties of the latter in specific gravity, colour and lustre, and like this mineral readily igniting and burning. Blocks, cut from the mass, are jet-black in colour and on polished surfaces much resemble jet.

During the course of operations at this locality, openings were made upon six different strata, the available beds varying from a few inches to four feet. In all about 1000 tons were extracted, and the operations would, no doubt, have been a source of profit, had it not been that the discovery, about this time, of the flowing petroleum wells of Pennsylvania brought the latter into active competition, making the further manufacture of the oil at Baltimore impossible. A few years later (in 1865) about 2000 tons of similar material, but less rich than at Baltimore, were removed from Taylorville, on the Memramcook River, in Westmorland county, and exported to the United States, selling there at the rate of $6 per ton. Amount removed.

PETROLEUM.

It has already been stated that the Albert shales, as seen at Baltimore and Memramcook, have been made the basis of the manufacture of oil, as also that the mineral albertite is in all probability an oxidized mineral oil derived from these same shales. It is now to be added that these are in places so saturated with petroleum as to result in a direct, though small, natural flow of the latter. This fact was well shown during the course of the operations in the Albert mines, when buckets placed in certain positions were found, after periods more or less prolonged, to be filled with oil. The gray sandstones associated with the shales, and for the most part above them, were found to be even more prolific than the shales themselves, and from these sandstones petroleum has been obtained, not only at the Albert mines, but in Upper Hillsborough, Beliveau and Memramcook. In the rear of St. Joseph College, in the last-named village, is a well from which small quantities of petroleum have been obtained, while at Dover, in the same county, a similar flow of oil has, by oxidation at the surface, given rise to deposits of maltha. Jets of inflammable gas are occa- Occurrence of oil at Albert mines, etc. Inflammable gas.

sionally met with in connection with springs and streams in the same district.

Results of borings.

Several attempts have been made by boring, in one instance to a depth of 2000 feet, to discover such oils in available quantities, but so far the flow has, in every case, been found to be too small to admit of profitable collection. It is possible that, with a more careful selection of locations, and with greater regard to the principles of geological structure, future efforts in this direction may be more successful. The facts relating to the albertite deposits seem to point to the former existence, in this region, of enormous quantities of oil, and unless this has been wholly oxidized into the condition of that mineral, (a view at least partly negatived by the occurrence of petroleum) it is difficult to assign a reason why it should not be still available.

Graphite.

Strata containing more or less disseminated graphite or plumbago, occur in connection with rocks of varied age and character in the province, but are especially distinctive of the upper portion of the Laurentian system as found in St. John county. They here consist largely of limestones, and in places carry sufficient bodies of graphite to admit of being worked.

Beds at Suspension Bridge, St. John.

The only point at which operations have been undertaken, is in close proximity to the Suspension Bridge, near the mouth of the St. John River, on the eastern side.* The first opening was made here some twenty-five years ago, close to the water's edge, and a quantity was shipped to the United States. Somewhat later, work was resumed by Mr. S. S. Mayer, of Carleton, from a point on the land of Messrs. Hazen and Botsford, some 600 yards from the river; a few hundred tons being removed, which was also sold in the United States. These works having also been abandoned, Mr. W. F. Best and others united in an effort to revive the industry by sinking a shaft in what was regarded as a position more favourably situated for working. This was 200 feet north-east from Mayer's workings, and four feet from the face of the limestone cliff. At fifteen feet below the surface the deposit was reached. The top was found to be in the form of the sharp edge of a wedge, which widened out rapidly, until, at a depth of thirty feet, it was eight or ten feet wide. Great difficulty being experienced on account of water (from the old workings) which penetrated the loose limestone, making it necessary that a pump should be constantly

Difficulties.

* For information relative to these deposits I am indebted to W. F. Best, analytical chemist, St. John.

employed, it was decided to start a level at the depth above mentioned. A drift from the shaft to the north-east resulted in showing a continuous mass of the material between layers of limestone and trap, which here come together and present an unbroken face as far as work was continued.

Quality. The quality of the graphite at thirty feet, was found to be far better than that of the first samples from the apex of the wedge, and could the deposit be tested with a diamond drill it is not improbable that at a lower level a still further improvement might be met with.

When this shaft was first opened, the results were fairly satisfactory, about $1,200 worth of the mineral being sold in two or three months. The workings were, however, expensive, chiefly on account of water, and a "combine" among the manufacturers of foundry facings having caused sales to fall off, it finally became necessary to again suspend operations.

Markets. The first shipments were made to Chicago, Cleveland, and other western points, the average price obtained being $7 per ton delivered on the railway at Fairville, St. John county. After the closing of the works, inquiries were made for several lots of ten car-loads each, but these orders could not then be filled. Somewhat later, the mine was opened by the Canada Paint Company, which uses graphite in connection with the manufacture of certain kinds of paint, but we are without information as to the results of their experience.

Analysis. In the case of a specimen of "disseminated graphite" from the old Split-rock plumbago mine, near the St. John River falls, collected by Mr. Wallace Broad and examined by Dr. Hoffmann in the laboratory of the Geological Survey, the associated earthy matter, amounting to about six per cent, having been excluded, the residue gave* :—

Graphitic carbon	48·775
Rock matter	50·058
Hygroscopic water	1·167
	100

Practical tests. A quantity of the graphite having been extracted, and its comparative freedom from foreign matter having been assured, samples were sent to England for the purpose of having them practically tested. The result is thus stated by Dr. Hoffmann :—

"In the one case—that examination has shown the graphite to be of fair quality and adapted to the manufacture of the commoner kinds of

* Report of Progress, Geol. Surv. Can., 1878-79, p. 3 H.

lead pencils; although its 'quality and nature' does not equal, as far as suitability for pencil making is concerned, the graphite obtainable in Bohemia and some other places.

Results.

"In the other—and as regards its employment in electrotyping—the trial did not give a very good result; it was not considered so good as that which they were in the habit of using for this purpose."

This failure to meet the higher requirements of the application of graphite, notwithstanding its purity, was thought by Dr. Hoffmann to result from its state of physical aggregation, as implied in the terms "quality and nature" quoted above.

PEAT.

Occurrence.

Peat-bogs are of common occurrence in New Brunswick and in several places cover large areas. The regions in which they are especially noticeable are the southern part of Charlotte county, the adjoining portions of St. John county, and the district bordering the Gulf of St. Lawrence. They have been made a subject of survey and study by Mr. R. Chalmers* and Prof. W. F. Ganong, and from an article by the last-named gentleman relating thereto, published in the transactions of the Royal Society of Canada, 1898, the following extracts bearing on their economic applications are taken :—

"Finally, the economics of the raised bogs merit some attention. In Europe the moss from them has long been used, and in great quantities, as a bedding for horses and for various sanitary purposes, for which its antiseptic qualities and great absorptive power make it especially adapted. It can absorb some twenty times its own dry weight of water, and in stables, by absorbing all liquid matters and allowing the water to evaporate, it retains the nitrogenous matter and becomes a valuable fertilizer. Considerable quantities are imported into New York from Germany for stable use, but no attempt to utilize our own bogs for this purpose appears to have been made until a few years ago, when a company, attracted by the great purity of the Spruce Lake bog (western St. John county), attempted to work it. It was soon found that natural methods of drying the moss as practised in Europe are not here practicable, partly on account of the cost of labour, partly on account of the foggy weather. Five years ago the bog came into the hands of Mr. W. F. Todd, of St. Stephen, N.B., who attempted to make steam and machinery supplant hand labour

Operations of Mr. W. F. Todd.

*Annual Report Geol. Surv. Can., vol. III, (N.S.), 1887-88, pp. 22-25, N. *Ibid.*, vol. IV. (N.S.), 1888-89. p. 70 N., p. 89 N., and p. 27 S. *Ibid.*, vol. VII. (N.S.), 1894, pp. 121-146 M.

and artificially replace natural heat. After long experimenting, an ingenious system of machinery was constructed by which moss was dug from the bog, passed through presses and hot air chambers and over hot air cylinders, and pressed into bales ready for shipment, all within three hours from the time it was in the bog, and without being touched by a workman from start to finish. The German process requires weeks of time and many handlings. The product of the new process is a spongy, finely divided substance, which is considered by good judges to be greatly superior to the imported material. In the autumn of 1895 the buildings were burned and have not been rebuilt. The supply is exhaustless, and if the many new uses occasionally reported for the fibre prove to be extensive, or if its preparation for stable purposes can be made profitable, it will be the basis here of a large industry." Results.

To the information given above, Prof. Ganong now adds:— "Another very fine bog owned by Mr. Todd is at Seely Cove, and another owned by Mr. Oscar Hansen at Little Lepreau. These three are the best, but there are some twenty-four of fair size scattered from Beaver Harbour to Spruce Lake. Hansen's peat-bog.

"The chief difficulty to be overcome in working these bogs, next to the foggy weather, is the freight rates, which are high to New York by rail; but if the material can be worked in large enough quantities, it could be easily sent from any of these bogs by schooner. Difficulties of working.

"The moss is coming to be much used in hospitals in Europe, and the moss powder is said on good authority to be germicidal. It has also been found that the fibrous part can be woven, and is said to have been made into a pulp from which boxes and ornaments of a rich dark-brown colour have been made." Uses.

A considerable quantity of the moss from the Spruce Lake bog was sold in the province and is reported to have given satisfaction.

It has also been suggested as a material adapted for packing perishable goods, and a consequent substitute for cold storage. It was recommended for this purpose by the late Edward Jack, C.E., and it is stated that the result of an experiment in the shipping of fruit to England, packed in this way, was entirely successful.

The area of the Spruce Lake bog is from 350 to 400 acres, while the depth is sometimes more than twenty-four feet. In sounding with a rod, Prof. Ganong was unable, at several places, to find the bottom Area of Spruce Lake bog.

*Report of the Department of Agriculture, 1893.

at a depth of sixteen feet, and Mr. Todd met with the same result at a depth of twenty-four feet.

Spruce Lake bog.

At Spruce Lake, according to Prof. Ganong, practically the entire deposit, except for two feet on the bottom, is adapted to the same uses. It is a pure sphagnous moss, with stems of sedges and some small roots of the dwarfed woody perennials, the latter not being in any way troublesome. Some parts are drier than others, but do not differ materially in composition. The proportion of sphagnum to sedge stems, etc., is far greater in these bogs than in specimens seen from Welland, Ont. The true peat forms a layer on the bottom, two to three feet thick, and no thicker, wherever trenches have been dug. Above that layer all of the moss is utilizable for bedding, etc., thus giving twelve feet or more in the places where the trenches have been dug. A microscopic examination made by Prof. Ganong of samples from different depths, shows that the conversion into peat does not even begin until a depth of seven or eight feet is reached, and it proceeds very slowly at lower levels. Mr. Todd's work shows that the moss makes good litter down to within two feet of the bottom or to depths of about fourteen feet. How it is in greater depth is unknown. There is also a fringe of peat around the margin over which the moss at a later period grows.

True peat.

Lepreau and Seely Cove bogs.

The area of the Lepreau bog is from 300 to 350 acres, and the known depth, as sounded by Mr. Hansen, from sixteen to twenty-three feet, in each case without bottom being reached.

The area of the Seely Cove bog is about 250 acres, and the depth unknown.

The true peat, as far as ascertained, has not been practically employed as a fuel.

Bogs in N.E. New Brunswick.

The following notes on peat-bogs in north-eastern New Brunswick, are quoted from the reports of Mr. R. Chalmers :—

Gloucester county :—

Miscou Island

1. A large peat-bog occurs on Miscou Island, covering fully half the entire island. "It occupies a shallow basin in the Middle Carboniferous rocks, portions of the rim of which are being eroded by the sea. The surface of the bog is ten to twenty-five feet above high-tide level in the centre, while the bottom, which is full of the roots of shrubs and small trees *in situ*, seems to lie below that of the lowest tides, and wherever visible appears to rest on gravel and sand. The bog as already mentioned, is dotted all over with ponds, which form

favourite resting places for the wild geese and brant in their passage over the region every spring and fall. Cranberries abound on it.

2. "A peat-bog about three miles long and a mile and a half wide, was seen on the east side of Shippegan Island, which also rests on a hard-pan of gravel and clay. The surface is ten to fifteen feet above the sea and is likewise destitute of trees. Numerous ponds were observed on it. In the bank the peat is ten feet thick, the bottom lying below high-tide level. Shippegan Island.

3. "The neck of land between St. Simon Inlet and Pokemouche Harbour, is formed of peat. Similarly to the two bogs just described, it is considerably higher in the central part than at the margin, but is nowhere more than ten to fifteen feet above high-tide level. Immense quantities of cranberries grow upon it." St. Simon Inlet.

Northumberland county :—

4. "South of Tracadie River, near Point Barreau, a peat-bog borders a lake, both being surrounded by a tamarac swamp. Point Barreau.

5. "An extensive bog occurs on the west side of the mouth of Tabusintac River, length about three miles, width two miles. Its general features are the same as those described. It is also a favourite resort for wild geese, brant, etc., every spring and autumn. Tabusintac River.

6. "On the east side of Point Cheval a bog was also seen which thins out on the northern margin over an old sand beach." A section of this bog is given on page 24 N. of the report cited. Point Cheval.

7. "A large and interesting peat-bog was observed at Point Escuminac...... covering an area of six or seven square miles. It is highest in the middle and also dotted over with numerous small ponds... ....Mr. Phillips, lighthouse keeper at Point Escuminac, informed me that he found it twenty-four feet deep in one place. Like those already described it is almost treeless, but is partly covered with heath plants." A section of this bog is also given on the page above referred to.* Point Escuminac.

Kent county :—

8. "An extensive peat-bog lies on the north side of Kouchibouguac Harbour. Kouchibouguac.

9. "Another occurs on the coast about a mile south of the mouth of Kouchibouguacis River facing the sea.

*The above quotations are from Annual Report, Geol. Surv. Can., vol. III. (N. S.), pp. 22-25 N.

Aldouane.

10. "A third occupies part of the peninsula between the estuary of Aldouane and the coast of Northumberland Strait. This bog is large and raised in the centre and merges into the salt-marsh on the shoreward side.

Near Kingston.

11. "Two large bogs occur along the Kent Northern Railway, situated from one to five miles above the village of Kingston."*

A number of other peat-bogs are enumerated in the reports cited, and although no use has yet been made of peat in north-eastern New Brunswick, Mr. Chalmers states that should it ever be required for fuel, or for any other purpose, there is here an almost inexhaustible supply.

LIMESTONES.

Geological horizons.

Limestones are met with in the province of New Brunswick in not less than six distinct geological formations, and therefore with much diversity of association and character. As will appear below, their value as a source of lime appears to be nearly in direct proportion to their age.

Distribution in St. John county.

A. LAURENTIAN LIMESTONES.—These include all the heavy beds of this rock exposed on either side of St. John River from Grand Bay to the Suspension Bridge, together with their extensions westward to Musquash and Lepreau, and eastward along either side of the Intercolonial Railway to Hampton. They are distributed in several parallel belts, disposed with reference to a general anticlinal structure, but severally exhibiting great diversity of attitude, as also of colour and texture. Certain beds sometimes attain a thickness of 350 feet, but usually alternate in thinner beds with fine-grained siliceous and dioritic rocks or with quartzites. Diorite dykes of all dimensions also cut the beds, the latter frequently exhibiting, for some distance on either side of the intrusive mass, a marked alteration as the result of the high temperature accompanying the intrusion of the diorite. The best limestones are dark-gray in colour from disseminated graphite, which, however, is wholly lost in calcination.

Used by Brouillon in 1701.

It would appear that the limestones of the St. John River narrows, which still form a striking feature in the scenery, were seen and described by Champlain and his associates not less than three hundred years ago. It is also asserted that from them came the lime used by Brouillon in rebuilding the fort at Port Royal in the year 1701.

*The above bogs in Kent county, are described in Annual Report, Geol. Surv. Can., vol. VII. (N.S.), pp. 117-122 M.

Somewhat later, but before the landing of the Loyalists, St. John lime was exported, in small sloops, to Newburyport and other New England ports, having even then a high reputation. It has at all times been preferred to other limes for use in the Maritime provinces, but as an article of export has only acquired importance in recent years.

Later exports.

The following figures of exports, (all to the United States), taken from the Trade and Navigation Returns of Canada, will serve to give some idea of the extent of the industry, as well as the variations in the amount of the product exported, between the years 1881 (when the trade practically began) and 1897 :*

1881,..	3,644	brls,..	Value, $	1,822
1882,..	6,804	" ..	"	3,402
1883,..	10,488	" ..	"	5,244
1884,..	6,840	" ..	"	3,420
1885,..	9,850	" ..		4,925
1886,..		" ..	"	
1887,..	76,858	" ..	"	38,429
1888,..	183,680	" ..	"	91,840
1889,..	232,710	" ..	"	116,355
1890,..	286,584	" ..	"	143,292
1891,..	203,668	" ..	"	101,834
1892,..	120,350	" ..	"	60,175
1893,..		" ..	"	61,017
1894,..		" ..	"	25,598
1895,..		" ..	"	35,709
1896,..		" ..	"	22,035
1897,..		" ..	"	15,634

There are about twenty-four draw-kilns in the vicinity of St. John, the most important quarries being the following :—

Armstrong's quarry.

I. and F. Armstrong's quarry.—Green Head.—This quarry was opened about the year 1825 or 1828, but for several years with an output not exceeding 800 casks per year. About 1837, this amount, under a different ownership, was increased to 1100 casks, and in 1839 to about 1500 casks. In 1866 the output had increased to about 10,000 barrels, and since that time has not varied greatly from this amount.

The width of the bed at this quarry is about 300 yards, with an exposed face of nearly 100 feet. The facilities for shipment are excellent, and the lime has always held a high reputation.

*Fiscal year ending June 30th.

Miller and Woodman's quarry.—Narrows of St. John River.—The rock here, as at Green Head, is a dark, somewhat graphitic limestone, the worked face being about forty feet.

Randolph and Baker's quarry.

Randolph and Baker's quarry.—Narrows of St. John River—There are here two kilns, each with a capacity of 120 to 140 barrels of lime per day, and therefore, for the nine months during which they are kept running (March to December), yielding from 25,000 to 30,000 barrels of lime.* "They are built of brick, faced with stone, about thirty feet in height; hopper-shaped inside for the upper third of the height, then with a straight funnel for the next third to the level of the fire, and again widening out to the lower floor, from which the lime is drawn. The limestone is put in at the rear of the kiln above, and the burnt lime drawn out from the front of the kiln below, while the fuel is fed in at the side, at the height of a few feet above the floor from which the burnt lime is drawn. The two kilns are inclosed in a large gravel-roofed shed, which extends to the edge of the wharf, so that the lime is protected from the weather even when being shipped."

Construction of kilns.

An analysis of limestone from the quarry made by Mr. A. E. MacIntyre, showed it to consist of 97·38 per cent of carbonate of lime with a little less than 2 per cent of magnesia.

Removal from quarry.

The quarries are distant from the kilns about one-eighth of a mile, and have an exposed face of forty or fifty feet in height, with a width of limestone of some sixty or seventy feet. The rock is removed by the use of a steam drill and dynamite, and has been already penetrated to a distance of 300 or 400 feet. The rock is fed to the kiln as fast as it can be brought by team during a working day of nine hours, and the burnt lime withdrawn from below every six hours.

Importance.

"Every article used in the manufacture of a barrel of lime is made on the premises, excepting hoops, which cost $4.50 to $5.00 per thousand, or about three cents for each barrel. Everything else represents labour employed at the mill and lime-kilns. Hence the great importance and value of the lime industry; for $100,000 worth of lime exported means $91,000 expended in labour." Of the 30,000 barrels of lime manufactured at this point during the year 1898, only 2000 were exported to the United States. This shows that the present tariff is almost prohibitory.

Stetson's quarry.—Indiantown, St. John City.

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*For these and some other particulars relating to the lime industry at St. John, I am indebted to a very interesting article upon the subject published in the St. John *News*, May 13, 1893.

W. D. Morrow's quarry.—Narrows of St. John River.—One kiln Product about 3000 casks per year (in 1886).

Steven's quarry.—South Bay.

Wm. Lawlor & Sons.—Brookville.—Operations have been carried on here for many years, the market being restricted to the city of St. John. The product in 1876 was from 8000 to 10,000 barrels.

The character of the St. John limestones is further indicated by the subjoined analyses, made in the laboratory of the Survey. Previous to analysis the specimens were dried at 100° C. the hygroscopic water thus abstracted being as follows, respectively :—No. 1, 0·09 per cent, No. 2, 0·04 per cent, No. 3, 0·05 per cent :—

	No. 1.		No. 2.		No. 3.	
Carbonate of lime		95·60		99·05		98·39
" magnesia		0·44		0·88		0·71
" iron		0·13		0·05		0·05
Alumina.	0·11	} 4·27	0·01	} 0·26	0·02	} 1·19
Silica, soluble.........	0·16		0·09		0·04	
Insoluble mineral matter	3·54		0·14		0·82	
Organic matter.........	0·46		0·02		0·31	
		100·44		100·24		100·34

The specimens were supplied by Mr. E. T. P. Shewen, of the Department of Public Works. No. 1 is from Messrs. Armstrong's quarry, Green Head; No. 2, from Stetson's quarry, Indiantown; and No. 3, from W. Lawlor & Sons quarry at Brookville.*

As in the case of so many other mineral products, the lime industry has suffered greatly from the effects of the adverse tariff imposed by the United States. This is well seen in connection with the table of exports already given. Thus, prior to the passage of the "McKinley bill," the total production of lime, from about twenty-four kilns, was not less than 350,000 barrels† per annum, employing about 300 men; but this was subsequently reduced to about 175,000 or 200,000 bbls., with a proportionate decrease of kilns and men employed. By the McKinley tariff a duty of six cents per 100 lbs., including the weight of the barrel, was imposed, which was equal to 13⅝ cents a barrel, or about twenty per cent on the value as delivered in United States markets. Hence, in 1892, a decline in the export of lime to about forty-two per cent of what it had been in 1890. Effects of adverse tariff.

*Annual Report, Geol. Surv. Can., vol. VIII. (N.S.), 1895, pp. 15-16 R. In the report cited No. 3 is, according to Prof. Bailey, assigned in error to "Lawlors Lake."

†A barrel holding about 218 pounds of lime.

Competition with Rockland, Me.

In addition to the deterrent effect of high duties, the St. John lime-burners are directly affected by the competition of the great lime-quarries at Rockland, Maine, in the interests of which, chiefly, those duties have been imposed. According to the authority above referred to, there were at Rockland, in 1893, 100 kilns in operation, with a very large output, showing that but for the adverse tariff the industry at St. John might assume great importance. In several respects St. John has great natural advantages, making the competition more equal, one of these being the situation of the quarries and the facilities for shipment (the quarries at Rockland being distant two miles and a-half from the kilns); and another, the cheapness of fuel, the latter consisting largely of the refuse from lumber mills. In several instances, indeed, as at Randolph and Baker's, the saw-mills and the lime-kilns are run by the same owners, and side by side. The cost of Rockland limestone, placed in the kilns, is twenty cents a barrel, as against ten cents a barrel at St. John. The cost of kiln-wood at Rockland is $3 for the small cord, as against $2 at St. John. Cord-wood burned in a kiln at St. John costs ten cents for each barrel of lime, while at Rockland it is fifteen cents. The Rockland people estimate that their lime costs, ready for shipment seventy-two cents per barrel, while the freight to Boston is thirteen cents and the price eighty-five cents, leaving no profit. The following figures show the corresponding cost at St. John.

Cost of St. John lime.

	Cents.
Stone at kiln	10
Boring (labour)	5
Cordwood	10
Barrel	16¼
Trimming barrel	1½
Foreman	½
Repairs	½
Interest on investment	¾
Duty	14
Freight	18
Consular certificate	½
	77

Freight by rail.

The freight by rail to Boston would be twenty cents, and the cost, laid down there, about eighty cents.

In addition to the localities in the vicinity of St. John, two other districts deserve notice as containing limestones of similar age and character, so situated as to be capable of easy working and shipment.

The first of these is in the vicinity of Musquash Harbour, upon both sides of which are large exposures of limestone. Some of these are dolomitic and others contain more or less serpentine, but beds free from magnesian compounds and suitable for burning, also occur. On the eastern side these limestones form a well defined band extending from near Frenchmans Creek to Pisarinco Cove; and on the western side, though less exposed to view, probably extend continuously to Lepreau Basin. Some quarries were at one time opened upon the Musquash River, but they have been long since abandoned.

A second district exposing large deposits of Laurentian limestone is the harbour of L'Etang in Charlotte county. The rock here is a bluish-gray, well stratified limestone, with a marked rhomboidal cleavage, covering an area of at least 100 acres and admirably situated for calcination and shipment. As at St. John, the limestones are intersected by dykes of intrusive rock. Quarries have been opened here, but have now been idle for many years. Similar beds occur upon Frye Island, near by. L'Etang deposits, Charlotte county.

B. HURONIAN LIMESTONES.—The rocks referred to the Huronian system include limestones at a number of points in the southern counties, but the beds are of much smaller dimensions than those of the Laurentian system, and no attempt, except perhaps locally and in a very small way, has been made to work them. Among localities of this character may be mentioned the mouth of the Nerepis River, in Kings county; the village of Lancaster, in western St. John county; Lepreau Basin, in eastern Charlotte county, the head of Dipper Harbour, in the same county, and in Albert county. The latter may possibly become of service in connection with the treatment of the bog-manganese ores of Dawson Settlement. Impure limestones also occur on Kent Island, off the south coast of Grand Manan. Huronian limestones.

C. CAMBRO-SILURIAN LIMESTONES.—These are of rare occurrence, but nevertheless are found at one or two points, chiefly in the northern part of York county, in the district lying north of the central granite range between Eel River settlement on the St. John River and Canterbury station. They have been utilized to a limited extent, but are quite impure, and have been used only for local consumption. Cambro-Silurian limestones.

D. SILURIAN LIMESTONES.—A large part of the counties of Carleton, Victoria, Madawaska and Gloucester are underlain by slates which are highly calcareous, and in places these become pure enough to be entitled to the designation of limestones. They are, however, greatly inferior to the Laurentian limestones of St. John as a source of lime, and such operations as have been undertaken in connection with them have been mostly with reference to use in the neighbourhood of the Silurian limestones.

localities where the beds occur. Of these, perhaps the most important is the Beccaguimic valley and its vicinity, where, in the aggregate, a considerable quantity of rock has been burned. The writer has not visited this region since 1885, but at that time the product at Turner's, in the Beccaguimic valley, was stated to be about 500 casks or 2000 bushels per annum.

About the year 1874, quarries were opened at Henderson Corner, in the parish of Brighton, and work carried on by the Hendersons until 1886, two kilns being kept in operation, yielding 450 casks for the two, each cask weighing about 350 pounds, and selling at Woodstock for $1.50, or at the price of St. John lime. About 1885 other quarries were opened in the Beccaguimic valley, at Turner's, with an annual product of about 500 casks, or 2000 bushels. In the same vicinity the Belyea Bros. are now burning lime at about the rate last stated, the product being used locally and in Hartland, and being well spoken of, but owing to want of capital and facilities for making casks, necessitating sales by the bushel, the business is less extensive than it might otherwise be.

Carboniferous mestones.

E. Lower Carboniferous Limestones.—These rocks, though abundant and widely distributed, are comparatively unimportant as a source of lime, the material which they yield being unable to compete with the highly esteemed product of the St. John quarries. They have, however, at times been the basis of somewhat extended operations, more especially in the vicinity of Demoiselle Creek, Albert county, where at one time lime burning was largely carried on for several years.

Other localities of Lower Carboniferous limestones, some of which have been worked locally, are Rush Hill and Merritt Landing (Long Island), in Queens county; Butternut Ridge, in Kings county; the vicinity of Hillsborough, in Albert county.

Gypsum.

Geological position of gypsum.

The occurrence of extensive deposits of gypsum is a notable feature in the rocks of the Lower Carboniferous formation in New Brunswick as it is also in Nova Scotia. These deposits, as fully described in the reports of the Geological Survey, usually occupy a position at or near the summit of the group, and are generally in close connection with beds of limestone, from which, in part at least, they may have been derived by alteration. Among them the beds found in the vicinity of Hillsborough, Albert county, are at once the most extensive, the purest, and the basis of the largest operations. They will, therefore, be described in some detail, other deposits being subsequently noticed chiefly as affording points of contrast.

For the following summary of facts relating to the development and present condition of the Hillsborough deposits, I am indebted to Mr. C. J. Osman, M.P.P., at present manager of the Albert Manufacturing Company. Hillsborough deposits.

Gypsum deposits in Hillsborough, Albert county, New Brunswick.

The picturesque little village of Hillsborough is situated at the head of the Bay of Fundy, on the west side of the Petitcodiac River, about five miles from its mouth. Owing to the great rise and fall of the tides of this bay, vessels of any draught can sail up to this point, and take in cargo, if of sufficiently strong build to permit of grounding and carrying loads when not water-borne.

There are no authentic records of the first discovery and opening of the large deposits of gypsum, which are now being somewhat extensively worked at Hillsborough, but there are some evidences of very early work, in the shape of small deposits of waste, and signs of excavations at different points in this formation. For accurate information regarding the early shipments, and extent of the same, it would be necessary to refer to the Custom-house records. It is, however, quite certain that the shipment of gypsum from Hillsborough was a very limited business previous to the year 1854, though for many years earlier than this, the farmers living in the vicinity, who owned lands that included portions of the gypsum deposit, quarried and hauled to the river on sleds during the winter small cargoes of "plaster rock," taken from points in the deposit which were exposed, and where this work could be done with the least amount of labour in stripping. These cargoes were purchased from the farmers during the season of navigation, by masters of small coasting vessels, and carried to ports on the United States seaboard, where "plaster" mills were in operation, the principal market being Lubec, in the state of Maine, at which place mills were operated by Messrs. Fowler Brothers; but some few cargoes were shipped as far south as New York; the principal source of supply of crude material for the New York manufacturers being, however, Windsor and other points in Hants county, Nova Scotia. First discovery Early developmen

Previous to the year 1854, Messrs. Fowler Brothers, of Lubec, Maine, acquired rights to a portion of the gypsum deposits of Hillsborough, and constructed a plank-road from the quarry, afterwards known as the Fowler quarry, to the Petitcodiac River, distant about three and one-half miles. The gypsum was hauled out in wagons during the summer months, and on sleds during the winter. During the period of their ownership, shipments did not exceed from two to three thousand tons per annum.

Change of ownership.

The superior quality of plaster of Paris made from Hillsborough gypsum, had by this time become well known to other manufacturers of plaster and building materials in the United States, and, about 1854, Mr. Calvin Tomkins, a manufacturer of cement and lime, who carried on an extensive business on the Hudson River, came to Hillsborough and acquired the properties then owned by the Fowler Brothers, and other gypsum properties adjoining, which included nearly all the available and valuable portions of this deposit. At this time the duty upon manufactured plaster entering the United States, was very low, and a large market was open for the product of a mill on the Canadian side of the line. These favourable conditions led to the formation, by Mr. Tomkins, of a company under provincial Act of incorporation, under the name of the Albert Manufacturing Company, for the purpose of carrying on the business of quarrying and mining gypsum, and erecting mills for the purpose of manufacturing it, carrying on the business of grinding grain, sawing lumber, constructing railways and operating the same, and all other work in connection with the operation of the quarries and shipment of the product. Subsequently a large milling establishment was erected, railways were built to two or three points in the gypsum belt and extended to the river, where wharf and timber beds for the accommodation of vessels were also constructed. A plaster mill was also built by Mr. Tomkins, at Newark, New Jersey, and the business of making plaster of Paris in Hillsborough, as well as that of shipping the crude rock to Newark, prosecuted with energy. Later the withdrawal of the reciprocal trade relations between the provinces and the United States occurred, and the favourable conditions under which a large trade in the manufactured article promised, was seriously interfered with, and only a very limited business was obtainable, and had it not been for the very superior quality of the plaster made from Hillsborough rock, profitable business with the United States would not have been possible.

Favourable conditions.

Drawbacks.

Exclusion of Canadian market.

The Canadian market was not at that time available for the Hillsborough mills, as plaster was extensively manufactured in Montreal, carried from Antigonish in Nova Scotia by vessels at a very much lower rate of freight than rock or manufactured plaster could be freighted from Hillsborough to the same point. The western Canadian market was also largely supplied with plaster manufactured at Grand Rapids, in the State of Michigan, which place is conveniently situated almost on the shore of Lake Michigan, and therefore has the advantage of cheap water communication with all the important cities of Canada. At that time a very low rate of duty was collected upon manufactured plaster imported into Canada, and the most important portion of the Canadian market was thus open to the manufacturers in the United States. For the finer grades of calcined plaster, required for casting and dental purposes, New York plaster was used, which, as already stated, was manufactured from rock plaster supplied to New York, either from Hillsborough or Windsor, neither the Michigan plaster or plaster made in Montreal being equal in quality for fine work, to what was then known as New York plaster.

Effect of opening I. C. R.

By the construction of the Intercolonial Railway, this market was made more available for the Hillsborough mills, and in 1876 active efforts were made to secure a share of the Canadian business, and with considerable success, for as soon as this plaster was placed on the market at competitive prices, dealers and consumers recognized that they were being offered plaster equal in all respects to the best New York plaster. Still the competition from Montreal and Michigan in a lower grade, made it difficult for Hillsborough to supply the demand for which an inferior grade was good enough, and not until the era of the Canadian protective tariff was it possible for the general demand in Canada to be supplied from Hillsborough. The increase in duty soon excluded Michigan plaster and the chief competition then came from Montreal, which, of course, enjoyed equal advantages with Hillsborough under protection, and freight at about half the rate paid by Intercolonial Railway; but in spite of this disadvantage, in a few years, the great superiority of Hillsborough plaster was so firmly established that the Montreal manufacturers retired from business. This left the Canadian market entirely open for Hillsborough plaster, with exception of the output of a small mill on the Grand River, near Hamilton, Ontario, and a more limited output from a factory at Paris, Ontario.

Influence of protective tariff.

Enlarged market.

The following figures will illustrate the development of this market between the years 1877 and 1897. In 1877, the total sales in Canada were about 8000 barrels. In 1897, the total sales in Canada were about 38,000 barrels from Hillsborough. In the interim a plaster mill had been established at Windsor, Nova Scotia, and limited shipments made from that point. Paradoxical as it may seem, the increase in the rate of duty and the surrender of the Canadian market to Canadian manufacturing establishments, have not perceptibly increased the cost to the consumer, for while the duty in 1897 was about twenty cents per barrel in excess of the duty in 1877, the average price to dealers throughout Canada is between twenty cents and twenty-five cents per barrel less in 1897 than it was in 1877, the price at mill in 1877 being $1.05 per barrel and in 1897 not averaging over eighty cents per barrel.

Exports from Hillsborough.

The development in the business of shipping crude rock to the United States shows also a large increase :—

Shipments of crude gypsum from Hillsborough to the United States.

1877, ...	5,000 tons.	1888, ...	26,784 tons.
1878, ...	5,380 "	1889, ...	25,672 "
1879, ...	5,641 "	1890, ...	24,126 "
1880, ...	8,575 "	1891, ...	21,125 "
1881, ...	7,540 "	1892, ...	24,588 "
1882, ...	14,095 "	1893, ...	23,764 "
1883, ...	15,792 "	1894, ...	37,170 "
1884, ...	21,132 "	1895, ...	50,128 "
1885, ...	14,334 "	1896, ...	59,266 "
1886, ...	22,600 "	1897, ...	59,334 "
1887, . ..	18,797 "		

Effects of ecent U. S. legislation.

Shipments of manufactured plaster to the United States have averaged for the last ten or fifteen years about 20,000 barrels per year. Under the " Wilson bill," a low tariff measure passed during President Cleveland's administration, it was hoped a larger business could be secured in the United States, and some gain was made : but owing to the large increase in rate of duty under the more recent " Dingley bill," new business then obtained has since been lost, and it is with difficulty and only at extremely low prices for the manufacturer, that any foot-hold can be retained in that market. Indeed, under the present rate of duty of $2.25 per ton, it is quite impossible for a Canadian manufacturer to compete with manufacturers in the United States, although under the " Dingley bill" a duty of fifty cents per ton upon the crude material is imposed. The difference in duty of $1.75 per ton between the crude and manufactured article very much more than covers the increased cost of manufacture in the United States as compared with cost of manufacture in Canada. Only the superiority of the Hillsborough plaster and its well established reputation, make sales possible in the United States at figures which would even cover the cost of manufacture. There is very keen competition between the manufacturers in the United States, consequently prices are exceedingly low.

The duty upon the raw material levied under the "Dingley bill" was inserted in the tariff to meet the wishes of the manufacturers of plaster in the Western States, who at first asked for a duty of $2 per ton. This would have enabled the western manufacturers to supply the whole of the eastern market with plaster suitable for all ordinary purposes, although it would have been necessary to meet a demand for a limited quantity of plaster suitable for fine casting and dental work, which would have to be made from Nova Scotia or New Brunswick rock, the western rock not being suitable for these purposes. This condition of things brought about strong opposition from the eastern manufacturers, who had a great deal of capital invested in their manufacturing plants. There was also a very strong opposition movement on the part of owners of U. S. coasting vessels, who were largely interested in this matter, from the fact that of the total shipments at that time, amounting to about 220,000 tons per annum, a large proportion was carried in these vessels, which were engaged in carrying coal from New York and points south as far as Newport News to New England ports. When these cargoes were discharged, they would run up the Bay of Fundy light, take in cargoes of gypsum, and return with them to New York, Philadelphia, Baltimore and other coaling points south; therefore, the business of carrying gypsum was essential to these vessels as a means of making a run back to the coal ports profitable, there being no other return freight upon which they could depend. In response to these protests, an agreement was arrived at under which a duty of fifty cents per ton on crude rock was imposed, and, to satisfy the demands of eastern manufacturers, the duty on manufactured plaster was increased from $1.25 per ton to $2.25 per ton. A very considerable quantity of the 220,000 tons of crude material, shipped to the United States, as before stated, is used in the manufacture of fertilizers, a great deal entering into the manufacture of high-grade fertilizers, and more being simply crushed and finely ground and put upon the market under the name of ground gypsum or "land plaster." This business is done in regular mills established for the purpose, as well as in small mills that are used for grinding corn, etc.

Duty.

Present conditions.

Character and Mode of Occurrence of the Gypsum Deposits of Hillsborough.

The gypsum deposits of Hillsborough are exceedingly varied in character, and in their mode of occurrence present many features of geological interest. These will be more readily understood by reference to the accompanying diagram, and by the descriptions which follow.

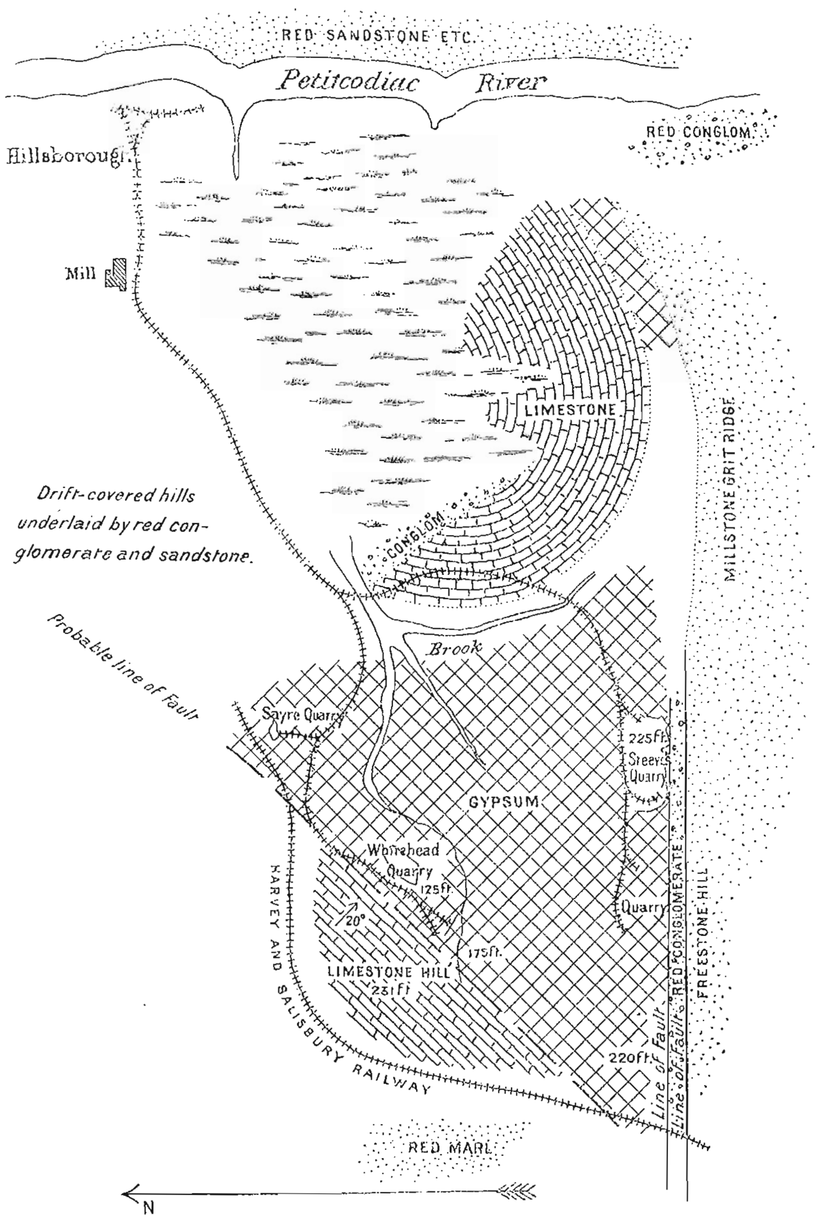
Varieties.

At several points on the northern edge of the outcrop, considerable quantities of gypsum are found, being snow-white in colour and varying in molecular structure, some of it being of exceedingly fine grain and some quite coarse and sufficiently soft to be crushed between the fingers, with intermediate grades of fineness, but all grades equal in purity and colour. This part of the deposit is in masses and not any in regular seams. With the pure, white stone are intermixed irregular veins of discoloured gypsum, of all shades of red, gray, and blue-gray, Most of these discoloured masses contain more or less "grit," which when subjected to hydrochloric acid effervesces and show evidence of the presence of carbonate of lime. Occasionally seams of red marl-like stone fill the spaces between the seams and fissures in the gypsum. These are rarely in horizontal positions, but as a rule cut the face at varying angles and occasionally are nearly perpendicular. This marl-like substance also contains carbonate of lime. Underlying the beds of pure white and mixed stone, as above described, masses of anhydrite are found; sometimes in thin layers only and at other times in beds of such thickness that attempts to penetrate them have been given up as unprofitable and work has been pursued elsewhere. Immediately under the white stone, and running into it without any perceptible break, are generally found beds of pure anhydrite, which at this time has no commercial value, although some of it has been ground and exported to the United States as terra alba for paper filling and other purposes; but for use as a paper filler, it is not as acceptable to manufacturers as the product of the pure white hydrated gypsum. The demand for white soft stone is limited, and it is used entirely as a paper filler; the process of manufacturing it for this purpose being to grind and bolt it through very fine silk bolts, after which it is calcined, mixed with water, and the setting properties destroyed by continuous stirring; when it is found to be more suitable as a filler for the higher grades of paper than china-clay, and is coming into more general use for this purpose every year.

Occurrence of anhydrite.

Indications of pure, white stone, of this character, are visible at many points along the northern edge of the gypsum deposit, for a distance of about three quarters of a mile. The surface indications of this gypsum belt extend in width for about half a mile, the belt running in a north-easterly and south-westerly course, the southern edge rising somewhat abrubtly against a very steep hillside, which is supposed to consist

Geological relation.



Sketch-map Showing Geological Relations of the Gypsum Deposits of Hillsborough, Albert Co., N. B.

Scale:—50 chains to 1 inch.

largely of a reddish conglomerate that apparently forms the south wall against which the gypsum rests. Still higher up on the hillside, and on the summit, freestone boulders are seen, and a short distance below the summit a clean break and opening exposing the freestone, is quite conspicuous. At this point several natural trenches, parallel to each other, with walls of freestone, and about twenty or thirty feet apart, are exposed for a distance of several hundred yards, strongly suggesting the existence of a series of faults or downthrows. Thus the gypsum area would seem to be bounded on two sides by marked dislocations converging westward at an angle of about 45°. Between the northerly and southerly edges of the gypsum formation are several small valleys, evidently the work of brooks which have cut their way through the gypsum, and have created at some points small bays or openings that have caught and retained alluvial deposits, producing meadows or intervales, which are exceedingly fertile. At many points the gypsum has entirely disappeared, leaving only the anhydrite exposed. The main brook on the northerly side, rises apparently at the west end of the gypsum deposit and flows in an easterly direction, until it falls over a limestone bed, with a descent of about eight feet, and at this point the conglomerate rock upon which the limestone rests is exposed, dipping towards the north-west at an angle of about twenty degrees, and rising rapidly to the south until it reaches the top of a hill about three-quarters of a mile distant, at an elevation of about 150 feet. At this point the limestone is exposed and plainly seen on the surface. It then dips slightly to the south and again underlies a gypsum formation of from fifty to sixty feet in height. The conglomerate rock is also to be seen a little further to the eastward on the slope of the hill as it descends towards the river. This exposed body of gypsum is very much broken and discoloured and of so little value that, though much nearer a convenient point for shipment than the main quarries now in operation, it is not at present worked and is not considered a profitable field from which to draw supply. Following the main brook, already referred to, in a westerly direction, the wall of anhydrite extends the whole length of the gypsum deposit, though not unbroken.

Boundaries.

Relations of gypsum and anhydrite.

Several quarries have been opened at points where the soft gypsum had been left untouched by the action of the brook and much pure, white stone, as well as good gray merchantable gypsum, have been taken therefrom, and there are still large quantities which have not yet been opened or worked; but in all operations extending in a southerly direction along the course of this brook, the anhydrite has made its presence evident, and consists of dark-gray and white stone, or of white stone containing blood-red streaks or veins ; the white anhydrite generally underlying the formation, and the wall being formed by the darker stone. This wall, however, is not uniform in hardness, there being many points where small brooks and springs have cut their way through, probably at places where seams of soft gypsum have broken the uniformity of the harder rock. In some instances the action of the water has created subterranean passages into which the brooks disappear, reappearing lower down the valley and joining the main brook.

Main quarries.

The most extensive plaster quarry now in operation is at the base of the high hill forming the southern wall of the deposit, and was first opened with the intent of making a permanent working about forty years ago. After going to a great deal of expense, work was abandoned at this point on account of the very large quantity of anhydrite encountered. This anhydrous gypsum is dark-gray in colour and very hard. After lying idle for a number of years, work was again undertaken at this place and the band of hard stone was broken through, when a very fine quality of gypsum, slightly gray in colour, was exposed, and since that time this quarry has been in constant operation, and still yields a large output of very fine close-grained stone, from which the best quality of calcined plaster is made. There is, however, considerable variation in the character of the rock, though nearly all of it will make plaster of Paris of good quality. Some of it, however, immediately underlying the clay, is coarse in grain and more or less intermixed with selenite crystals or consisting entirely of gray selenite. This character of stone will not make good plaster of Paris, and after calcination, if mixed with water and allowed to set, will yield and become more or less soft and non-coherent. The presence of a very small quantity of this stone will seriously impair the quality of a large quantity of plaster in process of manufacture. In extending this quarry the underlying beds of anhydrite have been followed, and represent to-day the floor of the quarry. Operations at a lower level have, however, established the fact that soft gypsum underlies the hard formation at a depth of thirty feet, but these operations have not been of sufficient extent to prove whether this is present in large bodies or not. White stone, both hydrous and anhydrous, has also been found at a lower level in this working.

Working face.

The working face of the quarry varies in height from thirty feet to one hundred feet, and at this time has from twenty to thirty feet of exceedingly tough clay overlying it. At several points there are veins, bands, or masses of anhydrite running through and across the face, not always connected with the main body of anhydrite, but sometimes in thin veins running out to a point and gradually assimilating with the softer stone; at other times, in small kernels, and often in large masses having no connection with the main underlying body. These masses of hard stone are removed by drilling and blasting, if not in too great quantities; if too large to be profitably removed, they are left and gradually worked around, the soft stone generally making its appearance at the back of the hard, sooner or later. The soft stone can all be bored with a common pod auger, although it is found more economical to use hand-power augers especially constructed for this purpose. The hard stone when struck with a pick will emit sparks.

Modes of removal.

Stratification. The formation is irregular, being at the west end very much stratified, and lying in horizontal beds which show a great variety in character, being in layers of varying thickness, purity and colour, from white to light-gray and dark-gray.

Irregularities. At this point there is no overlying earth and the surface is very irregular and full of depressions and holes that extend many feet down towards the base. Invariably, where there is no protecting earth-surface, the gypsum is very much broken up and can be removed with pick and bar with very little blasting, but is too much shattered to be of commercial value. The face of the main quarry at the eastern end, contains many seams and evidences of slips, continuous "face marks" being broken and signs of unequal settlement quite apparent, which may indicate the presence of a soft base of insufficient strength to sustain the whole overlying mass intact. The general character of the beds indicates an original horizontal formation, (see plan), but owing to settlement, subsidence, or upheaval, they have become very irregular and represent a wave-like formation. During the operations some few years ago, a dome-like formation was disclosed, very perfect and sloping towards the floor of the quarry, and from the summit an equal dip towards the back, which at this time was represented by a deep depression in the surface, towards which the face of the quarry was leading. This was worked through and the gypsum was found on the other side, but under a greater depth of clay than had before been noted. There has been very little variation in the excellent quality of this stone from the opening of the quarry until the present time.

Cover. It promises to yield indefinitely, but there is every evidence that the depth of clay is increasing as the face of the quarry is pushed into the hillside. When it becomes unprofitable to move the clay, it will be necessary to tunnel. From this point to the western end of the gypsum outcrop, where the white rock is found, is about three-quarters of a mile, and the outcrop of gypsum between these two points is continuous.

Two other quarries have been opened at intermediate points near this main working, and gypsum of excellent quality has been disclosed. The character of the stone is laminated, lying in almost horizontal beds with occasional waves and a slight general trend of dip to the south-west, but with surface indications of a counteracting rise in the formation as the hill is ascended. Very little selenite is found here, but occasional particles occur through all the stone and occasionally very narrow seams of fibrous gypsum are also found, generally slightly pink in colour. Beyond this point to the west end of the belt, no work has been done, and the surface indications show gypsum both hard and soft of different grades, but no pure, white stone. The high ridge that forms the backing of the main working of the Hillsborough quarry, apparently cuts off the gypsum, but after crossing this ridge and descending into the next valley, known as the valley of Demoiselle Creek, the gypsum outcrop is again apparent, and some soft rock of good quality is now obtained, and limited shipments made, from a quarry recently opened. The water of Demoiselle Creek is highly impregnated with lime and gypsum, and is known to run immediately over the gypsum formation at several points. No gypsum shows itself on the surface from this point until the lower end of the valley is reached, when there is a small outcrop at a little lake, and it is known to exist towards the main river in an easterly direction, on the other side of the ridge forming the east wall of this valley, and crops out on the opposite side of Shepody Bay, in the county of Westmorland; here it is very dark in colour and is not suitable for making plaster of Paris.

Other quarries.

Occurrence in valley of Demoiselle Creek.

Following the shore-line of Albert county, the next outcrop is at Hopewell Hill, about sixteen miles from Hillsborough, and back from the shore about two miles, and a half at an intermediate point between this deposit and the shore and then next at a point on the marsh near by, where it is some eight or ten feet below the surface, but no surface outcrop occurs. No more surface indications are visible until New Horton is reached, about twenty-eight miles from Hillsborough, and no further outcrop nearer than Martin Head, situated at the head of the Bay of Fundy, distant about fifty-three miles from Hillsborough. Here the gypsum is of poor quality and the deposit not worked. Inland from Hillsborough, the nearest outcrop of gypsum is at Petitcodiac in Westmorland county, about forty miles distant, where it is very much broken, selenitic in character, and not valuable for commercial purposes.

Hopewell Hill.

Methods of quarrying.

The method of quarrying gypsum is by boring holes of varying depth and blasting out with ordinary blasting powder. The hard rock is removed by drilling by hand and steam drills, and, when necessary to dislodge in large quantities, dynamite is found to be more economical than powder. The gypsum for shipment is carried to the river over a horse-railway in cars containing about three and one-third gross tons, each horse hauling three cars, making three trips per day, or an average output per day of thirty tons to a horse and driver, the distance from quarry to river being about three miles and a half. Average rate of wages paid to quarryman, $1 per day. Until within two or three years, common pod-augers were used for boring, but a special hand-power drill has been put upon the market by the Howells Mining Drill Co. of Plymouth, Pa., U.S.A., which is found to be especially suited for this work and character of stone, a short hole being first bored into the face, into which an arm is placed and upon which the drill is clamped, being then adjustable, so that holes can be bored in any direction or at any angle, either up or down.

Wages.

Process of Manufacturing Plaster of Paris.

Manufacture of plaster of Paris.

The old process of manufacturing plaster of Paris from gypsum was to burn the stone in kilns, in the same manner as limestone is burned, and this method is still followed to some considerable extent in England and the Continent of Europe, but in the United States and Canada it is found that more uniform results are obtained by first grinding and afterwards subjecting the ground material to a process of calcination, which can be regulated in duration and temperature. The method followed at Hillsborough is to pile the newly quarried stone in sheds until it is sufficiently dry to grind easily without clogging the mill-stones, after which it is passed through crushers in which the stone is broken into fragments about the size of a hazel nut and then delivered to ordinary granite mill-stones, when it is ground to whatever fineness of grade may be required. Thence it is conveyed to bins, under which are placed large iron kettles furnished with stirring arms, so that the material may be kept in constant motion. These kettles are set in brick and have grates and large fire-boxes below them. The fuel used is soft wood in four-foot lengths. In the United States, the fuel used for calcining plaster is anthracite coal, which produces a much hotter fire, and the work of calcination is very much more rapid. Each kettle has a capacity of about sixty barrels of 300 pounds, of calcined plaster. By this process, the water contained in the gypsum in a state of combination is driven off as steam through openings in the top of the kettles constructed for that purpose. These openings discharge into a dust-loft that collects large quantities of the finer particles of the ground gypsum, carried off in steam from the kettles; a considerable portion of which can be returned to the kettles when next filled, but not all, as too large a proportion would seriously interfere with the setting properties of the product. Thermometers are used, and when a temperature of 285 degrees Fahrenheit is reached, the kettles are at once emptied into bins, and the plaster is then elevated to revolving bolts and thence delivered to bins from which it is packed into paper-lined barrels, for market. A branch line of railway connects the mill with the Salisbury and Harvey Railway, and car-load shipments are made to all important points in Canada, to some points in the western United States, and to the Pacific seaboard without transhipment.

Crude gypsum will not stand exposure to the weather, but is speedily affected by moisture. A method has, however, been recently discovered under which, by chemical treatment, it can be both hardened and toughened, and when so treated will take a very perfect polish. In this state gypsum may be employed instead of the more expensive marbles. Recent uses of gypsum.

The price obtainable for crude gypsum delivered to vessels in the Petitcodiac River, ranges from 60 cents to $2.50 per ton of 2240 lbs., the lower grades of rock and discoloured stone, suitable only for the manufacture of land-plaster, being sold at 60 cents per ton; that of a quality suitable for the manufacture of calcined plaster, at from $1.00 to $1.20 per ton, and the selected pure, white stone at $2.50 per ton. Price.

The total number of hands employed in quarrying, conveying to point of shipment, milling and otherwise in this work, in the year 1897, was about 225, including boys. Labour employed.

The following is an analysis of a sample of gypsum from Hillsborough, by A. A. Breneman, of New York :— Analysis.

	Per cent.
Lime	32·45
Sulphuric acid, (SO_3)	46·38
Water	21·05
Silica	0·25
Iron	Trace
Magnesia	"

The analysis indicates an almost absolutely pure gypsum, 99·88 per cent of the whole consisting of that mineral.

Origin of gypsum.

An examination of the Hillsborough deposits, as indicated in the foregoing description, suggests many interesting questions as to their origin. A lengthy discussion of these would be out of place here ; but a few general conclusions may be referred to as highly probable.

(1.) A large part of the deposit, by its markedly stratified character, points clearly to a sedimentary origin, whatever may have been the original nature of the sediment.

(2.) As it is well known that anhydrite, on exposure to percolating waters, can absorb moisture and thus become converted into gypsum, and as the first-named mineral forms the general floor upon which the workable gypsums rest, as well as occurring irregularly intermixed with the latter, it is highly probable that the present condition is the result of such alteration. In this case the conversion may have begun at any time since the formation of the original anhydrite beds and may still be in progress.

(3.) The conversion of anhydrite into gypsum, the latter containing 20·9 of water, of which the former is wholly destitute, involves a great expansion in bulk of the original rock, amounting, according to Geikie, to about thirty-three per cent ; and the anhydrite, if confined on either side by unyielding rock, must as the result of this expansion be thrown into undulations, with accompanying breaks and dislocations. The removal of the rock by the solvent action of water, clearly indicated by the numerous and large sink-holes surrounding the gypsum beds, may further tend, by undermining, to determine such displacements.

Geological conditions.

(4.) The conditions under which aqueous deposits of anhydrite may have been originally laid down are not understood. Sir J. Wm. Dawson has suggested that they may have been formed from beds of calcium carbonate *in situ*, acted upon by vapour or heated solutions of sulphuric acid, the latter resulting from springs or streams issuing from volcanic rocks. In the present instance the plaster beds have been described as resting on limestone ; but no deposits of a volcanic nature are found in near proximity.

We may now proceed to notice briefly some of the other localities in which gypsum occurs.

Albert county.

Albert County.

Demoiselle Creek.—This locality has been referred to above. The beds here are, apparently, quite limited in extent, forming a narrow ridge between the valley of the creek and a small tributary of the latter, the western side of which shows a different rock. The ridge is about 150 feet high, and shows some good white plaster, but also a large proportion of anhydrite. Similar rock also forms cliffs east of Demoiselle Creek, but these are mostly on the land of the Albert Manufacturing Company.

The Demoiselle Creek deposits are being worked by the Hillsborough Plaster Company, under the direction of Messrs. C. H. Dimock & Co., of Windsor, Nova Scotia. About 600 tons were shipped from this this locality in the year 1892 to the New York market. At present the product is said to be largely used in the manufacture of "cold water paint." Only about five or six men are employed. In connection with these gypsum deposits there is a remarkable subterranean lake.

Hopewell Hill.—Two miles and a half from the shore, and at intermediate points. No surface outcrop.

New Horton.—Surface indications.

St. John County. St. John county.

Martins Head.—Deposit small and of poor quality.

Westmorland County. Westmorland county.

Petitcodiac.—At Fawcetts Brook, about two miles and a half northwest of Petitcodiac station, is a deposit of gypsum, about forty rods in breadth and about a mile in length, mostly of the fibrous variety. It is traversed for the whole distance by a vein of coarse selenite, about eight feet wide. The material is unsuited for the manufacture of plaster of Paris, but being easily crushed is well adapted for a fertilizer and at one time was somewhat extensively employed for that purpose.

Kings County. Kings county.

Considerable beds of gypsum occur in the vicinity of Sussex and in the parish of Upham, near the road connecting Sussex and Quaco; but they are less pure than those of Hillsborough, and have never been turned to useful account, unless, it may be, locally and to a very limited amount.

Victoria County. Victoria county.

The succession of the Lower Carboniferous strata of the Tobique valley is as follows, in ascending order :—

Red conglomerates and sandstones, the former with pebbles of Silurian slates.

White, red and variegated calcareous sandstones and grits.

Red, gray and green shaly and marly beds, with thin beds of fine-grained gray, red or mottled limestone. Thickness, 140 feet.

Heavy beds of impure gypsum, of pale-green and reddish colours, mostly fibrous but sometimes compact, alternating with thin beds of red shale. Thickness, about 350 feet. Trappean beds, consisting of gray amygdaloidal dolerite.

Extent of deposits.

It is therefore a succession corresponding in the main features to that of Hillsborough, in Albert county. The total breadth of the Carboniferous area is about twelve and the total length, from Red Rapids to Blue Mountain, about twenty-seven miles. What proportion of this area is underlain by gypsum beds has not yet been definitely ascertained, but from observations made on different outcrops it is certain that the extent of the deposits is large.

Comparison with Hillsborough gypsum.

Where the area described is intersected by the Tobique River, the presence of gypsum beds is conspicuously marked by the occurrence of high bluffs (130 feet) known as the "Plaster cliffs," which are largely composed of this mineral. In contrast with the beds of Hillsborough which are so largely compact, amorphous and of snowy whiteness, these are coarsely granular, often looking like a rough sandstone, for the most part deeply stained a reddish colour, or mottled with red and green. Thinner layers, however, of pure, white gypsum, as well as fibrous selenite, also occur.

Use as a fertilizer.

The impurity of the Tobique gypsum, as indicated both by its colour and texture, render it unfit for the uses for which the Hillsborough gypsum is employed. It is, however, admirably adapted for use as a mineral fertilizer, and for many years considerable quantities of it were annually removed on sleds during the winter season, to find a market in the valley of the St. John River or in Aroostook county, Maine, under the name of "land plaster." So highly valued was it, indeed, for this use that, for the purpose of facilitating its removal, a railway, now known as the Tobique Valley Railway, was constructed from Perth, opposite Andover on the St. John River, to the Plaster Rock, a distance of twenty-eight miles. This has recently become a branch of the northern division of the Canadian Pacific Railway in New Brunswick.

The Tobique Valley Gypsum Mining and Manufacturing Company, (Limited), incorporated in 1893, erected machinery for crushing and grinding gypsum at this place, the plant being very conveniently situated on the railway. A quantity of the material was ground and shipped for "land plaster," meeting with a very favourable reception, but difficulties arose in connection with railway facilities and rates, In 1897 the property passed into new hands and it is supposed that operations will shortly be resumed.

Granites, Diorites, etc.

The areas covered by granites and similar crystalline rocks in New Brunswick are very large, and the supply, including many varieties, is practically inexhaustible. It will be necessary to consider here only those which, either from their advantageous position or from peculiar features of texture or colour, acquire special economic importance. Distribution

Hampstead, Queens County.—These granites, from their position on the right bank of the St. John River, near the foot of Spoon Island, (and hence often known as Spoon Island granites), attracted early notice, and, though never the seat of a very extensive industry, have, in the aggregate, yielded a large supply of rock, well suited to the purposes to which it has been applied.

Hampstead granite.

Though geologically related, in age and position, to the granites of the Nerepis range, the Hampstead rocks are not actually continuous with the latter, besides lacking some of the features usually characterizing the rocks of those hills. Thus the rock at Spoon Island is uniformly gray, without any admixture of red, and though somewhat porphyritic, usually less markedly so, and at the same time of a finer grain, than much of the Nerepis granite. A conspicuous feature in the quarries is the existence of divisional planes, sometimes horizontal and sometimes inclined 6° or 8°, by which the mass of the rock is separated into bed-like layers from four to ten feet in thickness, which greatly facilitate quarrying. Vertical joints are also common, but unlike those in the rock at St. George, to be presently noticed, are said to have no detrimental effect upon the quality of the stone. A more objectionable feature is the occurrence in the gray rock of nodules or irregular masses of a darker colour, looking like imbedded pebbles; but these are important only where the stone is to be used for monumental purposes, and are neither common nor large.

Suited for building foundations.

The Hampstead granites are especially suited for foundations, and have been thus used in the construction of the Parliament Building at Fredericton, the piers of the Fredericton bridge, and the cotton mill at Marysville, besides many buildings, both public and private, in the city of St. John. At present much of the rock is sent to the works at St. George to be polished. Columns of any desired size may be readily obtained, but the larger part of the output is employed in the construction of monuments. Shipment is easy, the quarries being upon the face of a hill and connected with a wharf at a distance of about a furlong, by tramways. At the date of our visit (1897) work was slack, only ten men being engaged, but at times as many as one hundred and fifty men have been employed.

Nerepis Valley.—This transverse depression across the Nerepis range of hills, through which passes the main line of the Canadian Pacific Railway, has, in its high and precipitous sides, been at several points the basis of quarrying operations. At the time of the construction of the railway, most of the rock required in the making of culverts was obtained from a series of bluffs known as Eagle Rock, about two miles below Welsford station, and subsequently other quarries were opened for general purposes, a little above the same station. In these localities the rock is rather a syenite than a granite, the mica being more or less replaced by hornblende, and the colour either a tawny yellow or pale red. The rock is easily quarried, splits readily into blocks of convenient size, and owing to the proximity of the railway, may easily be carried away. It is an excellent and durable building material. Full particulars as to these and other granites of the Nerepis range will be found in the Report of the Geological Survey for 1870-71, (pp. 184-185).

Welsford quarries.

St. George.—The granite range of the Nerepis Hills, in its extension westward, crosses the Magaguadavic River a few miles above the town of St. George, and is there very noticeable for the bright-red colour which distinguishes it, and its consequent adaptability to monumental and ornamental purposes.

St. George quarries.

The existence of these red granites and their suitability for the uses mentioned, were noticed by the writer and his associates as early as the year 1869, during the course of a geological examination of southern New Brunswick then in progress, and in the report relating thereto they compared the rock with the well-known red granites of Aberdeen in Scotland. Several years, however, elapsed before this evident similarity attracted the investment of capital with the consequent undertaking of systematic operations for the quarrying and finishing of the stone. For information as to the subsequent development and present status of the granite industry, I am indebted to Mr. Milne, of the firm of Milne, Coutts & Co., of the Bay of Fundy Red Granite Works at St. George. Mr. Milne writes :—

First discovery.

"Regarding the granite business at St. George, we might say that it was started in 1872 by a company of New York capitalists and practical granite men, who purchased some 2000 acres of granite

First development.

mountains and built and equipped the best manufacturing plant in America, their buildings and machinery costing over $75,000. They employed about 150 men, and did a large business for a few years, but the dull times during the years 1875 and 1876 drove them to the wall. Several different firms tried to handle the business after they closed down, but failed to make a success. In the year 1881, Milne, Coutts & Co. rented the property, and in 1883 bought the land and plant, and have since succeeded in building up a good trade in the Dominion. Three other firms have since sprung up, and are doing a fair business. The output is valued at between $80,000 and $90,000 per year, and about 300 men are employed.

"Our chief competition is with Aberdeen, where they not only manufacture their own granites, but import stone from Norway and Sweden. The low rate of wages in those countries enables them to lay down these granites in Aberdeen at about the cost of quarrying their own. The wages for stone cutters in Aberdeen are between four and five shillings per day. The wages in St. George are from $2 to $2.50 per day. Our close proximity to the United States granite centres keeps the wages at their rates, as our men, who are well-known and famed as good workmen, and a much steadier class of men than the general run of journeymen, are always welcome in the neighbouring republic; consequently we have to pay the wages to keep them. Competition

"The freight rates from Aberdeen to Ontario are about the same or a little less than from St. George. The duty on foreign granite has been 30 per cent for some years. On a fine class of work that required a good deal of labour this did not make up the difference in the wages. Consequently a great deal of the better work has come from Scotland.

"There is quite a demand in Canada for Quincy, Westerley, Barrel and other American gray granites. St. George firms import the rough stone and compete favourably with American firms for this work. In large jobs the American firms send the rough granite to Scotland, have it manufactured there and shipped to Canada. ...... The St. George granite is well and favourably known throughout Canada and the United States, and is extensively used both in monumental and building work. The Museum of Natural History in New York is in part built of it, and a great many public and private buildings are trimmed with it in the form of polished columns, pilastres, etc. Its crushing test is 13,000 lbs. to the cubic inch." Competition of American granites.

The following are the names of the companies now working granite in the vicinity of St. George, with their output for the year 1893:— Companies engaged.

	Tons.	Value.
Milne, Coutts & Co., Bay of Fundy Red Granite Co.	400	$32,000
Tayte, Meeting & Co	300	24,000
Epps, Dodds & Co	300	24,000
Victoria Red Grantite Co.	...	.....

Returns received by the Geological Survey for 1897, show a production of granite in New Brunswick valued at $87,300, the industry giving employment to 170 men during eight or nine months. Of the total output, about seventy-five per cent is to be credited to the vicinity of St. George.

Works a Carleton.

For several years Messrs. Taylor Bros. did a considerable business, their output for each of the years 1892 and 1893 being 300 tons, worth, at $80 per ton, $24,000. The Messrs. Burpee were also at one time largely engaged in the business, the rough stone being shipped to Carleton (St. John), where an extensive manufacturing plant was for several years in active operation; but difficulties having arisen in connection with the export of the product to the United States, their works were abandoned, and the raw stone was shipped from St. George by the Grand Southern Railway to Calais, Maine, where the industry is now carried on.

Duties.

The duty on manufactured granite sent to the United States was, under the "Wilson" tariff, thirty per cent; but the subsequent increase to forty per cent is well nigh prohibitive. The St. George product is now almost wholly marketed in Canada, being sent west even to Manitoba and British Columbia.

Situation of St. George quarries.

The St. George quarries are situated on the southern slope of a range of granite hills about two miles and a half distant from the town of St. George, and not far from the so-called "canal" or "thoroughfare" connecting Lake Eutopia with the Magaguadavic River. Openings have been made at many different points upon the sides and summits of the hills, the rock exhibiting considerable variety of colour and texture in passing from one to another. The rock is also intersected by numerous large and smooth-faced joint-planes, while in places it is irregularly seamed or even shattered. No difficulty is experienced in getting out good blocks of any desired dimensions, but columns from eight to ten feet are about the largest ever made. A curious feature is the covering of the surfaces of some of the joint-planes by a pale-green soft mineral resembling serpentine, mixed with scattered grains of graphite. At some points the rock is highly charged with scales of specular iron.

At the base of the main ridge of red granite, may be seen some ledges of so-called "black granite" somewhat similar to those described below. It takes a good polish and is not without beauty, but is apt to be streaky and is not regarded by the proprietors as a good or durable stone.

The possibility of successful operations at St. George is due not only to the fine quality of the stone, but also to the facilities afforded by the great water-power of the Magaguadavic River. Between the hills and the town, the stream traverses meadow land and is sufficiently deep and broad to allow of the easy carriage of blocks in scows, if desired; but then, changing its character, it descends for about a quarter of a mile in a deep narrow gorge and is broken into a series of tumultuous falls, the whole descent from the upper to the lower basin being probably forty or fifty feet. The granite works are situated on the edge of the ravine, and from the stream all needed power is directly drawn. To avoid the re-handling involved in shipping by scows, the rock is hauled directly from the quarries to the works.

The following description of the works at St. George is taken from a report of Dr. G. F. Matthew: *

"The [Bay of Fundy Red Granite] company have their works in this village [St. George] on the branch or the Magaguadavic, just below the falls. The river here connects with tide-water in a narrow gorge in which the water-power machinery is placed, by which the works are driven. The power is taken from a five feet Leffel wheel (of 160 horse-power), with twenty-four feet of water, to a line of shafting passing into the buildings. The buildings of the company occupy three sides of an oblong space, about 300 feet long and 175 wide, extending to the nearest street. In the enclosed yard is a travelling crane, for lifting and carrying the stone to all parts of the buildings; it has a hoist of twenty feet, and is capable of lifting eight tons. On the south side is the grinding and polishing shop, and on the west and north the cutting shed. The offices of the company are also on the north side, at the entrance to the yard. The buildings are so constructed that the work can be carried on without hindrance from storm and winter cold. The grinding and polishing shed is 300 feet long, and contains four large rotary carriage machines or vertical rubbers, capable of polishing seventy or eighty superficial feet at once; also four hand rotary, vertical polishers, six pendulum machines, two of which are double, and thirteen lathes. This machinery is driven by a long line of four-inch shafting connected with the water-wheel under the falls.

Description works.

*Report of Progress, Geol. Surv. Can., 1876-77, p. 347.

There is an additional line of shafting at the west end of the polishing shop, for driving the lathes. These lathes are of various sizes, the largest being capable of turning columns twenty-eight feet long and three feet in diameter. The large carriage machines have carriage-beds four feet by ten feet, and the motion is taken to the vertical rotary polishers which work upon them by cog-wheel movements; on the tables of these machines the stones are bedded to a uniform level with plaster of Paris. The four small rotary polishers are moved in a similar way, and have universal joints, to enable the workmen to move them at will to any part of their work.

Process of cutting and polishing.

"The rough stone is first taken into the cutting shed, which is about 250 feet long, where it is dressed with chisels to the required form. It is next transferred to the grinding and polishing shop, where the rough grinding is done with sand and water. When the stone is sufficiently smooth the sand is cleaned off, and emery applied to the amount of one pound to two superficial feet of surface; this is kept upon the stone till it (the emery) is ground to an impalpable powder, or "sludge," free from grit. The emery is then thoroughly cleaned off, and moist putty powder (oxide of tin) applied, to polish the stone and give it a brilliant surface.

"An ordinary spire, six feet high, can be cut and shaped in four days by one workman, and when transferred to the polishing shop, about four days more are consumed in grinding and polishing the several sides of it. The expense connected with the preparation of the stone for market is, therefore, considerable; but its colour and quality is such as to make it well worthy of the expenditure of time, labour and capital, and it is highly prized wherever it is known."

Existing appliances.

At the present time (1898) the grinding and polishing machinery consists of one granite lathe or column cutter, six Jenny Lind polishing machines, six vertical polishing machines, two sets pendulum polishing machines, seven polishing lathes, and other necessary appliances. About $3500 worth of finished work is turned out monthly, and about sixty men are employed for eleven months of the year, but the facilities are much in excess of this output.

The granites of the northern, or York county belt, are too remote from shipping ports to make them a profitable source of supply on an extended scale; they have, however, been employed to a limited extent. Then on the St. John River, just opposite the mouth of the Sheugomoc are the works of the Southampton Marble and Granite Company (Oldham Bros.) which extracts in the vicinity and uses each year from 400 to 500 tons, chiefly for the manufacture of monumental bases, but sometimes for entire monuments. A considerable quantity of rock was also removed from that neighbourhood to be used as foundations in the construction of public buildings in Fredericton.

"*Black Granites*," or *Mica-diorites*.

Black granite.

At various points in connection with the great mass of granitoid rocks constituting the Nerepis Hills, rocks containing more or less hornblende, and often of a highly basic character, as well as of a dark colour, are met with, some of which have been quarried to a limited extent and brought to market under the above designation.

Bocabec.

One such locality is that of Bocabec, bordering the north side of Passamaquoddy Bay, in Charlotte county, where a quarry has been opened by Sheriff Stuart and others, in a rock consisting of a granular admixture of Labrador felspar and hornblende, with grains of magnetic iron. It is a handsome stone and susceptible of a good polish, but tougher and harder to work than ordinary granites, and said to require, as compared with that of St. George, about 20 per cent more labour for its finishing.

Frye road.

A rock of somewhat similar aspect, but carrying a certain percentage of quartz, and at the same time somewhat lighter in colour, occurs on the Frye road, a little west of Bocabec, and not far from the line of the Canadian Pacific Railway at Limeburner Lake. It is the property of Angus Kennedy, of St. Andrews, by whom a quarry has been opened and a considerable quantity of rock taken out, but not removed. The stone is of even texture, firm and durable, besides being susceptible of a good polish. Its position is favourable to shipment.

Dolins Lake, St. John county.

Rocks of a highly basic character and dark colour like that of Bocabec, also occur at Dolins Lake, near St. John, and Bull Moose Hill, Kings county, as well as at many other points, but as yet have not been worked.

During the summer of 1897, a company known as the Dominion Granite Company, of Bridgewater, N.S., have opened quarries and erected works at Welsford (Queens county, N.B.) for the manufacture of so-called "black granite." The rock is in reality a mica-diorite, and is described as forming a mass about one mile long and half a mile wide. It is situated about a mile from the line of the Canadian Pacific Railway, and about twenty-two miles from the city of St. John. It takes a good polish and is being worked for monumental purposes.

Ornamental Stones.

Ornamental stones.

The materials found in New Brunswick which are capable of being employed for ornamental or decorative purposes, besides granite, include certain varieties of marble, serpentine and porphyry, with, possibly, the minerals quartz, garnet, tourmaline and fluorite.

Marbles.

Marbles.—These are almost wholly confined to the rocks of the Laurentian system, in which they occur in considerable beds, and of many different varieties. In tint they vary from pure white to cream-colour, reddish, grayish or greenish, the latter tint due to associated pale-green serpentine, constituting *verde antique.* In texture they similarly graduate from kinds which are almost cryptocrystalline to others which are coarsely saccharoidal. Many of them are not without beauty, and are susceptible of a fine polish, but they are apt to be much shattered by the shearing strains to which they have been subjected, and this has greatly interfered with their being turned to useful account. Small quarries have at times been opened, but no extensive or continuous work has yet been undertaken.

Serpentines.

Serpentines.—As stated above, pale-green serpentine is at various points (St. John, Pisarinco, Musquash, Fry Island) associated with Laurentian limestones, forming a variety of *verde antique* marble. Hand specimens are often quite handsome, but large blocks, free from cracks, are not easily obtained.

Porphyry.

Porphyry.—In the hills around Passamaquoddy Bay, the upper portion of the Silurian system is marked by the occurrence of extensive sheets of fine-grained rock, consisting to a large extent of felspar, with porphyritic crystals of the same mineral, but having associated with the felspars more or less of finely disseminated quartz. It is probable that among these rocks, all of which are ancient volcanic overflows, quartz-porphyries and rhyolites are included. In many instances the beds are of very fine texture, and readily take a high polish, while their colour, varying from a pale salmon-red to a deep brownish-red, diversified by the occurrence of numerous small felspar crystals dis seminated through the mass, is such as to make them very attractive. In some instances, in addition to minute crystals, the rock is further characterized by what would appear to have been lines of flow, producing a delicately banded and wavy structure, suggestive of some varieties of polished wood.

Situation favourable for working.

Some of these beds are very favourably situated for quarrying and shipment, being (as at Chamcook Lake) directly on a branch line of the Canadian Pacific Railway, or (as at MacMaster Island) close to navigable waters. That they have not, up to this time, been regarded as worthy of attention, seems to be largely due to the fact that, as seen near the surface, they are freely intersected by divisional planes, and blocks of suitable size are not easily obtainable; but the interior of these blocks is often of a very firm texture, and it is not at all improbable that, were excavations made sufficiently deep to get beyond the reach of the frost, the objection referred to might be greatly if not wholly removed. At all events there would seem to be no good reason why small blocks of the rock should not be used, in the form of tablets, etc., in connection with the red granites of St. George, with the colour of which they would completely harmonize.

Freestones, Millstones, Grindstones.

With the rocks of the Carboniferous system, including the Millstone Grit formation, occupying so large a portion of its surface, it is not to be wondered at that rocks of the character indicated by the above title should be abundant in New Brunswick. As a matter of fact they can be obtained, more or less readily, over almost all parts of the area thus occupied. Their extraction has been chiefly determined by demand, and by their greater or less accessibility and proximity to means of transport. Carboniferous rocks.

For many years, the chief centre of the freestone industry was to be found at the head of the Bay of Fundy, along portions of the Albert county coast, upon that of Westmorland county and some of the adjacent islands. One of these latter, viz., Grindstone Island, emphassises in its name the nature of the materials of which it is composed, as it was also one of the earliest localities at which grindstones were made. On Mary Point, on the mainland near by, similar beds occur, and about forty years ago considerable quantities of stone were quarried and removed from both places. It is said that, in 1851, as many as 58,949 grindstones were made, mostly from the Bay of Fundy beds. In 1856, more considerable quarries, known as the Budreau quarries, were opened on the left bank of the Petitcodiac River, in Westmorland county, and in 1864 the Caledonia quarries at Rockland in the same county. Still later, a quarry known as the Westmorland Union Freestone quarry, was opened near Cumberland Basin, with others in the valley of Demoiselle Creek, in Albert county. Bay of Fundy quarries. Budreau quarries.

At all the above localities, the rocks lie at or near the base of the Millstone Grit, and may often be seen to rest upon and to graduate Geological conditions.

into the red rocks of the underlying Lower Carboniferous formation. The former are usually gray or olive in colour, but shade on the one hand into chocolate-brown, or on the other into a bluish-gray. At Mary Point a portion of the beds were of a pale purplish-gray colour. The olive-gray was generally preferred, and of this very massive beds, from two to six feet in thickness, were readily obtained, yielding in the case of the Budreau quarries, blocks of any desired size up to a length of thirty feet, and a weight of twenty tons. The fine, even texture of these rocks, the facility with which they could be worked, their durability, combined with their pleasing colour, soon led to their being held in high estimation, and the so-called "brown stone fronts" of some cities of the United States, as well as many public buildings both in the United States and in the Maritime Provinces, illustrate the extent to which they were at one time employed. All this, however, is now changed, there being at the present time, so far as known to the writer, not a single quarry in either Albert or Westmorland county, at which work is being prosecuted. The explanation of this is mainly, if not wholly, to be found in the operation of the adverse tariff imposed by the United States.

Cessation of work.

While the working of freestones and grindstones in the south-eastern counties is thus for the time being dormant, somewhat extensive operations have, for a number of years, been in more or less continuous progress along the so-called north shore of the province, more especially near Newcastle, in Northumberland county, and on the shore of the Bay Chaleurs at New Bandon or Stonehaven, in Gloucester county.

French Fort quarry near Newcastle.

The French Fort quarry, near Newcastle, was opened in the year 1885, by Mr. C. E. Fish, as the result of inquiries then made for sandstone in connection with the construction of the large departmental building at Ottawa, now known as the Langevin block. For this building some 30,000 cubic feet of stone were quarried and shipped. Since that time the output has varied considerably, but the work has been continuously carried on, with an average, for the full seven months in each year, of between 3000 and 4000 tons, an amount which might easily have been increased by the employment of a larger plant and by additional effort to secure a market. The average number of men employed is about thirty, with wages at about $9 per week.

Situation.

The quarry is situated almost on the line of the Intercolonial Railway, and three-quarters of a mile from the Miramichi River, with both of which it is connected by tramways for ship ping. The upper thirty feet of stone is olive-gray in colour, becoming sometimes greenish-olive, beneath which, to the level of the river, the rocks are gray. The greenish-olive or olive stone is most pleasing to the eye, whether with a natural or rock face, or dressed in various ways. It retains its colour well.

The best grades of the stone are almost entirely free from defects, and are generally quarried from the same level. The stone is so easily wrought that it can be cut and carved very elaborately and at a small cost. It also makes a most desirable stone for trimming brick buildings. Other grades are admirably suited for the manufacture of stones, for wood-pulp grinding and for all classes of foundation work. The natural outcroppings, structures nearly one hundred years old, the numerous bridge-piers, culverts, abutments etc., for which it has been employed, both in salt and fresh water; its exposure to rough wear from the lashing of the ocean or swift running water, as well as to the grating of ice-floes and the knocking of drift timber, all tend to show the great durability of the stone and its fitness for every class of work, there being no evidence of weakness or decay under any of these circumstances. The stone needs to be quarried long enough before using to become thoroughly dried. The finer grades however, are much affected by the frost, while the coarser grades, do not seem to be affected in any way. Its power of resistance to shearing and crushing forces has not as yet been definitely determined.

Various grades.

Durability.

The thickness of the beds in the quarry runs from six inches to nine feet, the thickest being always the lowest. They contain seams, called by the quarrymen "sand-beds," "mica-beds," "mud-beds," "iron-beds," and "coal-beds," according to their predominant characteristics, and also hold spots and nodules of slate, as well as of a soft brownish-black material, probably manganese, occurring in "pockets." Iron is more abundant in some localities than in others. In some quarries it is found very largely in the best grades of stone, and in others it occurs chiefly in the less valuable sheets. Joint-planes occur throughout the quarry, some of them very long and deep while others are much shorter, branching off from the former in different directions. The width of the beds between these joint-planes is from 4 to 30 feet, and the actual joints are in some places quite close, while in others a little more open—about three-fourths of an inch—and then usually full of a very tough clay. Concretions are of common occurrence in the larger sheets of stone. They are usually round and consist of a brownish-black soft material on the outside, similar to that of the "pockets" referred to above, while the interior is of a fine, hard,

Thickness of Beds.

Concretions.

gray material. Much larger deposits of a like nature and termed "bull" by the quarrymen, are occasionally met with. They are sometimes three feet in diameter and six to ten feet in length. The stone surrounding concretions is always of poor quality.

Waste.

In the quarrying operations there is generally a good deal of waste, consisting of "earth," "shelly rock" and "bad rock," all of which has to be handled and got out of the way in producing the best grades of stone. This of course makes it a little expensive, but not more so than in the case of similar grades elsewhere at the quarries. The consequence is that very little of the rock is used in the Maritime Provinces, architects and their clients being there satisfied with the second grade of stone. Whether this is due to a lack of knowledge of the quality on the part of the builders, or to the aim of the architect to give a stone building at a small cost, is not known. Probably both these reasons come into play. It would, however, certainly be much better, in the case of our public buildings at least, if more definite instructions were given to the architects, properly specifying the quality of stone. Any class of stone can be produced at these quarries and as cheaply as elsewhere. The outcrops extend in distance for over three miles.

Markets.

The cost of transportation to our own markets very seriously injures the expansion of the stone industry at Newcastle. The distance to our larger cities and more prosperous towns entails a freight charge that cripples these works very much in competition with nearer quarries situated in the United States, as these can deliver stone, freight and duty included, at a less rate than the freight alone from Newcastle.

Effects of tariffs.

The change in tariff lately made, allows building stone and grindstones to come into Canada at a much less rate of duty than that imposed by the United States. This practically gives to Ohio and the West, our Ontario and Quebec market, while we are shut out from the New England market. Ontario takes no grindstones from the Maritime Provinces, and what is produced by them has been and is marketed in the New England states at a very great disadvantage, in competition with the quarries in the United States.

Competition from abroad.

Another very serious hindrance in the development of this industry, is the very large quantity of foreign stone that is brought to this country in vessels coming for return cargoes. These boats often carry it as ballast, at very small cost, and while the quarries in Great Britain actually get more for the same grade of stone than the Newcastle quarries, the latter are at a disadvantage.

In 1894 the United States duty was as follows :—

Grindstones finished and unfinished..............	10 per cent.
Building stone, etc., in rough.......	7c. per cubic foot.
do dressed.......	30 per cent.

In 1897 the United States duty is as follows :—

Grindstones finished and unfinished..............	$1.75 per ton.
Building stone, etc., in rough....	12c. per cubic foot.
do dressed...........	50 per cent.

In addition to the Langevin block in Ottawa, Newcastle stone has been used in the construction of the city hall, Hamilton, Ontario; Erskine and St. James churches, Birks' building and various private residences in Montreal; the post-offices of Rimouski, Fraserville, Richmond, Chatham and Newcastle in Quebec and New Brunswick, and in St. Dunstan cathedral in Charlottetown, P.E.I. It has also been employed extensively as trimmings for brick structures.

The Bay Chaleurs stone quarries are, geologically, probably a little lower than those of Newcastle in the Carboniferous system, but do not differ essentially in their character.

They are two in number, the principal one being that of Stonehaven (formerly New Bandon) and the other at Clifton, the two being about two miles apart. Both are situated directly upon the shore, which here presents, for several miles, a series of nearly vertical bluffs of rock, the admirably exposed strata having a very light south-east dip. At Stonehaven, the rocks are all gray in colour, including massive beds from sixteen to twenty feet in thickness, while at Clifton, only the basal beds are gray, the greater part of the fifty feet of rock that here constitutes the bluff being composed of gray, green and red crumbling shales. Layers of the latter are replete with fossil ferns, remarkable alike for their variety and the perfection of their preservation. At one point (Knowles' quarry) may be seen several beds of bituminous coal, the thickest being about eight inches. Other seams are said to show at very low water, one of them with a thickness of eighteen inches. Stonehaven quarries.

The freestone of Stonehaven, according to its proprietor, Mr. John W. Love, is not well suited for building, being subject to too rapid decay. The post-office at Bathurst has, however, been built of it. By far the larger part of the rock is used in the manufacture of grindstones, with pulp-stones, scythe-stones etc., as subordinate products. About fifty or sixty men are employed, and the yearly product is from 1000 to 1200 tons. The grindstones vary from four inches to seven feet in diameter, and their value is estimated at ½ a cent per pound or Manufacture of grindstones.

Market. $10 to $12 to the ton. At one time as many as 300 men were employed, but the production of stone in the west and the imposition of high duties by the United States have greatly reduced the force engaged. At present the product is wholly used by one firm near Hartford, Ct., U.S., (Collins Co., manufacturers of edged tools).

Freight charges from Stonehaven to New Haven, are about $3 per ton, the duty on large stone under the old tariff being $2 a ton.

History. Quarrying was first begun at Stonehaven about 1844, the first workers being Messrs. Sprague, of Boston. The present proprietor commenced operations about 1852. The quarries are worked for about five months each year, the wages paid being $1.40 to $1.50 per day. The facilities for shipment by water are all that can be desired, while the line of the Caraquet Branch of the I. C. R. is less than a mile distant.

Some eight or nine years ago, a small quarry was opened in Scotch Settlement, at the head of the Shediac River, under the name of McSweeny's quarry. The stone therefrom was used in the building of the Roman Catholic chapel in Moncton, but since that time nothing further has been done.

At Cocagne Bridge, on the Cocagne River, in Kent county, where this stream is crossed by the Moncton and Buctouche railway, eighteen miles from the city of Moncton, quarries have been opened and are now being worked, but on a small scale only, by Mr. John Dobson. The rock is partly gray and partly purple, and can be readily removed either by rail or water. The building of the Young Men's Christian Association in Moncton is constructed of rock from these quarries and presents an attractive aspect.

No other quarries of importance are at present being worked in the province. Stone for local consumption has, however, at different times been obtained from other localities, especially along the line of the Fredericton Branch of the C. P. R. From quarries opened there was obtained the stone used in the construction of the Fredericton city hall as well as the large departmental building of the Provincial Government. Besides a gray stone, these quarries yield a rather dark-purple rock. When used together, as in the first of the buildings named, the effect is pleasing to the eye; but when employed alone, as in the second, is so dark as to be somewhat sombre.

Quarries near Fredericton.

Slates, Flags, etc.

No slate quarries have as yet been opened in New Brunswick, but probably rather because of the very limited demand for the material than from the inability of the province to produce it. Slate is in fact a very common rock in New Brunswick, and though nothing has been done in the way of testing its quality, it can hardly be doubted that localities could be found in which it would satisfy all requirements.

Among the districts which may be especially referred to as likely to furnish good slates, is that of northern Charlotte county, in the parishes of St. James and Dumbarton; the southern part of Queens, in Petersville and Hampstead; the Tobique valley, in Victoria; and portions of Madawaska, Gloucester and Restigouche counties. It is stated that the court house at Bathurst is roofed with slate from the Tattagouche River. Slate districts.

Flags.—Materials suitable for flagging are also not uncommon. In northern Charlotte county, the country is strewed with large tabular blocks of sandy and micaceous argillites, showing the natural tendency of the rocks there met with to break in this form. Portions of the Cambrian system east of St. John would also furnish good flags.

Hearth-stones.—During the operation of the blast-furnaces at Woodstock, sandstones derived from the Lower Carboniferous rocks of the Tobique and Beccaguimic valleys were to some extent used in the making of the hearths of these furnaces and were stated to give good results. Hearth-stones.

Hone-stones.—It is stated by Mr. M. H. Perley, in his Handbook for Emigrants to New Brunswick (London, 1857), that fine oil-stone, equal to Turkish, is found at Cameron Cove, near the northern head of Grand Manan, whence it has been taken in quantity. He also states that excellent blue whetstone has been worked to some extent near the Sevogle, a tributary of the North-west Miramichi, and again from Moose-horn Brook, in Kings county. The present writer has no personal knowledge of either of these localities. Hone-stones.

At Rockport, on the shores of Cumberland Bay, Westmorland county, a small quarry opened by Capt. S. Cole, includes beds which appear to be well fitted for the manufacture of scythe-stones and similar articles.

CLAYS.

Clays suitable for the manufacture of bricks occur in many parts of New Brunswick, being a common feature among the deposits of Pleistocene age, especially along river-valleys and upon the seaboard. Some are doubtless of estuarine or marine origin; others are probably Origin.

to be ascribed to the deposition, either in lakes or rivers, of the mud of melting glaciers. The former usually contain fossils and are, in consequence, more or less calcareous; the latter are usually destitute of such remains, and are more purely argillaceous, except where derived from calcareous rocks. In connection with the Coal Measures, especially at Grand Lake, are found thick deposits of under-clay, occurring beneath coal-seams, and stated to be adapted for the manufacture of fire bricks.

The manufacture of bricks has been carried on at so many different points and with so much irregularity that, with few exceptions, no very definite statements can be made regarding it. Only the most important works will be here particularly noticed.

1. Works of Messrs. John Lee & Co., Little River, Simonds, St. John County.

These works are by far the most important in New Brunswick. The following information regarding them has been kindly furnished by the proprietors :—

Lee Brothers brickyard.

John Lee, about 1846, bought a tract of land two miles from the city of St. John, containing a bed of brick-clay, and started brick-making by the hand-moulding process. On this site he continued to make brick until his death in 1860. In 1861, James and John Lee, under the name of Lee Brothers, enlarged the works by leasing an adjoining brick-yard from Mr. Thomas Davidson, and increased the output to one million bricks per year. Half of these were for five years sold to the Imperial Government to build the fortifications at Halifax, having been selected by the engineers for strength and durability in preference to any other bricks offered.

Development.

In 1870, the brick-yard of Mr. James Sullivan, situated at Little River, was bought. With increased facilities the three yards were kept running, five million being the output for 1877 and 1878, after the St. John fire. In 1880 the name of the firm was changed to John Lee and Co., and operations have since been continued with increased capital and improved machinery.

Quality of product.

The excellence of the product of these works is so well known to the building trade that "Lee's bricks" have been used in nearly every building of note erected in New Brunswick for the past twenty years.

Pressed-brick making was made a specialty in 1870, with an average annual output of 150,000. Drain-tiles have been made since 1863, varying in size from one and a-half to six inches in the bore. The annual consumption of them has been about 35,000, the chief markets being in Nova Scotia and New Brunswick.

To Lee Brothers belongs the credit of introducing the manufacture of brick by steam machinery in New Brunswick in 1870. For the past thirty-seven years the average annual output of pressed and common brick has been one and a-half millions, with an annual average consumption for fuel of 700 cords of wood. The output for 1897 was 1,700,000 of common and pressed bricks, and 20,000 drain tiles. The number of men employed, thirty-five; the average wages paid, $1.35. The price of labour amounted to $6,000; the wood consumed, 800 cords, costing $2,400; the cost of hauling, $2,000; the price of the products delivered in St. John, $12,000. The brick-making season lasts from April to November, and the working day is nine hours. Output.

Although St. John is the chief market for these products, one-third of the output each year has been sold in the surrounding villages and cities of New Brunswick and Nova Scotia. Lots of small and large quantities are from time to time sold in Prince Edward Island, Newfoundland, the West Indies and the State of Maine. Market.

The residences, offices and brick-works are located at Little River, two miles from St. John, on the sea-shore of Courtney Bay, the position being favourable for the landing of wood and shipment of brick, besides being within easy hauling distance of railways. The plant consists of two semi-stiff-mud wire cutting machines, of their own invention, one Martin soft-mud machine, with a capacity of 50,000 bricks per day, one drain-tile machine and six brick presses, the whole driven by two twenty horse-power steam engines. The company's property covers 400 acres, thirty of which are of brick clay, very strong, and averaging nine feet in depth. The stock on hand on the first of January, 1898, was 1,700,000 stock bricks, 100,000 pressed bricks and 40,000 drain tiles. Plant.

According to Mr. R. Chalmers*, bricks have been or are being manufactured from marine clays at Campbellton, Restigouche, Bathurst, Newcastle and Moncton; while clays of apparently fluviatile origin have been similarly employed at Fredericton, Marysville, Woodstock, Shiketehawk and elsewhere on the St. John River.

The brick-yard at Newcastle is on the main line of the Intercolonial Railway, about half a mile east of the station, and formerly produced about 200,000 bricks per year. It has not been worked for about three years. The material is said to be of superior quality. Newcastle brick-yard.

* Annual Report, Geol. Surv. Can., vol. I. (N.S.), 1885, p. 58 GG.

The plant is still upon the ground, and an abundant supply of wood is within easy reach.

Fredericton brick-yards.

At Fredericton, the brick-yards of Mr. M. Ryan are situated at the north-west outskirts of the city, and within a few rods of the bank of the St. John River. The thickness of the clay is unknown. The works here were begun in the spring of 1872, and have since that time yielded an annual output of from 1,000,000 to 1,500,000 bricks, and from 50,000 to 60,000 drain tiles, the latter ranging in size from two to six inches. Mr. Ryan employs on an average twenty men, the average wage paid being $1.50 per day. The clay is removed to a depth of twenty-five feet, and has been tested to a depth of fifty feet, without reaching stone. It is blue in colour, quite free from surface stones or loam, and is very easily tempered. Occasionally fragments of land plants are met with, and in one instance a very perfectly preserved fossil fish was found in the clay, but whether of marine or fresh-water origin is not yet known. The bricks from this yard find a market in various parts of York, Carleton, Madawaska and Sunbury counties, but especially in the city of Fredericton. Prior to the opening of these yards others had been in operation, but upon a smaller scale, at different points in this vicinity, which is probably everywhere underlain by similar clay deposits.

At Marysville, on the Nashwaak River, three miles from Fredericton, are beds of brick-clay from which were obtained the bricks used in the building of the large cotton mills of Mr. Alex. Gibson, besides many residences in the same town. The works are not, however, carried on continuously, or for other than local consumption.

Moncton.

The Moncton brick-yard is that of Mr. W. H. Cummings, and is distant from the city about two miles, but only a quarter of a mile from the track of the Intercolonial railway, and less than this from the rails of the Moncton and Buctouche railway. The annual product is from 500,000 to 1,000,000 bricks, sometimes a little more. The market for the output is found chiefly in Moncton, Amherst and Sackville. About thirty men are employed, at about $1.50 per day, the cost of wood being about $1.50 per cord. No tiles are made here. Two qualities of bricks are manufactured, the one for inside and the other for outside work. Pressed bricks are also made if ordered. The works have been in operation here for forty years or more. At first the bricks were made by hand, but now steam is employed in connection with a dry-house and fans. The dry-house is capable of holding 65,000 bricks at a temperature of 150°. The Aberdeen school, recently constructed in Moncton, was made of bricks from these works.

Silica, Infusorial Earth, Etc.

Infusorial Earth.—As far as known to the writer, deposits of this material have been found in quantity at but two places in New Brunswick, though it is highly probable that careful search would reveal its presence at many other points as well.

Pollet River.

The first of the localities referred to is that of Pollet River Lake, Mechanic Settlement, Kings county. As described in the report of Dr. Hoffmann (Report of Progress, 1878-79 4 H) from data afforded by Dr. R. W. Ells, The deposit is of considerable extent, having a depth of about four feet over the floor of the lake, from which it could be removed either by dredging or draining. An analysis showed a little over eighty per cent of silica, a little over three per cent of alumina, and about thirteen per cent of water and organic matter, with very small quantities of ferric oxide, lime, magnesia and carbonic acid.

Economic value of product.

As regards the economic value of the material Dr. Hoffmann says :—"It may be said to constitute an excellent polishing material ; and although no experiments have been made to determine its absorbent power, it may reasonably be expected to prove well adapted for the preparation of dynamite. Again, the extreme facility with which it is dissolved by caustic alkalies (potash or soda), would suggest its advantageous employment for the manufacture of what is commonly known as water-glass or soluble-glass, a preparation which meets with many important applications in the arts, as for instance, as a cement for the manufacture of artificial stone ; for the hardening and preserving of building-stones ; in fixing fresco colours by the process of stereochromy ; as an addition to soap in the preparation of the so-called silicated soaps."

Fitzgerald Lake.

A second locality in which infusorial earth has been found, is that of Fitzgerald Lake in St. John county, seven or eight miles from St. John city, brought to notice in draining the lake by the St. John Water Company. The character of the material is essentially the same as that of Pollet Lake.

Silica.

Silica.—Deposits of this material, which are entirely sedimentary and not of organic origin like those above noted, occur in several parts of Charlotte county. The most remarkable is one found near Blacks Harbour, regarding which the following particulars have been kindly furnished by Prof. W. F. Ganong and Mr. C. E. Boardman.

The deposit occupies a flat plain, of which the extent is between one hundred and two hundred acres, but nowhere with a greater depth than ten inches. Though referred to as silica it is by no means purely silicious, though in some samples the silica has been found to be over ninety per cent. A darker coloured material of the same nature underlies that just referred to and has, in some places a depth of at least twenty feet. Both materials may be described as fine silts.

Analysis.

An analysis by the Ledoux Chemical Laboratory of New York gave—

Silica	72·65
Alumina	17·93
Sesquioxide of iron	0·57

with small quantities of lime and magnesia and some combined water.

Considerable quantities of the material have been taken away to be tested for various uses, among which are: polishing powder, filling of wood preparatory to varnishing, filling for the walls of safes, and the making of scouring soaps; but in none of these has it proved superior or equal to infusorial earth.

Deposit not now being worked.

It has also been proposed to use it for the making of special kinds of bricks, but the negotiations in this direction have not been successful. At present nothing is being done with it. The property is now owned by Mr. G. W. Ganong and others of St. Stephen.

Mineral Paints.

Ochres.

Clays containing sufficient admixtures of ferric oxide or of manganese, to make them available for this use have been observed in various parts of the province, but have never been utilized except locally and on a very small scale. One of the best known to the writer, is represented by a specimen collected by the late James Robb in the vicinity of Edgett Landing, near Hillsborough, Albert county. It is a brownish-red ochre, which, after burning, gives a fine deep-red powder, well adapted for the manufacture of some varieties of paint.

On the North-west Miramichi River, in Northumberland county, and about one mile and a half above Chaplins Island, the slates of the district are found to hold veins and masses of brownish-red ochre which has a local reputation as a mineral paint, but the quantity appears to be small.

At Lyndfield, Charlotte county, in the excavation of a well, a quantity of dark-brown, almost black earth, was found beneath a mass of trap rock, and was penetrated without change to a depth of eighteen feet. An analysis of a sample made by Dr. Hoffmann, showed it to consist essentially of bog manganese and oxide of iron. It would require some treatment to fit it for use as a mineral paint.

Another occurrence of ochre has been noted by Mr. Chalmers on the North-west Miramichi River, near Chaplin Island.*

It is also probable that some of the bog-iron ores elsewhere mentioned (p. 18) might be advantageously employed as ochres.

Mineral Springs.

Springs more or less charged with mineral matters have been observed in various parts of the province, but only in a few instances have so far been employed.

Salines.—The rocks of the Lower Carboniferous formation are in several places the sources of salt springs, as in the vicinity of Sussex in Kings county, at Salt-spring Brook, parish of Upham, in the same county, and on the Tobique River, in Victoria county. Of these the Sussex springs are the most important.

Salt works at Sussex.

As nearly as can be ascertained, the first operations for the manufacture of salt near Sussex were begun fully one hundred years ago, the quantity manufactured being, however, but small, very variable in amount, and employed wholly for local consumption. A similar description would to a large extent, apply to more recent undertakings in the same direction. The present proprietor (Mr. Geo. N. Hendricks) commenced work in 1887, since which time, on an average, about 150 barrels of salt per year have been made, each barrel holding four bushels. During the year 1897, 140 barrels were made, at a cost of about $2 per barrel. The salt is sold for $3 per barrel, and is especially esteemed for table and dairy use.

Mode of manufacture.

The salt is made by evaporation, two furnaces being employed, side by side, and having over them one pan made of boiler-plate, holding 2000 gallons and one holding 400 gallons. There are also two kettles holding 200 gallons each, and four holding 150 gallons each. These latter kettles, weighing 1000 lbs. and costing $50 each, are found to be very liable to crack, and sometimes last only a single season, thus increasing materially the cost of production, as well as giving uncertainty to the amount of product. Wood, in four-foot lengths, is burnt in one end of each furnace, and the fire is continued from Monday morning until Saturday night. Only two men are employed, one for the day and the other for the night, and great care is taken to secure a

* Annual Report, Geol. Surv. Can., vol. III. (N.S.), p. 33 N.

product which is pure and clean. Work is carried on in warm weather only. During the time the works were running in 1897, they turned out a little over twenty-one barrels per week; but there is plenty of brine to run a much larger plant, while if, by boring, a brine of greater strength were reached and more economical methods of concentration were employed, the yield could, no doubt, be very largely increased. There would be no difficulty in selling a larger quantity. The strength of the brine at present is twenty per cent. Salt made at this place is held in high repute for the curing of meat.

Output.

Results of borings.

About ten or twelve years ago, a boring was made to a depth of 150 feet, solid rock being struck at a depth of twenty-six feet from the surface. The water obtained at the depth of 150 feet showed an increase in strength of about four degrees in the salinometer. There are half a dozen springs within a radius of a quarter of a mile, all about six miles from Sussex station, but less than a mile from the line of the Intercolonial Railway. No attempt has been made to manufacture salt in other localities in the province.

Brine springs also occur at Salina, on Salt-spring Creek, Kings county, about thirty miles south of Sussex. This locality was visited by Mr. R. Chalmers, of the Geological Survey, in 1895, when a boring in the highly inclined Lower Carboniferous rocks had been made to a depth of 330 feet. A specimen of the brine was collected and subjected to analysis in the laboratory of the Survey with the following result, expressed in grains to the imperial gallon, and remarkable because of the large proportion of potassium* :—

Potassium chloride	19·963
Sodium "	1293·648
Magnesium "	22·315
Sulphate of lime	268·212
" magnesia	11·336
	1615·474

Sussex mineral water.

Mineral Waters.—A spring of mineral water found on the property of Mr. S. H. White, 1500 feet south of Sussex station, in connection with rocks of Lower Carboniferous age, has within the last two years become the basis of somewhat extensive operations. The flow, which is the result of an artesian boring, is at present that of a four-inch pipe, without pressure, but if confined, is sufficient to throw a jet to a height of fifty feet. It is, however, subject to considerable variation, apparently unconnected with the variations in rainfall, the flow even in a single day varying from five to twenty-five barrels.

* Annual Report, Geol. Surv. Can., vol. VII. (N.S.), p. 55 R.

An analysis of this water, made by Mr. F. G. Wait, under direction of Dr. G. C. Hoffmann, in the laboratory of the Survey, gives the following results, expressed in grains to the imperial gallon* :— Analysis.

	Grains.
Potassium chloride	0·21
Sodium chloride	2·10
Sodium carbonate	25·35
Carbonate of lime	1·47
Silica	1·05
	30·53

Carbonic acid in excess of that required to form the mono-carbonate, 9·24 grs.

In commenting on this analysis Dr. Hoffmann remarks that "the amount of water at the disposal of the analyst was far from adequate to allow the detection of any of the more rarely occurring constituents met with in waters. The analysis cannot be said to be an exhaustive one. It is, however, sufficiently so to show the general character of the water, which would be regarded as an alkaline water. If used dietetically it would be classed as a table water and might be drunk *ad libitum*."

No trace of hydrogen sulphide was found in the water at the time of analysis, having undoubtedly decomposed in the interval after bottling. The presence of this gas is, however, very obvious at the well, both to taste and smell.

The waters described above, are now the property of the Sussex Mineral Spring Company, and are used by them as the basis of the manufacture of various beverages, the water being carbonated and variously flavoured. The company is now putting up about 3000 bottles a day, and during the year 1897 the total product was some 300,000 bottles. Output.

In the parish of Havelock, also in Kings county, are other mineral waters which are being extensively used in the manufacture of beverages, but the writer has been unable, after repeated inquiries, to get particulars. Havelock water.

Road Material.

The subject of the better construction of highways is one which has of late been attracting a good deal of attention in New Brunswick, as illustrated by the formation of a Good-Roads Association and the making to the latter, by the Provincial Government, a legislative grant. Importance of using better road material.

* Annual Report, Geol. Surv. Can., vol. VII. (N.S.), p. 55 R.

The better construction of roads necessarily involves, as a most important factor, the consideration of the materials most suitable for their construction; and as the question has elsewhere, and especially in Massachusetts, been made the subject of extensive and elaborate investigations, it only remains to see in what position New Brunswick stands with reference to the supply of those kinds of material which the investigations referred to show to be best adapted for the purpose.

Considering the sparsely settled character of a large part of New Brunswick and the great cost involved in the transportation of quantities of stone such as would be required for macadamizing purposes, it is not to be expected that, for many years at least, the materials used for the purpose of ordinary road construction will be other than those to be found in the vicinity of the roads themselves. The conditions, of the principal towns, are, however, such that portions at least of their streets should be so made as to enable them to endure a considerable amount of wear. As examples it may be sufficient to consider here the two cases of St. John and Fredericton.

Road material used in city of St. John.

In the city of St. John, where rock-material has been employed as the basis of road or street construction, the material used has been largely derived from the beds of crystalline limestone, of pre-Cambrian age, which occur abundantly in that vicinity. It can hardly be said that the result has been satisfactory; for the same softness which admits of the rock being readily broken at comparatively slight cost, leads also to its rapid comminution and to the consequent necessity of frequent renewal, while the dust which results from its pulverization is of an especially fine and irritating character.

The slates and quartzites formerly removed in large quantities in the grading of the streets and in excavating for cellars, have been largely employed for a like purpose, but never gave satisfactory results. This supply having also now failed, the city authorities have resorted to the felsites and ash-rocks of the Huronian system, found just behind the city. In each case convenience and present cost have been the main guiding motives in the choice.

Fredericton.

In Fredericton the case has been still worse, the material here used having, until quite recently, been obtained solely from the beds of sandstone, belonging to the Coal Measures, which outcrop at various points in the vicinity of the city. This rock, at the best, has little durability, but when, as was often the case, material from near the surface which had long been exposed to the action of the air was chosen, a single season sufficed to reduce it to powder, forming masses of mud when wet or clouds of dust when dry. It was also wholly deficient in binding power. At last, however, better counsels have prevailed, and by advice of the author of this Report, resort has been had to the deposits of diabase and related rocks which are found not far from the city, and especially about Curries Mountain in connection with the Lower Carboniferous formation. As yet but little of the material has been used, but so far as employed it has given perfect satisfaction.

As this type of rock is that which, after exhaustive comparisons, has been pronounced by Prof. Shaler and the members of the Massachusetts Road Commission to be the best suited for the purpose, it is of interest to know that it may be abundantly and cheaply obtained in almost every part of the province.

MISCELLANEOUS.

The following substances, though either from lack of quantity or deficient quality are of little present economic interest, are deserving of mention, if only as indicative of possible future discoveries.

Barytes.—This mineral is formed in veins traversing Laurentian limestones on Frye Island, Charlotte county, and about the Northern Head of Grand Manan. Barytes.

In the settlement of Gouldville, one mile and a half east of Memramcook, in Westmorland county, barytes has been found in connection with a series of dark-red rubbly sandstones and shales, capped by gray rocks of the Millstone Grit formation. It is therefore near the summit of the Lower Carboniferous system. It is not now possible to see the vein, but several pits were at one time sunk upon it, and a considerable quantity of the mineral was removed and shipped. It proved, however, to be too impure to be of much value. It carries small quantities of galena.

Fluor.—Found associated with the barytes of Frye Island, Charlotte county; also in connection with semi-volcanic rocks of the Lower Carboniferous system near Harvey station and Listers Mills, York county. Fluor-spar.

Iceland Spar.—Veins of this mineral, sufficiently clear for optical purposes, are now of considerable value. Specimens suitable for such use were formerly found at Belledune, in Gloucester county, but the locality is now exhausted. Iceland spar.

Asbestus.—Veins of this mineral are found associated with serpentine, in the limestones of the Laurentian system of St. John county. They are of the variety chrysolite, but are too thin, so far as observed, to yield workable fibre. Asbestus.

Gem-stones.

Gem-stones.—Garnets are somewhat abundantly distributed through the mica-slates of the region about Moores Mills, in Charlotte county, and less commonly in the similar beds of Canterbury, York county, but none large enough to be of value have as yet been observed.

Crystals of black tourmaline, well crystallized and of considerable size, have been found near Moores Mills, but are very rare.

Amethysts of some beauty have been found on Grand Manan, but are not common.

Rare Metals.

Molybdenite.

Molybdenite.—Occurs in granular quartz-rock in Pennfield, Charlotte county, two miles north of the post-road on Trout Brook. It is in scattered grains and scales, some of the latter being as large as the thumb-nail. The quantity is said to be considerable. It has also been observed in granite rocks near St. Stephen, on the Nipisiguit River, near Bathurst, and elsewhere in rocks of like character.

Conclusions.

Having now given, as fully as the data available for the purpose will permit, the facts relating to the distribution and characters of the economic minerals of New Brunswick, it only remains to offer a few suggestions of a practical character, which may help in the extension of our present knowledge, and possibly lead to discoveries of importance.

Materials abundantly represented.

As regards materials used for purposes of construction, such as granite and freestone, already the basis of profitable industries, it is not necessary to say anything further. The same remark will also apply to deposits of gypsum, limestone, clay, sand, and probably to those of bog manganese. There is no dearth of any of these materials, their working depending solely upon their more or less favourable location and the obtaining of profitable markets.

Coal.

The question of the occurrence of coal has already been fully discussed, and will be made the subject of further consideration in a special report now in course of preparation. To set at rest any doubts which may still exist regarding its possible existence along the eastern seaboard, a line of systematic borings should be made parallel to this seaboard, from the vicinity of the Lutz Mountain ridge in Westmorland county to Bathurst in Gloucester county, with, possibly, another parallel line some thirty miles further west. This would fully settle the questions upon which doubt still exists, and even if yielding only negative results, would be of value as tending to save useless expenditure in abortive exploration.

As regards Albertite, the large sums of money already spent in the fruitless search for further deposits of this mineral, together with its greatly diminished value, make it undesirable that there should be any further considerable expenditure in that direction. Albertite.

The extent and character of the Bituminous shales of Albert and Westmorland counties are fully known. Nothing more is needed in this direction; but a possibly profitable field for experiment is to be found in the methods of their use. Apart from their character as sources of oil, they possess qualities of texture and composition which seem to suggest their possible employment in the manufacture of cements, pavements, etc. It is now proposed to make practical tests in this direction.

Among metallic minerals, it is certain that gold is that around the existence of which the greatest amount of interest at present centres. From what has been already stated, it will be evident that the existence of the metal in profitable quantities in New Brunswick remains to be proven, and that that proof is only to be had by a prolonged and systematic prospecting of the areas in which it is likely, if anywhere, to be found. These areas are large, and at the same time, for the most part, difficult of access. They are not, therefore, likely to obtain anything like thorough exploration through the efforts of private parties; and, if left to the chance discoveries of those who occasionally traverse them in the interests of sport or the lumber industry, may for an indefinite period remain, from a mineral point of view, the *terra incognita* which they are at present. If, however, the local government were to offer reasonable wages to competent prospectors for a limited period, with the provision that, in case of discovery of valuable ores, the finders should have the first claim thereto on returning to the government the previous cost of exploration, it is probable that the offer would be readily taken up and might lead to important results. Should this plan be thought desirable, small maps, such as could be easily prepared, and which should clearly designate the region to be prospected, might be furnished to intending prospectors, and the whole subject made public by advertisement in the daily papers as well as in the mining journals of Canada. It might at the same time be made the duty of such prospectors to collect samples of quartz leads and of such other minerals as they might meet and to send these to the Crown Lands office for examination. Gold. Suggested aid to competent prospectors.

As regards minerals other than gold, a similar plan might be adopted.

Mining laws.

It is an important question, in this connection, whether the mining laws of New Brunswick, imported with but slight alteration from the statute-book of Nova Scotia, sufficiently recognize the very different situation of a province rich in mineral wealth, with an organized mining bureau, and mines of many kinds yielding handsome returns, and that of one with but little known resources of this character, with no distinct mining bureau, and with mines yielding but little if any profit. In the latter case, not only should every inducement be held out to stimulate exploration, but the methods of acquiring proprietory rights should be at once simple and such as would tend to secure to the discoverer the fruits of his discovery. At present many a farmer, stumbling upon what may or may not be of value, hesitates to make any inquiries as to its character, fearing lest some one else more shrewd than he, or better acquainted with the requirements of the law, may step in and reap the profits of his observations; whereas if he were assured that his claim would have priority, he would make no delay in proving its value, and thus perhaps become the means of making known facts which would be of great and general importance.

Information for prospectors.

The appointment of a local officer, whose duty it should be to spend the summer months in visiting regions likely to become the seat of mineral discoveries, to pronounce, without elaborate assays, upon the probable value, or the reverse, of specimens brought in for examination, to direct the operations of the diamond drills and to be prepared to answer reasonable inquiries as to promising districts for exploitation and the mode of occurrence of useful minerals, would probably also be a step which would be justified by its results. The submission by such an officer of an annual report to the provincial legislature, would be the means of keeping the latter, as well as the public at large, accurately informed as to the condition of the mineral industries of the province for each successive year, would supply important information to those seeking an investment for capital in this direction, and would enable the government to make from time to time such legislation or such grants as would tend to originate or to stimulate new enterprises.

ADDENDUM.

On page 110 M, the statement is made that no freestone was being worked in the Albert or Westmoreland quarries. This is still essentially true as regards the county first named, but not as regards the second. Through information since received it would appear that there are two brown-stone quarries at Wood Point, in the parish of Sackville, owned and operated by Mr. H. C. Read. They are fully equipped to handle rock up to the extent of 3000 tons each per year, of the best grade, and more of lower grades. These quarries have been in operation for several years, and have furnished stone for some prominent buildings, among others the city hall in Toronto (in 1896), and the new armoury in Halifax (1897). Freestone

In addition to the above Mr. Chas. Pickard is opening a quarry, said to be a very excellent one, in Sackville; while the Hon. A. D. Richard, with others, has been working successfully a quarry near the old Boudreau quarry, opposite Dorchester. G. P. Sherwood & Co., also have a quarry at Boudreau village, and expect soon to ship stone therefrom for the construction of the new government building at Liverpool, N.S.

While the freestones about the head of the Bay of Fundy are abundant in quantity, excellent in quality and usually well situated for shipment, their actual working is of a very irregular and intermittent character, and dependent on the varying demand.

GEOLOGICAL SURVEY OF CANADA

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

SECTION OF

MINERAL STATISTICS AND MINES

ANNUAL REPORT

FOR

1897

ELFRIC DREW INGALL, M. E.,

Associate of the Royal School of Mines, England, Mining Engineer to the Geological Survey of Canada.

ASSISTANTS

THEO. C. DENIS, B.A.Sc. J McLEISH, B A.

OTTAWA

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

1898

No 662

To Dr. G. M. Dawson, C.M.G., F.R.S, &c.,
Director Geological Survey of Canada.

Sir,—Herewith permit me to hand you the detailed statistical report of the mineral industries of Canada for 1897. The preliminary summary statement for that year which was completed on 23rd of February, 1898, is of course replaced by the revised statement herein contained.

The work of the Section has proceeded during the year on the usual lines. The collecting, compiling and editing all the varied material statistical and other relating to the various mineral industries has occupied our time and attention. Much of this information does not come to hand until well on in the year, so that although parts of the report are ready, its completion must wait till all the data are in and can be dealt with.

The work connected with the answering of the very numerous inquiries constantly coming to hand also entails much research and occupies considerable time, and this branch of the work has naturally increased very much of late years in connection with the much greater interest felt everywhere in the mineral resources of Canada.

The accumulation of information relating to individual mineral deposits and to borings has been proceeded with as time and opportunity permitted, and the classified system of mines records is thus added to steadily if slowly.

In all this work pertaining to the Section, efficient and cordial aid has been rendered by Mr. J. McLeish during the year, and by Mr. Theo. Denis since his joining the staff in May last, vice Mr. A. A. Cole, who resigned in February. To the latter sincere acknowledgments are also due for the part he took previous to that date.

Thanks are also due to those, although too numerous to mention individually, who by answering our circulars or letters provided much valuable material for the report. Our acknowledgments are also due to the provincial mining departments of Nova Scotia, Quebec, Ontario and British Columbia, and to the Dominion Customs and Inland Revenue Departments for aid received.

I am, sir,

Your obedient servant,

ELFRIC DREW INGALL.

Section of Mineral Statistics and Mines,
31st October, 1898.

NOTE.—*Unless otherwise stated, the bearings in this report are all referred to the true meridian.*

EXPLANATORY NOTES.

YEAR AND TON USED.

Except for the figures of imports, which refer to the fiscal year ending 30th June in the current calendar year, the year used throughout this report is the calendar year. The ton is that of 2000 pounds, unless otherwise stated.

EXPORTS AND IMPORTS.

The figures given throughout the report referring to exports and imports are compiled from data obtained from the books of the Customs Department, and will occasionally show discrepancies, which, however, there are no means of correcting.

The exports and imports under the heading of each province do not necessarily represent the production and consumption of the province, *e.g.*, material produced in Ontario is often shipped from Montreal and entered there for export, so falling under the heading, Quebec.

N.E.S. = Not elsewhere specified.

VALUES ADOPTED.

The values of the metallic minerals produced, as per returns to this department, are calculated on the basis of their metallic contents at the average market price of the metal for the current year. Spot values have been adopted for the figures of production of the non-metallic minerals.

GENERAL NOTES.

As in the past, care is taken to avoid interference with private interests in the manner of publishing results, and all returns of production of individual mines are treated as confidential, unless otherwise arranged with those interested. The confidence of the mining community thus gained, has resulted in an increasingly general response to our circulars, although to complete our data personal application is still necessary in a small number of instances, and a yet more prompt response on the part of all applied to, will help still further towards an earlier publication of the material.

In view of criticisms of these statistics which have been made recently, and from time to time in the past, it may be well to take this opportunity to explain the working methods adopted, in order to prevent the misunderstandings which underlie such criticisms and suggestions, and to correct the impression thereby conveyed to the public that the reports are unreliable.

The figures given throughout the reports are based, as far as possible, upon returns obtained direct from the various operators, or from official data, and the totals have for some years been checked by comparison with railway shipments, exports, and all other available sources of information. It can be therefore fairly claimed, that they are as accurate as it is possible to make such figures.

After investigation of the subject we have, however, found that in the nature of things, export and railway figures can only be taken as approximately correct in most instances. In the case of the export figures, entries are made as a rule by those having no technical knowledge of mineral substances, and in the case of the railways, but few of the shipments are actually weighed, so that car-load lots, for instance, may differ considerably from the theoretical load of the car.

The lists of operators given throughout the report are not put forward as complete in every case, only those reporting their production being included. Producers finding their names omitted are invited to communicate with the office that they may be included in the next issue.

CORRECTIONS—ALTERATIONS.

Corrections and alterations have been made throughout this report wherever they seemed to be called for, according to more complete and reliable data available since previous issues.

The tabulated statement given in the folded sheet at the beginning of the report, represents a compilation of all the similar statements found in previous reports, re-modelled and further revised wherever possible.

INTRODUCTION.

The progress of the different mineral industries of the Dominion is well exemplified by the data given in the following general table of mineral production. In the period of twelve years covered, a study of the figures given will show many changes, which it would, however, be superfluous to point out here, as they are fully dealt with later in the report.

Some features of progress of mineral development in the country as a whole are, however, worthy of comment. The grand total of 1897, as compared with 1896, shows an increase of nearly 27 per cent, and as compared with 1895, of over 30 per cent. It will be observed that this is almost altogether due to the metallic minerals, and that amongst these gold, silver, copper and lead are those showing the most marked advance. This is chiefly due to the continued expansion of the mining industries of British Columbia, to which source must be credited practically all the increase in silver and lead and most of that in copper, that province dividing the honours with the Yukon district in the matter of gold. In metallic products the nickel-copper industry of Sudbury, Ontario, showed a gratifying increase as did also the gold industry of Nova Scotia.

In the class non-metallic substances, asbestus shows a very great increase in the quantity, which is, however, due to the production of the by-product "asbestic" and this being a low-priced commodity, the total value shows an increase of but 3·6 per cent. The only other notable features are increases in the values of the production of gypsum, natural gas and cement, as set forth in the following table :—

GEOLOGICAL SURVEY OF CANADA.

SECTION OF MINERAL STATISTICS AND MINES.

Mineral Production of Canada, Calendar Years 1886 to 1897.

PRODUCTS.		1886.		1887.		1888.		1889.		1890.		1891.	
		Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
METALLIC.			$		$		$		$		$		$
Antimony ore	Tons.	665	31,490	584	10,860	345	3,696	55	1,100	26½	625	10	60
Copper (c)	Lbs.	3,505,000	385,550	3,260,424	366,798	5,562,864	927,107	6,809,752	936,341	6,013,671	947,153	8,928,921	1,149,598
Gold (d)	Oz.	66,061	1,365,496	57,465	1,187,804	53,150	1,098,610	62,658	1,295,159	55,625	1,149,776	45,022	930,614
Iron ore (a)	Tons.	69,708	126,982	76,330	146,197	78,587	152,068	84,181	151,640	76,511	155,380	68,979	142,005
Lead (e)	Lbs.			204,800	9,216	674,500	29,813	165,100	6,488	105,000	4,704	88,665	3,857
Mercury	"												
Nickel (f)	"							(l) 830,477	498,286	1,435,742	933,232	4,626,627	2,775,976
Platinum	Oz.			1,400	5,600	1,500	6,000	1,000	3,500		4,500		10,000
Silver	"	*210,141	*209,090	355,083	347,271	437,232	410,998	383,318	358,785	400,687	419,118	414,523	409,549
Total value, Metallic			*2,118,608		2,073,746		2,628,292		3,251,299		3,614,488		5,421,659
NON-METALLIC.			(a)		(a)		(a)		(a)		(a)		(a)
Actinolite	Tons.												
Arsenic (white)	"	120	5,460	30	1,200	†30	†1,200			25	1,500	20	1,000
Asbestus	"	3,458	206,251	4,619	226,976	4,404	255,007	6,113	426,554	9,860	1,260,240	9,279	999,878
Chromite	"	*60	*945	38	570								
Coal	"	*2,116,653	*3,739,840	2,429,330	4,388,206	2,602,552	4,674,140	2,658,303	4,894,287	3,084,682	5,676,247	3,577,749	7,019,425
Coke (g)	"	*35,396	*101,940	40,428	135,951	45,373	134,181	54,539	155,043	56,450	166,298	57,084	175,592
Felspar	"									700	3,500	685	3,425
Fire clay	"		(b)		(b)		(b)	*400	*4,800			250	750
Graphite	"	500	4,000	300	2,400	150	1,200	242	3,160	175	5,200	260	1,560
Grindstones	"	*4,020	*46,545	5,292	64,008	5,764	51,129	3,404	30,863	4,884	42,340	4,479	42,587
Gypsum	"	162,000	178,742	154,008	157,277	175,887	179,393	213,273	205,108	226,509	194,033	203,605	206,251
Limestone for flux	"		(b)	*17,171	*17,500	16,857	16,533	22,122	21,909	18,478	18,361	11,376	11,547
Lithographic stone	"												
Manganese ore	"	1,789	41,499	1,245	43,658	1,801	47,944	1,455	32,737	1,328	32,550	255	6,694
Mica	Lbs.	*20,361	*29,008	22,083	29,816	29,025	30,207	36,529	28,718	770,959	68,074		71,510
Mineral pigments—													
Baryta	Tons.	3,864	19,270	400	2,400	1,100	3,850			1,842	7,543		
Ochres	"	*350	*2,350	485	3,733	397	7,900	794	15,280	275	5,125	900	17,750
Mineral waters	Galls.		(b)		(b)	*124,850	*11,456	424,600	37,360	561,165	66,031	427,485	54,268
Molybdenite	Lbs.	150	*156										
Moulding sand	Tons.		(b)	*160	*800	169	845	170	850	320	1,410	230	1,000
Natural gas													
Petroleum (h)	Brls.	584,061	525,655	713,728	556,708	695,203	713,695	704,690	653,600	795,030	902,734	755,298	1,010,211
Phosphate (apatite)	Tons.	20,495	304,338	23,690	319,815	22,485	242,285	30,988	316,662	31,753	361,045	23,588	241,603
Precious stones											700		1,000
Pyrites	Tons.	42,906	193,077	38,043	171,194	63,479	285,656	72,225	307,292	49,227	123,067	67,731	203,193
Quartz	"									200	1,000		
Salt	"	62,359	227,195	60,173	166,394	59,070	185,460	32,832	129,547	43,754	198,857	45,021	161,179
Soapstone	"	*50	*400	100	800	140	280	195	1,170	917	1,239		
Structural materials and clay products—													
Bricks	M.	*139,345	*873,600	181,581	986,689	165,818	1,036,746	200,561	1,273,884	211,727	1,266,982	176,533	1,061,536
Building stone	c. yds.	*165,777	*642,509	262,592	552,267	411,570	641,712	341,337	913,691	382,563	964,783	187,685	708,736
Cement, natural } " Portland }	Brls.		(b)	*69,843	*81,909	50,668	35,593	90,474	69,790	102,216	92,405	93,473	108,561
Flagstones	sq. ft.	*70,000	*7,875	116,000	11,600	64,800	6,580	14,000	1,400	17,865	1,643	27,300	2,721
Granite	Tons.	*6,062	*63,309	21,217	142,506	21,352	147,305	10,197	79,624	13,307	65,985	13,637	70,056
Lime	Bush.	*1,535,950	*283,755	2,269,087	394,859	2,216,764	339,951	2,948,249	362,848	2,501,079	412,308	1,829,824	251,215
Marble	Tons.	*501	*9,900	242	6,224	191	3,100	83	980	780	10,776	240	1,752
Miscellaneous clay products (i)			*112,910		182,150				239,385				
Pottery			(j)		(j)		*27,750		(j)		195,242		258,844
Roofing cement	Tons.		(b)		(b)		(b)		(b)	*1,171	*6,502	1,020	4,810
Sands and gravels (k)	"	*124,865	*24,226	180,860	30,307	260,929	38,398	283,044	52,647	342,158	65,518	243,724	59,501
Sewer pipe			(j)		(j)		*266,320		(j)		*348,000		227,300
Slate	Tons.	*5,345	*64,675	7,357	89,000	5,314	90,689	6,935	119,160	6,368	100,250	(l) 5,000	65,000
Terra-cotta			(j)		(j)		*49,800		(j)		*90,000		113,103
Tiles	M.	*12,416	*142,617	14,658	230,068	7,518	114,057	10,526	134,265	10,521	140,877	11,839	141,399
Tripolite	Tons.												
Whiting	Brls.	*400	*600	†400	†600	160	240			500	500		
Total structural materials and clay products			*2,225,376		2,707,579		2,798,001		3,247,674		3,761,271		3,074,534
All other non-metallic			*5,627,271		6,290,006		6,842,601		7,264,940		9,137,594		10,230,423
Total value, non-metallic			*7,852,647		8,997,585		9,640,602		10,512,614		12,898,865		13,304,957
" metallic			*2,118,608		2,073,746		2,628,692		3,251,299		3,614,488		5,421,659
Estimated value of products unspecified or not reported (m)			*250,000		†250,000		†250,000		†250,000		†250,000		†250,000
Grand total			*10,221,255		11,321,331		12,518,894		14,013,913		16,763,353		18,976,616

PRODUCTS.		1892.		1893.		1894.		1895.		1896.		1897.	
		Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
METALLIC.			$		$		$		$		$		$
Antimony ore.													
Copper.		7,087,275	818,580	8,109,856	871,809	7,737,016	739,659	8,789,162	945,714	9,393,012	1,021,960	13,300,802	1,501,660
Gold.		43,909	907,601	47,247	976,603	54,605	1,128,688	100,806	2,083,674	133,274	2,754,774	291,582	6,027,016
Iron ore.		103,248	263,866	125,602	299,368	109,991	226,611	102,797	238,070	91,906	191,557	50,705	130,290
Lead.		808,420	33,064	2,135,023	79,636	5,703,222	187,636	16,461,794	531,716	24,199,977	721,159	39,018,219	1,396,853
Mercury.								5,431	2,343	4,437	1,940	688	324
Nickel.		2,413,717	1,399,956	3,982,982	2,071,151	4,907,430	1,870,958	3,888,525	1,360,984	3,397,113	1,188,990	3,997,647	1,399,176
Platinum.			3,500		1,800		950		3,800		750		1,600
Silver.		310,651	272,130	422,158	330,128	847,697	534,049	1,578,275	1,030,299	3,205,343	2,149,503	5,558,446	3,323,395
Total value, Metallic			3,698,697		4,630,495		4,688,551		6,196,600		8,030,633		13,780,314
NON-METALLIC.			(a)		(a)		(a)		(a)		(a)		(a)
Actinolite.												* 205	* 1,845
Arsenic.						7	420						
Asbestus.		6,082	390,462	6,331	310,156	7,630	420,825	8,756	368,175	12,250	429,856	30,442	445,368
Chromite.						1,000	20,000	3,177	41,300	2,342	27,004	2,637	32,474
Coal.		3,287,745	6,363,757	3,783,499	7,359,080	3,847,070	7,429,468	3,478,344	6,739,153	3,745,716	7,226,462	3,786,107	7,303,597
Coke.		56,135	160,249	61,078	161,790	58,044	148,551	53,356	143,047	49,619	110,257	60,686	176,457
Felspar.		175	525	575	4,525				(k) 2,545	972	(k) 2,583	1,400	3,290
Fire clay.		1,991	4,467	540	700	539	2,167	1,329	3,492	842	1,805	2,118	5,759
Graphite.		167	3,763			3	223	220	6,150	139	9,455	436	16,240
Grindstones.		5,283	51,187	4,600	38,379	3,757	32,717	3,475	31,932	3,713	33,310	4,572	42,340
Gypsum.		241,048	241,127	192,568	196,150	223,631	202,031	226,178	202,608	207,032	178,061	239,691	244,531
Limestone.		22,967	21,492	27,797	27,519	35,101	34,347	34,579	32,916	37,462	36,140	31,273	30,258
Lithographic stone.						180	30,000		2,000				
Manganese ore.		115	10,250	213	14,578	74	4,180	125	8,464	123½	(k) 3,975	15¼	1,166
Mica.			104,745		75,719		45,581		65,000		60,000		76,000
Baryta.		315	1,260			1,081	2,830			145	715	571	3,060
Ochres.		390	5,800	1,070	17,710	611	8,690	1,339	14,600	2,362	16,045	3,905	23,560
Mineral waters.		640,380	75,348	725,096	108,347	767,460	110,040	739,382	126,048	706,372	111,736	749,691	141,477
Molybdenite.													
Moulding sand.		345	1,380	4,370	9,086	6,214	12,428	6,765	13,530	5,739	11,478	5,485	10,931
Natural gas.			150,000		376,233		313,754		423,032		276,301		325,873
Petroleum.		779,753	984,438	798,406	874,255	829,104	835,322	726,138	1,086,738	726,822	1,155,647	709,857	1,011,546
Phosphate.		11,932	157,424	8,198	70,942	6,861	41,166	1,822	9,565	570	3,420	908	3,984
Precious stones.			†1,000		1,500		†1,500						
Pyrites.		59,770	179,310	58,542	175,626	40,527	121,581	34,198	102,594	33,715	101,155	38,910	116,730
Quartz.				100	500					10	50		
Salt.		45,486	162,041	62,324	195,926	57,199	170,687	52,376	160,455	43,960	169,693	51,348	225,730
Soapstone.		1,374	6,240	717	1,920	916	1,640	475	2,138	410	1,230	157	350
Bricks.		202,147	1,251,934	290,000	1,800,000		†1,800,000	308,836	1,670,000		1,600,000		† 1,600,000
Building stone.			609,827		1,100,000		1,200,000		1,095,000		1,000,000		† 1,000,000
Cement, natural.		{ 88,187	94,912	126,673	130,167	} 108,142	144,637	128,294	173,675	{ 70,705	60,500	85,450	65,893
" Portland.		{ 29,221	52,751	31,924	63,848					{ 78,385	141,151	119,763	209,380
Flagstones.		13,700	1,869	40,500	3,487	152,700	5,298	80,005	6,687		6,710		7,190
Granite.		24,302	89,326	22,521	94,393	16,392	109,936	19,238	84,838	18,717	106,709	10,345	61,934
Lime.		2,260,640	411,270	6,750,000	900,000		†900,000	5,225,000	700,000		650,000		† 650,000
Marble.		340	3,600	590	5,100			200	2,000	224	2,405		
Miscellaneous clay products.													
Pottery.			265,811		213,186		162,144		151,588		163,427		129,629
Roofing cement.		800	12,000	951	5,441	815	3,978		3,153	86	430		
Sands and gravels.		297,878	85,329	329,116	121,795	324,656	86,940	277,162	118,359	224,769	80,110	152,963	76,729
Sewer pipe.			367,660		350,000		250,325		257,045		153,875		164,250
Slate.		5,180	69,070	7,112	90,825		75,550		58,900		53,370		42,800
Terra-cotta.			97,239		55,704		65,600		195,123		83,855		155,595
Tiles.		15,689	190,857	100,000	200,000		†200,000	19,200	210,000		225,000		† 225,000
Tripolite.										664	9,960	15	150
Whiting.						500	750						
Total structural materials and clay products			3,603,455		5,133,946		5,004,408		4,726,368		4,327,542		4,388,550
All other non-metallic			9,076,265		10,020,641		9,990,898		9,585,482		9,976,338		10,242,566
Total value, non-metallic			12,679,720		15,154,587		14,995,306		14,311,850		14,303,880		14,631,116
" metallic			3,698,697		4,630,495		4,688,551		6,196,600		8,030,633		13,780,314
Estimated value of products unspecified or not reported (m)			†250,000		†250,000		†250,000		†250,000		†250,000		† 250,000
Grand total			16,628,417		20,035,082		19,933,857		20,758,450		22,584,513		28,661,430

(a) Value at mine, quarry or works.
(b) Not reported.
(c) Copper contents of ore, matte, etc., at the average market price for the year.
(d) Ounces, fine, calculated at value of $20.67 per oz.
(e) Lead contents of ore, matte, etc., at average market price for year.
(f) Nickel " "
(g) Oven coke.
(h) Calculated from official inspection returns and computed at average yearly price per barrel (of 35 imp. gallons)
(i) Includes (for the years given) terra-cotta, pottery, sewer pipe and earthenware.
(j) Included in miscellaneous clay products.
(k) Exports only.
(l) Railway shipments.
(m) Mostly structural materials.

NOTE.—The above figures represent the summary statements incorporated in the annually issued reports of the Section, those for the earlier years being corrected and revised to make the method of statement conform with that adopted for recent years.
The differing type shows the increases, decreases, etc., as compared with the previous year as follows:—Heavy faced type, increase; ordinary type, decrease; ordinary type with †, same as previous year; ordinary type with *, neither increase nor decrease to record, the figures for previous years not being available.

MINERAL PRODUCTION OF CANADA.

TABLE OF INCREASES AND DECREASES IN THE PRODUCTION OF THE VARIOUS MINERALS IN 1897, AS COMPARED WITH 1896.

PRODUCT.	QUANTITY.		VALUE.	
	Increase.	Decrease.	Increase.	Decrease.
	p. c.	p. c.	p. c.	p. c.
Metallic—				
Copper	41·6		46·9	
Gold	118·8		118·8	
Iron ore		44·8		31·9
Lead	61·2		93·7	
Nickel	17·7		17·7	
Silver	73·4		54·6	
Non metallic—				
Asbestus and asbestic	148·5		3·6	
Coal	1·1		1·1	
Gypsum	15·8		37·3	
Natural gas			17·9	
Petroleum		2·3		12·5
Cement	37·6		36·5	

The following table is self explanatory :—

PROPORTIONATE VALUE OF DIFFERENT MINERAL PRODUCTS, 1897.

Product.	Contributing over 10 p.c.	Contributing between 10 and 5 p.c.	Contributing between 5 and 1 p.c.	Contributing under 1 p.c.	Total.
Coal	26·87				
Gold	21·02				
Silver	11·59				
Bricks (estimated)		5·58			
Copper		5·24			
Nickel			4·88		
Lead			4·87		
Petroleum			3·53		
Building stone (estimated)			3·49		
Lime (estimated)			2·27		
Asbestus			1·55		
Natural gas			1·14		
Cement				0·96	
Gypsum				0·85	
Salt				0·79	
Coke				0·62	
Sundry under 1 p.c.				4·75	
Totals	59·48	10·82	21·73	7·97	100·00

Mineral Production of Canada.

Comparing the above table with the corresponding one given last year, the main feature is seen to consist in the much greater relative importance assumed by gold as a contributor to the grand total. This metal was credited with but 12·3 per cent in 1896, as compared with 21 per cent this year. Silver also has assumed a greater importance, while copper has jumped from seventh to fifth place and lead from ninth to seventh place. All of which changes are of course due to the increase in the mining activities of British Columbia and the Yukon district. Taking the minerals by classes, we find that the metallic in value constituted about 48 per cent as compared with nearly 37 per cent in 1896. In consequence of the above increase, the miscellaneous non-metallic products dropped relatively to 36 per cent as compared with about 44 per cent in 1896, whilst the structural materials also show a relative drop from about 19 per cent in 1896, to about 15 per cent in 1898.*

The value of the mineral production of the country calculated on a per capita basis shows a most encouraging growth.

The population of the country for each year has been taken from a memorandum furnished by the Census office for the years 1886 to 1897. The resulting per capita rates show an increase of from about $2.23 in 1886, to about $5.53 in 1897, or nearly 150 per cent, the increase of 1897 over 1896 being over 25 per cent.

* In studying a comparative statement such as the tabulation given, it must be remembered that the above percentages are of the gross values, which vary from year to year, not only by reason of varying amounts produced, but also on account of the fluctuations in the price. This latter factor has affected some minerals more than others. The heavy decline in the price of silver, for instance, in the past few years, has very greatly affected its place in the scale, and copper, nickel and asbestus have also suffered heavily in this respect. This can be seen by comparison of 1897 with earlier years in the main table, and in order to facilitate this use of the table, the features of increase and decrease have been brought out by the use of differing type as explained in the foot notes.

The following tables of Imports and Exports need no explanation.

MINERAL PRODUCTION OF CANADA.

Exports.

EXPORTS.

MINERALS AND MINERAL PRODUCTS OF CANADA DURING CALENDAR YEAR 1897.

Products.	Value.	Products.	Value.
Asbestus, first class.	$ 59,054	Mica..............	$ 69,101
" second class	198,014	Mineral pigments.........	7,706
" third class	216,206	Mineral waters	7,466
Bricks	2,679	Nickel	723,130
Cement..................	644	Oil, crude	... .
Chromite............	26,254	" refined	49
Clay, manufactures of....	427	Phosphate..	910
Coal.	2,964,325	Platinum	190
Coke.......	6,078	Plumbago, crude..........	2,988
Copper...........	850,336	" manufactures of	1,337
Felspar	5,637	Pyrites	30,812
Gold	3,741,758	Salt	1,193
Grindstones.........	18,807	Sand and gravel	76,729
" rough........	3,966	Silver	3,576,391
Gypsum, crude......	197,150	Slate	.. ..
" ground.	6,763	Stone, unwrought.........	42,034
Iron and steel	592,849	" wrought	9,415
Iron ore	811	Other articles............	27,214
Lead	925,144		
Lime..	53,177	Total...............	$14,449,038
Manganese ore	2,294		

EXPORTS

DESTINATION OF PRODUCTS OF THE MINE, DURING THE FISCAL YEAR 1896–1897.

Destination.	Value.	Destination.	Value.
United States (and Alaska)	$10,533,581	Spanish West Indies ...	$ 8,017
Great Britain.	354,769	Hayti	2,937
Newfoundland.....	173,516	Hong Kong	2,630
Germany	69,373	Argentine Republic.......	1,476
Hawaiian Islands	38,798	Australia	1,274
British Guiana	22,031	France	1,158
St. Pierre	22,015	Italy.....................	612
Mexico	16,012	Belgium	600
British West Indies. ...	15,259	Spain	50
China	13,413		
Japan	11,269	Total...............	$11,298,915
Central American States..	10,125		

IMPORTS.

MINERALS AND MINERAL PRODUCTS, FOR FISCAL YEAR 1896-1897.

MINERAL PRODUCTION OF CANADA.

Imports.

Products.	Value.	Products.	Value.
Alum and aluminous cake	$ 32,517	Iron and steel—mfrs of—	
Aluminium	5,717	Machinery, hardware, &c.	$ 6,221,708
Antimony	8,031	Lead—pigs, bars, bl'ks, old	
Arsenic	8,378	scrap, &c	187,556
Asbestus and mfrs. of	19,032	" manufactures of	60,735
Asphaltum	9,012	Lime	10,529
Bismuth	208	Litharge	34,538
Blast furnace slag	4,500	Lithographic stone	6,360
Borax	53,020	Manganese, oxide of	2,741
Bricks	11,055	Marble—blocks, slabs, &c.	50,531
" bath	1,217	" mfrs. of	26,619
" and tiles, fire	100,025	Mercury	33,534
Buhrstones	1,827	Metallic alloys—	
Building stone	38,714	Brass and mfrs. of	457,342
Cement	8,255	Bronze, german silver,	
" Portland	252,587	pewter, &c	82,654
Chalk	7,432	Mineral and bituminous	
Clay, china	29,993	substances, N.E.S	28,490
" fire	22,089	Mineral and metallic pig-	
" pipe	555	ments, paints and colours	524,198
" all other, N.E.S.	6,749	Mineral waters	47,006
Coal, anthracite	5,695,168	Nickel	4,737
" bituminous	3,254,217	Ores of metals, N.E.S.	105,072
" dust, &c	59,609	Paraffine wax	7,945
" tar and pitch	36,942	" candles	2,929
Coke	267,540	Petroleum and products of.	697,169
Copper, pigs, precipitate,		Phosphorus	8,575
scrap, &c	5,449	Platinum	9,031
" ingots and mfrs. of	264,587	Precious stones	506,728
Copperas	2,785	Pumice	2,903
Cryolite	2,106	Salt	345,587
Earthenware	595,822	Saltpetre	43,066
Emery	16,318	Sand and gravel	25,222
Felspar, quartz, flint, &c.	13,800	Slate	21,615
Fertilizers	60,106	Stone and granite, N.E.S.	34,026
Fuller's earth	1,552	Spelter	32,826
Graphite, crude	1,406	Sulphate of copper	40,469
" mfrs. of	38,537	Sulphur	87,719
Grindstones	25,547	Sulphuric acid	8,033
Gypsum, crude	772	Tiles, sewer pipes, &c	36,139
" plaster of Paris, &c.	4,612	Tin—pigs, bars, &c.	251,360
Iron and steel—		" mfrs. of tin plate	1,022,748
pigs, scrap, blooms, &c.	471,018	Whiting	22,541
rolled—bars, plates, &c.,		Zinc—pigs, bars, dust, &c.	60,003
including chrome steel.	3,921,852	" mfrs. of	5,145
Ferro-silicon, ferro-manganese, &c.	9,233	Total	$ 26,526,020

ABRASIVE MATERIALS.

ABRASIVE MATERIALS.

Grindstones.

Grindstones.—The production of grindstones, wood-pulp stones, etc. for 1897 was 4572 tons, valued at $42,340, being an increase of 859 tons in quantity and $9,030 in value over that of the previous year. The average yearly production for the past 12 years has been 4437 tons, and the average yearly value $42,278, or $9.53 per ton.

As formerly, the production has come from the quarries in New Brunswick and Nova Scotia. The statistics of the output of these two provinces are given below in table 1.

TABLE 1.

ABRASIVE MATERIALS.

ANNUAL PRODUCTION OF GRINDSTONES.

Calendar Year.	Nova Scotia.		New Brunswick.		Total.		Average Value per Ton.
	Tons.	Value.	Tons.	Value.	Tons.	Value.	
1886	1,765	24,050	2,255	22,495	4,020	46,545	$11.58
1887	1,710	25,020	3,582	38,988	5,292	64,008	12.10
1888	1,971	20,400	3,793	30,729	5,764	51,129	8.87
1889	712	7,128	2,692	23,735	3,404	30,863	9.07
1890	850	8,536	4,034	33,804	4,884	42,340	8.67
1891	1,980	19,800	2,499	22,787	4,479	42,587	9.51
1892	2,462	27,610	2,821	23,577	5,283	51,187	9.69
1893	2,112	21,000	2,488	17,379	4,600	38,379	8.34
1894	2,128	16,000	1,629	16,717	3,757	32,717	8.71
1895	1,400	14,000	2,075	17,932	3,475	31,932	9.19
1896	1,450	14,500	2,263	18,810	3,713	33,310	8.97
1897	1,407	17,500	3,165	24,840	4,572	42,340	9.26

The table shows considerable variations in the industry, and it is quite apparent also that the general tendency has been towards a decreased rather than an increased output, the production in 1887 and 1888, both in quantity and value, having been much larger than that in recent years.

In Nova Scotia, operations are carried on principally by the Atlantic Stone Co., at Lower Cove, Cumberland, which employed last year an average of 40 men. With respect to the work done at this quarry, Mr. Madden, deputy inspector of mines for Nova Scotia, says:

"This company exports most of the large grindstones, or 'water-stones' as they are called, manufactured by them, to the United

States. The stones manufactured by the company vary in size from 6 inches diameter x 1 inch breadth to 84 inches diameter x 15 inches breadth. Scythe-stones, holy-stones for use on board ship, and currier-stones for use in tanneries, are likewise items in the manufacture at this quarry. All these are manufactured from a blue grit reef 75 feet thick, composed of layers from one inch to five feet thick. The quarry is situated about four miles from the Joggins coal mines on the Cumberland Basin, with good shipping facilities."* ABRASIVE MATERIALS. Grindstones.

TABLE 2.

ABRASIVE MATERIALS.

EXPORTS OF GRINDSTONES.

Calendar Year.	Value.
1884	$28,186
1885	22,606
1886	24,185
1887	28,769
1888	28,176
1889	29,982
1890	18,564
1891	28,433
1892	23,567
1893	21,672
1894	12,579
1895	16,723
1896	19,139
1897	18,807

TABLE 3.

ABRASIVE MATERIALS.

EXPORTS OF GRINDSTONES BY PROVINCES.

Provinces.	CALENDAR YEAR.				
	1893.	1894.	1895.	1896.	1897.
Quebec	$ 625	$ 1	....	....	$ 112
Nova Scotia	11,317	10,048	$ 8,723	$ 12,145	12,094
New Brunswick	9,730	2,530	8,000	6,994	6,601
Totals	$ 21,672	$ 12,579	$ 16,723	$ 19,139	$ 18,807

*Report of the Department of Mines, Nova Scotia, 1897, p. 20.

ABRASIVE MATERIALS.

Grindstones.

TABLE 4.

ABRASIVE MATERIALS.

IMPORTS OF GRINDSTONES.

Fiscal Year.	Tons.	Value.
1880	1,044	$11,714
1881	1,359	16,895
1882	2,098	30,654
1883	2,108	31,456
1884	2,074	30,471
1885	1,148	16,065
1886	964	12,803
1887	1,309	14,815
1888	1,721	18,263
1889	2,116	25.564
1890	1,567	20,569
1891	1,381	16,991
1892	1,484	19,761
1893	1,682	20,987
1894	1,918	24,426
1895	1,770	22,834
1896	1,862	26,561
*1897	1,521	25,547

* Not mounted and not less than 12 inches in diameter.

Buhrstones.

TABLE 5.

ABRASIVE MATERIALS.

IMPORTS OF BUHRSTONES.

Fiscal Year.	Value.
1880	$12,049
1881	6,337
1882	15,143
1883	13,242
1884	5,365
1885	4,517
1886	4,062
1887	3,545
1888	4,753
1889	5,465
1890	2,506
1891	2,089
1892	1,464
1893	3,552
1894	3,029
1895	2,172
1896	2,049
*1897	1,827

* Buhrstones in blocks, rough or unmanufactured, not bound up or prepared for binding into mill-stones.

ABRASIVE MATERIALS.

Corundum.

Corundum.—Although there is no production of corundum to report, yet the extensive deposits recently discovered in Ontario will probably before long give rise to a new industry in Canada.

The following is an abstract from the Summary Report of Mr. Barlow, of the Geological Survey, for 1897, giving details of these occurrences :—

The presence of corundum in the northern part of the county of Hastings was really made known as the result of a visit made in October, 1896, by Mr. Ferrier, of the Geological Survey. Immediately on Mr. Ferrier's return to Ottawa the Director of the Survey communicated to the Ontario Bureau of Mines the results of this visit, and in consequence, the lands which belonged to the Crown were withdrawn from sale by the Ontario Government.

During the past summer, repeated reports of alleged "finds" of corundum were circulated from time to time, and a personal examination was made of a large number of these, which invariably arose from mistaking some species of grayish felspar, usually albite, for corundum. Prospectors working in the district should remember the great hardness of the unaltered corundum, the sharp edges of which will readily scratch the hardest steel; this is perhaps its most valuable characteristic. Its greater weight in contrast to any of the associated minerals is also of value in recognizing this mineral, and the barrel-shaped outline of many of the crystals is likewise very characteristic.

The name corundum embraces those varieties of oxide of aluminum having dull colours; the colours being generally light-bluish, greenish, grayish or brownish. The granular corundum of a grayish-black colour, when intimately mixed with magnetite or hæmatite, is usually referred to as emery. The mineral found in Hastings county is essentially pure. The susceptibility of corundum to alteration, and the difficulty of getting rid of the scaly decomposition products seem to be the chief hindrances to a more profitable, and therefore more general mining and use of the mineral.

Throughout the region examined, however, the corundum is, as a rule, comparatively fresh and unaltered, and it is confidently believed that the deposits will, if properly handled, furnish sufficient material of such uniform hardness and purity that it can be successfully treated for the removal of impurities by the use of machinery like that employed for this purpose in Georgia. In the State of Georgia, where corundum has been successfully mined since the year 1880, three varieties are commonly distinguished, and it is probable that in the Hastings area, these subdivisions will, in a rough way, hold good—1. Sand corundum, 2. Block corundum, 3. Crystal corundum.

ABRASIVE MATERIALS.

Corundum.

The limit of what may for convenience be called the "corundum-bearing belt," extends on the west from lot 14 in the XIVth concession of the township of Carlow, where it was originally found, north-eastward as far as lot 25 in the VIth concession of the township of Brudenell. The territory further to the east has not been explored. The assumption at present seems very reasonable that corundum will be found, if careful and systematic prospecting is undertaken, in the northern portion of Lyndock, the southern part of Brudenell, and the middle concessions of Sebastopol. In width the corundum belt is rather variable. In the township of Carlow, corundum has been found in a large number of places over the hill which forms the north-eastern part of the township east of lot 14. It occurs at intervals at places from the XIIIth concession to the XVIth concession, thus showing a breadth of over two miles. In the township of Raglan, the mineral has been found in a large number of places on the high ridge which runs across the XVIIIth and the XIXth concessions as far as the York River, a branch of the Madawaska. Prof. Miller and his assistants proved the existence of the mineral on many of the lots in the XVIIth, XVIIIth and XIXth concessions of Raglan, between the York River and the Madawaska, and likewise on a number of lots in the XVIIIth and XIXth concessions to the east of the Madawaska. In Raglan, therefore, the belt is very nearly two miles wide, but further east corundum has been found on lot 32, concession II. of Radcliffe; lot 34, concession V.; lot 25, concession VI.; and lot 32, concession VII., of Brudenell township.

At present the chief obstacles presenting themselves to the successful and profitable mining of this mineral, are the exceeding irregularity of the deposits and their wide separation from one another. Careful search may get rid of much of the latter objection, as the prospecting so far undertaken, though done very carefully, has been by no means exhaustive, and the richness of some of the masses already encountered seems to show that the average yield of considerable bodies of rock will be satisfactory.

The main use of corundum is as an abrasive entering into the manufacture of emery wheels. These are made by mixing the powdered substance with some binding material and moulding into the required shapes. Corundum and its impure form emery are also the main constituents of the emery powders used as polishing materials.

Corundum in its pure form is the oxide of aluminium, $Al_2 O_3$, containing 53·2 per cent of aluminium. It can be used as an ore in the production of the metal, if mined under favourable conditions and obtained in a state of sufficient purity at reasonable prices.

ABRASIVE MATERIALS. Corundum.

At present the producing fields of corundum in America are in the southern Appalachian region, and the following mode of working of one of the deposits in Georgia, as condensed from the Mineral Resources of the United States for 1895, may be of interest.

The corundum in this case occurs at the contact of peridotites and gneisses, in belts of chlorite and vermiculite from 1 to 15 feet in width. Operations are carried on at the surface by open quarrying, and when the workings have extended in depth, timbering and drifting are resorted to.

From the dump to the mill, extends a line of sluice-troughs one and a half mile in length, with a steep grade and an occasional vertical drop. The material of the dump is thrown into the upper part of the sluice, and is carried to the mill by a very swift current of water, the steep grade and the drops disintegrating and separating the chlorite and vermiculite from the heavier corundum. As the material reaches the mill, it is further disintegrated by crushing through rolls, and is subjected to hydraulic separating. Thence it passes into the "muller," which consists of a large shallow tub with revolving heavy wooden rollers. The partially cleaned corundum is thrown into this tub and is kept in motion by iron teeth that move in front of the rollers. A scouring motion is thus continuously kept up and the impurities, reduced to fine powder, are carried away by a small current of water flowing through the tub. The material is dried by being dropped down the stack of a furnace, at the bottom of which it is diverted by an inclined plane, and it slides down this plane for several feet through the flame of a wood fire. It is then screened through 14 mesh sieves, and the coarse stuff is sent back to the rolls.

Concentration of Corundum.—Mr. Courtenay de Kalb, of the Kingston School of Mines, has just completed a series of experiments on the concentration of this mineral, in the milling laboratory of the school.

As may be imagined, it is very difficult to ascertain the exact amount of corundum either in the rock or in the tailings. By a method dependent on specific gravity, however, Mr. de Kalb arrived at the conclusion that the content of the rock treated was 18·44 per cent. This can only be taken as approximate, as the other heavy constituents of the rock, especially magnetite (sp. gr. 4·9 to 5·2) render an exact figure almost impossible.

Two lots of the rock were operated upon—550 pounds and 1250 respectively.

ABRASIVE MATERIALS.
Corundum.

In crushing, no peculiar difficulty was experienced. It is apparent that sheating and grinding machines are out of the question on account of the hardness of corundum. Jaw or other breakers can be used for coarse crushing, and, for further reduction, rolls with hard steel jackets (chrome or manganese) are best adapted.

For the concentration-tests, the rock was first broken into pieces 1 inch in diameter in a Blake crusher, then passed through ¼ inch rolls, the product was then separated into eight sizes, from No. 8 mesh to 40, and finer. These were then submitted to a series of combinations of concentrations, in which were used Hartz jig, spitzlute, fixed buddle Frue Vanner and Wetherill magnetic concentrator.

The very interesting details of the methods of procedure have been published as a supplement to the Report of the Bureau of Mines of Ontario for 1898.

The results of two series of experiments gave concentrates containing respectively 87·6 and 89·2 per cent of corundum and magnetite; the corundum represents 12·7 and 15·5 per cent of the rock treated. These figures, if one adopts 18·44 per cent above mentioned as the content of the original material, represent losses of 31·1 and 15·9 per cent respectively.

Emery.

TABLE 6.

ABRASIVE MATERIALS.

IMPORTS OF EMERY.

Fiscal Year.	Emery. *a.*	Mfrs. of Emery. *b.*
1885	$ 5,066	$ 4,920
1886	11,877	5,832
1887	12,023	4,598
1888	15,674	4,001
1889	13,565	3,948
1890	16,922	5,313
1891	16,179	6,665
1892	17,782	6,492
1893	17,762	5,606
1894	14,433	2,223
1895	14,569	7,775
1896	16,287	11,913
1897	16,318	11,231

a Emery, in bulk, crushed or ground.
b Emery wheels and manufactures of emery.

TABLE 7.

ABRASIVE MATERIALS.
IMPORTS OF PUMICE STONE.

ABRASIVE MATERIALS.
Pumice Stone.

Fiscal Year.	Value.
1885	$ 9,384
1886	2,777
1887	3,594
1888	2,890
1889	3,232
1890	3,003
1891	3,696
1892	3,282
1893	3,798
1894	4,160
1895	3,609
1896	3,721
*1897	2,903

* Pumice and pumice stone, ground or unground.

ASBESTUS.

ASBESTUS.
Production.

Owing to the very large increase in the production of the by-product asbestic, it is deemed advisable this year to separate this item from the total, so that the production for 1897 may be stated as follows:—

	Tons.	Value.	Average value per ton.
Asbestus	13,202	$399,528	$30.26
Asbestic	17,240	45,840	2.66
	30,442	$445,368	$14.63

The production for 1896 was 12,250 tons, valued at $429,856, made up as follows:—

	Tons.	Value.	Average value per ton.
Asbestus	10,892	$423,066	$38.84
Asbestic	1,538	6,790	5.00
	12,250	$429,856	$35.09

ASBESTUS. Production.

Compared with 1896, therefore, the production of asbestus in 1897 increased 2,310 tons or 17·5 per cent in quantity, and decreased $23,538 or 5·9 per cent in total value. The decrease in the average value per ton was $8.58 or 28·3 per cent.

In considering these figures of production, and especially that of the average value per ton of the asbestus, it must be remembered that this product includes three grades of material, commanding different prices varying between $80 and $160 for firsts; $35 and $60 for seconds; and $12 and $30 for thirds; so that a decrease in the average value per ton above given does not necessarily indicate a fall in the price of asbestus, since the same result might be brought about by an increase in the output of the lower grade product.

Unfortunately, it has been found quite impossible to separate the returns of production of asbestus into distinct grades, owing to the great variation in the standards adopted by the various producers.

The production of asbestic bids fair to assume considerable proportions, the product of 1897 being over eleven times that of 1896.

As a result of the large increase in the production of asbestic, the total production in 1897, viz., 30,442 tons, was an increase of 18,192 tons or 148 per cent on the production of 1896.

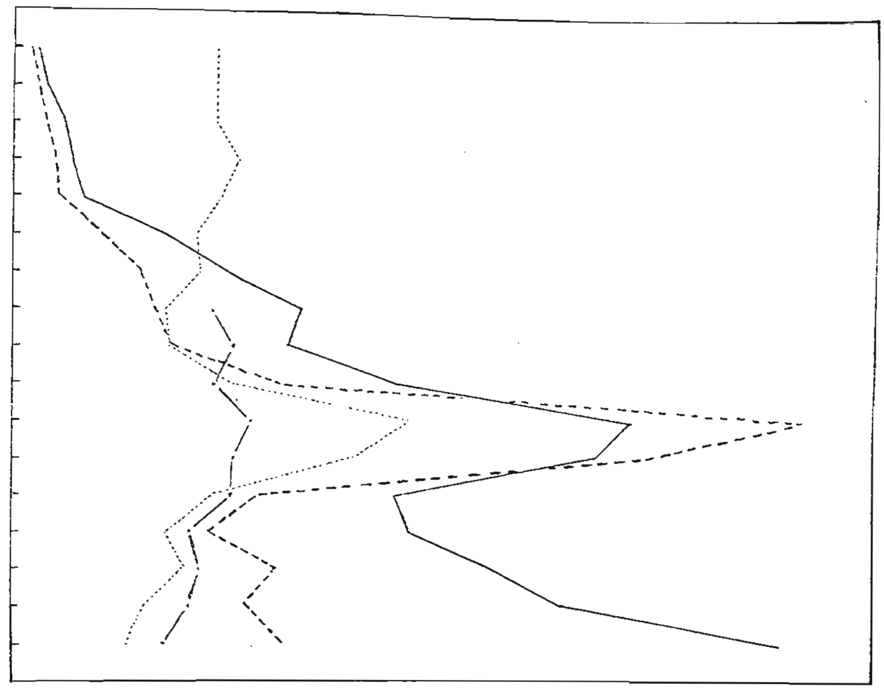
Tables A and Nos. 1 and 2 show the history of the variations in the asbestus industry in respect of production, value, exports, etc., from 1880 to 1896, inclusive.

ASBESTUS.

ANNUAL PRODUCTION.

Table A.

Calendar Year	Production. Tons (2,000 lbs.)	Production. Value.	Production. Average value per ton.	Exports, Average value per ton.
		$	$ cts.	$ cts.
1880	380	24,700	65 00	Exports taken as Production.
1881	540	35,100	65 00	
1882	810	52,650	65 00	
1883	955	68,750	71 98	
1884	1,141	75,097	65 80	
1885	2,440	142,441	58 37	
1886	3,458	206,251	59 64	
1887	4,619	226,976	49 14	63 25
1888	4,404	255,007	57 90	70 56
1889	6,113	426,554	69 77	64 44
1890	9,860	1,260,240	127 81	75 52
1891	9,279	999,878	107 75	70 07
1892	6,082	390,462	64 19	69 35
1893	6,331	310,156	49 02	57 24
1894	7,630	420,825	55 15	59 82
1895	8,756	368,175	42 05	56 66
1896	12,250	429,856	35 09	47 96



▬ Production, tons. - - - - Production, value. . . . . Production, average value per ton. . —. — Exports, average value per ton.

Asbestus.
Exports.

TABLE 1.
ASBESTUS.
EXPORTS.

Calendar Year.	Tons.	Value.
1892	5,380	$373,103
1893	5,917	338,707
1894	7,987	477,837
1895	7,442	421,690
1896	11,842	567,967
1897 1st class	1,249	$ 59,054
1897 2nd "	4,015	198,014
1897 3rd "	10,306	216,206
Total, 1897	15,570	$473,274

Imports.

TABLE 2.
ASBESTUS.
IMPORTS.

Fiscal Year.	Value.
1885	$ 674
1886	6,831
1887	7,836
1888	8,793
1889	9,943
1890	13,250
1891	13,298
1892	14,090
1893	19,181
1894	20,021
1895	26,094
1896	23,900
*1897	19,032

* Asbestus, in any form other than crude, and all manufactures of.

There is nothing very noteworthy in connection with the asbestus industry in 1897.

Only six mines were worked in 1897, and in some cases the work was intermittent or only consisted in prospecting, although large shipments were made from stock on hand.

The asbestus industry has been thoroughly studied and reported on, on several occasions. The Reports of this Section for 1890, '91, '92 and '96 contain descriptions of the deposits and of their exploitation. A very short summary, however, may not be out of place.

QUEBEC.

The largest known deposits of asbestus in America occur in the serpentines of the "Quebec group." The variety is therefore chrysotile. ASBESTUS. Occurrences.

These serpentines are found in several places in the strip of the Lower Silurian formation which extends from the boundary of Vermont to the extremity of the Gaspé peninsula. Economic occurrences of asbestus, however, are restricted to two areas, one comprising the townships of Thetford, Coleraine, Ireland and Wolfeston, on the line of the Quebec Central Railway, and the other being that smaller area, to the west of this district, at Danville, on the line of the Grand Trunk Railway, between Montreal and Point Lévis.

The mineral occurs in small veins, distributed throughout the rock, and mining is conducted in almost every case by open quarrying, some of the workings being 120 feet deep. The blasted rock is submitted to crushing, and the asbestus is separated, sorted and graded, according to length of fibre, by the aid of special machinery.

Asbestus is also found in some serpentines of the Laurentian area. In this case the mineral occurs in the serpentinized portions of crystalline limestone. In these occurrences, however, the proportion of the product which can be ranked as *firsts* is small as compared with the material obtained in the "Eastern Townships" of Quebec.

The following is a list of occurrences known in the Laurentian rocks of Quebec, as gathered from the reports of officers of the Geological Survey, and those of the Mining Engineer of the Province.

Ottawa Co.—Templeton, VIII., 11, 15; West Portland, V., 15, 16; Wakefield; Bouchette; Lathbury; Denholm, I., 42.

Pontiac Co.—Calumet Island; Cawood.

Lake Temiscamingue.—Duhamel Township, VI., 13, 14, VII., 17, 18. These last deposits are said to be worthy of further investigations.

Asbestus occurrences have been noticed in the Gaspé peninsula, on the Dartmouth River, ten miles from its outlet, in an area of serpentine and limestones. The veins, however, are small and not numerous, and, from appearances, would not justify any expenditure for development.

To the north of the Chaudière River, in the vicinity of that stream, between St. Joseph and St. Francis, are several occurrences of small and irregular veins, but as far as examined these do not seem to have economic value.

ONTARIO.

ASBESTUS. Occurrences.

In Ontario there are no deposits of asbestus proper, though deposits of actinolite are known in Hastings county, in Elzivir and Kaladar townships. These have been worked at intervals for a number of years.

NORTH-WEST TERRITORIES.

A specimen of asbestus (chrysotile), being part of a small vein of that material about half an inch in thickness, has been brought from the Stewart River, and rather coarse specimens of the same mineral from Forty-mile, both in Yukon District.—(Rep. of G. S. C., 1887-88, & 1888-89.)

BRITISH COLUMBIA.

"Small veins of chrysotile have been observed in or near some of the deposits of serpentine contained in the Cache Creek rocks, especially in the vicinity of the Fraser River, between Texas Creek and Bridge River, and in the southern base of Mount Soues, near Junction Valley. It is possible that workable deposits of asbestus may yet be found in these rocks, but the specimens so far obtained are too small and too short in the fibre to be of economic value."—(Rep. G.S.C., 1894, Dawson.) Specimens of a rather coarse and brittle variety of serpentine asbestus have been obtained at Thibert Creek, Cassiar. Finds of asbestus have also been reported from Trout Lake City in W. Kootanie and from the S. side of the Tulameen River, nearly opposite Bear Creek, but whether of economic importance in any case is not known.

CHROMITE.

CHROMITE.

The production of chromite, or chromic iron ore, in 1897 was 2,637 tons, valued at $32,474, or $12.31 per ton, being an increase of 295 tons or 12 per cent in quantity, and an increase in value of $5,470, or 20 per cent over the production of 1896. The total production since the inception of the industry in 1894, has been 9,156 tons, valued at $120,778, or an average value per ton of $13.19, the average yearly production being 2,289 tons.

According to the returns received, the prices in 1897 ranged from $9 to $15, the average, as above stated, being $12.31. Most of the product was marketed in Pittsburgh and Philadelphia. The figures of production given above represent only that portion of the product sold and shipped, there being at the end of the year at least 2,000 tons of stock on hand.

CHROMITE. Production.

TABLE 1.

CHROMITE.

ANNUAL PRODUCTION.

Calendar Year.	Tons, (2000 lbs.)	Average Price per ton.	Value.
		$ cts.	$
1886	* 60	15 75	945
1887	38	15 00	570
1888 to 1893	no output	....	....
1894	1,000	20 00	20,000
1895	3,177	13 00	41,300
1896	*2,342	11 53	27,004
1897	2,637	12 31	32,474

* Railway shipments.

The Canadian deposits of chromic iron ore occur in the serpentine belt of the "Eastern Townships" of Quebec, which belt also includes the asbestus mines. The exploitation of these deposits is very recent, and the methods of working them are yet quite primitive. Only the richest ores have been extracted, but with the development of the industry, it may be surmised that mining and concentrating machinery will be brought into use, so as to allow of profitably working the poorer deposits which abound in the district.

By referring to the table of analyses it will be seen that the product obtained is quite marketable, even with only the rough hand selection which it undergoes.

The chromite finds a ready market in the United States and in Scotland.

It is used in the manufacture of bi-chromates, from which are derived the chrome colours. The bi-chromate of potassium is also one of the elements of the bi-chromate cell for the generating of electric currents.

For these purposes the ore is marketable only when containing a minimum of fifty per cent of chromium sesquioxide, the theoretical maximum being sixty-eight per cent. Ore of lower quality is used as refractory lining material for furnaces.

CHROMITE. Occurrences.

Chromium also enters the composition of certain steels, imparting great hardness and toughness to the metal.

The following is a list of occurrences of chromite, most of which are believed to be workable deposits. All these are in the province of Quebec.

County.	Township.	Range and Lot.
Brome	Bolton	IV.—13.
		VI.—26.
		VII.—9, 13, 26 W.
Megantic	Coleraine	Block "A."
		II.—25, 26.
		III.—25, 26.
		IV.—7, 8, 9, 10, 25.
		X.—19.
		XIII.—5, 9.
		Block "B."
	Leeds	X.—1.
	Thetford	IV.—16.
Richmond	Melbourne	VI.—22.
Wolfe	Ham, South	II.—4, 20, 21.
	Garthby	I.—b, c, i.
		Island in Lake Breeches.
		II.—N. 4, 5, 6, 7, 8.
		V.—36, 37.
	Wolfeston	II.—24.
		III.—23, 24, 25.

The above list is taken from the pamphlet entitled "Chromic Iron Ore in the Province of Quebec," (by Mr. J. Obalski), 1898.

The main sources of supply of chromic iron ores are Russia, Asia Minor and New Caledonia, which together produce about eighty per cent of the world's consumption, Canada in 1897 having supplied a little more than eight per cent.

CHROMITE. Analyses.

Following is a table of analyses of chromic iron ores:

ANALYSES OF CHROME ORES.

	Number.	Cr_2O_3.	FeO.	Al_2O_3.	SiO_2.	MgO.	CaO.	Total.
		%	%	%	%	%	%	%
Canadian.	1	45·90	35·68	3·20	....	15·03	....	99·81
	2	49·75	21·28	11·30	....	18·13	....	100·46
	3	52·82	....	....	....	....	....	....
	4	35·46	....	....	....	....	....	....
	5	39·15	27·12	7·00	7·00	16·11	3·41	99·79
	6	51·03	13·06	12·16	5·22	16·32	2·61	100·40
	7	53·07	15·27	8·01	6·44	16·08	1·20	100·07
	8	56·06	21·70	....	1·60	....	....	....
	9	65·16	27·36	7·48	....	....	....	100·00
	10	50·65	13·93	12·70	3·35	15·04	....	95·67
Foreign.	11	55·04	11·57	10·81	3·80	16·10	1·13	98·45
	12	51·80	24·72	13·90	2·05	7·81	0·41	100·69
	13	55·54	14·50	15·43	1·30	12·85	0·80	100·42
	14	42·40	12·28	20·23	5·69	16·52	1·40	98·52
	15	42·45	14·83	16·75	6·48	16·42	1·21	98·14

No. 1. Tp. Bolton, Que. G. S. C. Report, Geology of Canada, 1863, p. 504.
" 2. Lake Memphremagog. G. S. C. Report, Geology of Canada, 1863, p. 504.
" 3. Tp. Coleraine, Megantic Co., Que. Coleraine Mining Co. G. S. C. Report, 1894, p. 67 R.
" 4. 17. IV. Thetford, Mégantic Co., Que. G. S. C. Report, 1887-88, pt. II, 56 T.
" 5, 6 and 7. Canadian Mining Manual, 1896, p. 342.
" 8. Coleraine Mining Co. } Chrome Iron in the Prov. of Quebec, Obalski, 1898:
" 9 " "
" 10. Canada. } Mineral Industry, 1895, p. 101. Scientific Pub. Co., New York.
" 11 and 12. Turkish (Asia).
" 13. New Caledonia.
" 14 and 15. California.

The principal producers of chromite in Canada in 1897, were the following:—

Producers.

Name.	Shipping Station, Quebec Central Railway.	Address.
Anglo-Canadian Asbestus Co.	Black Lake.	314 Board Trade, Montreal, Que.
Coleraine Mining Co.	"	Côte de la Place d'Armes, Montreal.
W. H. Lamblay.	"	Inverness, Que.
Victoria Mining Co. (P. P. Hall).	"	Quebec "
H. Leonard.	D'Israeli.	D'Israeli "
James Reed, M.D.	Broughton.	Reedsdale "

COAL.

COAL.

The total production of coal in Canada in 1897 was 3,786,107 tons of 2000 lbs., equivalent to 3,380,453 tons of 2240 lbs., and valued at $7,033,597. Of this production Nova Scotia supplied approximately 65·9 per cent; British Columbia, 26·9 per cent; the North-west Territories, 7 per cent, and New Brunswick less than 1 per cent. The increase over 1896 was but 40,391 short tons, or a little over 1

COAL.
Annual Production.

per cent, the increase in value being $77,135, practically the same percentage as for the quantity.

The production since 1886 is shown graphically in Table A. below :—

COAL.

ANNUAL PRODUCTION.

Table A.

Calend'r Year.	Tons.	Value.
		$
1886	2,116,653	3,739,840
1887	2,429,330	4,388,206
1888	2,602,552	4,674,140
1889	2,658,303	4,894,287
1890	3,084,682	5,676,247
1891	3,577,749	7,019,425
1892	3,287,745	6,363,757
1893	3,783,499	7,359,080
1894	3,847,070	7,429,468
1895	3,478,344	6,739,153
1896	3,745,716	7,226,462
1897	3,786,107	7,303,597

In Table 1 the figures of production are repeated, there being also shown the average value per ton, and the increase or decrease in tonnage, and the increase or decrease per cent. of each year, compared with the previous one :— COAL. Annual Production.

TABLE 1.

COAL.

ANNUAL PRODUCTION SHOWING THE INCREASE OR DECREASE EACH YEAR.

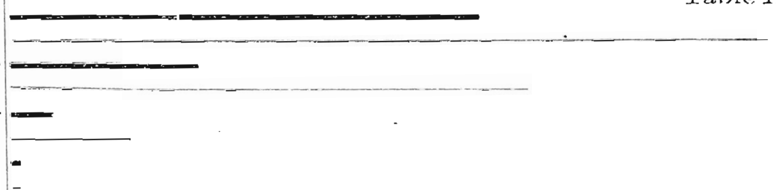
Calendar Year.	Tons.	Value.	Average Value per Ton.	Increase (*i*) or Decrease (*d*), in Tonnage.	Inc. (*i*) or Dec. (*d*) per cent.
1886.....	2,116,653	$3,739,840	$1.77	....	....
1887.....	2,429,330	4,388,206	1 81	*i* 312,677	*i* 14·8
1888.....	2,602,552	4,674,140	1 80	*i* 173,222	*i* 7·1
1889.....	2,658,303	4,894,287	1 84	*i* 55,751	*i* 2·1
1890.....	3,084,682	5,676,247	1 84	*i* 426,379	*i* 16·0
1891.....	3,577,749	7,019,425	1 96	*i* 493,067	*i* 16·0
1892....	3,287,745	6,363,757	1 94	*d* 290,004	*d* 8·1
1893. ...	3,783,499	7,359,080	1 95	*i* 495,754	*i* 15·1
1894. ...	3,847,070	7,429,468	1 93	*i* 63,571	*i* 1·7
1895.....	3,478,344	6,739,153	1 94	*d* 368,726	*d* 9·6
1896.....	3,745,716	7,226,462	1 93	*i* 267,372	*i* 7·7
1897.....	3,786,107	7,303,597	1·93	*i* 40,391	*i* 1·1

The production by provinces is graphically shown in Table B, and in Table 2 following are exhibited the increases or decreases for the different provinces in 1897, as compared with 1896 :—

COAL.
Production by provinces.

COAL.
Calendar Year, 1896.
Production by Provinces.
Table B.

Province.	Tons, 2,000 lbs.	Value.
		$
N.S.	2,508,579	3,919,655
B.C.	1,003,769	2,688,666
N.W.T.	225,868	606,891
N.B.	7,500	11,250



COAL.
Calendar Year, 1897.
Production by Provinces.
Table B.

Province.	Tons, 2,000 lbs.	Value.
		$
N.S.	2,493,554	3,896,179
B.C.	1,019,390	2,730,510
N.W.T.	267,163	667,958
N.B.	6,000	9,000

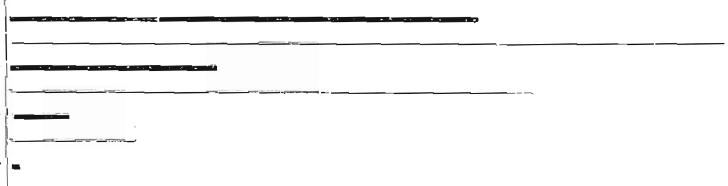


TABLE 2.

COAL.

COAL. Production by provinces.

PRODUCTION. COMPARISON OF 1896 AND 1897.

Province.	Increase or Decrease.			
	Tons.	Per cent.	Value.	Per cent.
Nova Scotia	15,025	·60	23,476	·60
British Columbia	15,621	1·56	41,844	1·56
North-west Territories.	41,293	18·28	61,017	10·05
New Brunswick	1,500	20·00	2,250	20·00
Dominion	40,391	1·08	77,135	1·07

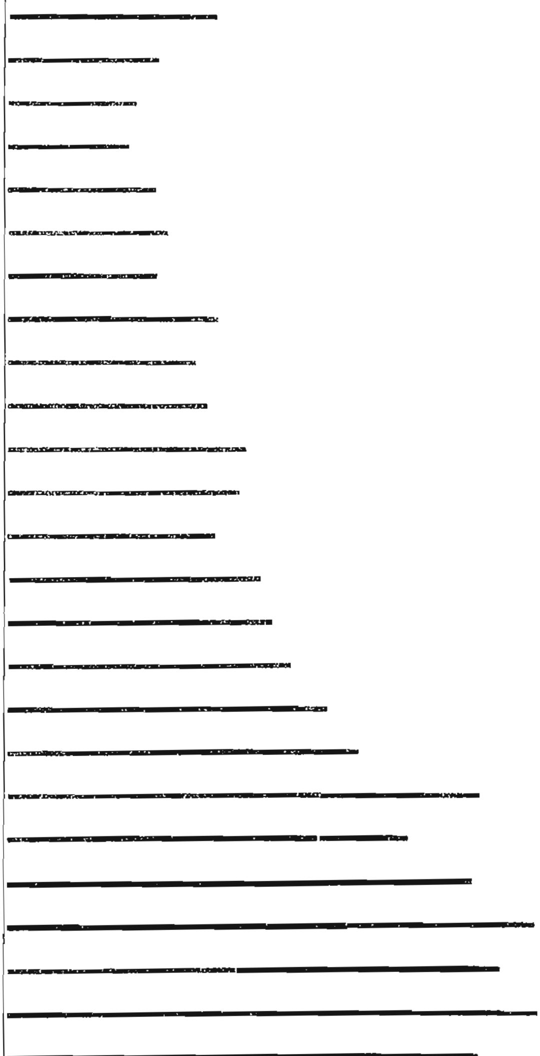
NOTE.—The figures underlined in this table represent increases, the others decreases.

As usual, the figures of exports and imports are obtained from the Customs Department. In graphic Tables C and D are exhibited the exports of coal "the produce of Canada," and "not the produce of Canada," respectively. The figures of the latter table, although they have little bearing upon the mineral industry, are, nevertheless, of value in calculating the consumption of coal in Canada. An examination of the tables will show that the largest export trade was done in 1896, 1897 showing a falling away of 120,531 tons or 10·9 per cent in exports "the produce of Canada."

Coal. Exports.

COAL.
Exports.
(Produce of Canada.)
Table C.

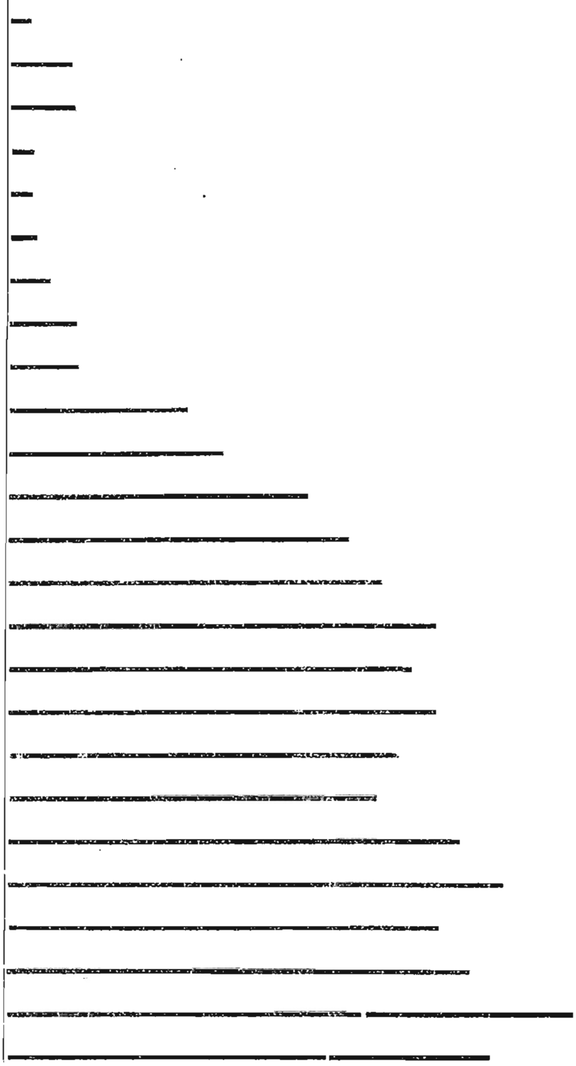
Calendar Year.	Tons.
1873	420,683
1874	310,988
1875	250,348
1876	248,638
1877	301,317
1878	327,959
1879	306,648
1880	432,188
1881	395,382
1882	412,682
1883	486,811
1884	474,405
1885	427,937
1886	520,703
1887	580,965
1888	588,627
1889	665,315
1890	724,486
1891	971,259
1892	823,733
1893	960,312
1894	1,103,694
1895	1,011,235
1896	1,106,661
1897	986,130



Coal. Exports.

COAL.
Exports.
(Not the Produce of Canada.)
Table D.

Calendar Year.	Tons.
1873	5,403
1874	12,859
1875	14,026
1876	4,995
1877	4,829
1878	5,468
1879	8,468
1880	14,217
1881	14,245
1882	37,576
1883	44,388
1884	62,665
1885	71,003
1886	78,443
1887	89,098
1888	84,316
1889	89,294
1890	82,534
1891	77,827
1892	93,988
1893	102,827
1894	89,786
1895	96,836
1896	116,774
1897	101,848



Tables 3 and 4 give the exports detailed by provinces and require no further comment, except that, in using them, it should be borne in mind that the entries under any particular province do not at all necessarily represent the production of that province.

TABLE 3.

COAL.

EXPORTS. THE PRODUCE OF CANADA.

Provinces.	Calendar Year.					
	1895.		1896.		1897.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
Ontario	......	......	......	......	......	......
Quebec	148	$ 382	......	......	610	$ 1,830
Nova Scotia ...	241,091	534,479	380,149	$ 787,270	307,128	642,754
New Brunswick	4,445	13,343	1,075	3,364	8,208	25,816
P.E. Island	150	450	......	......	......	......
N. W. Ter.....	37,118	77,015	45,638	90,349	39,843	72,188
Brit. Columbia.	728,283	2,692,562	679,799	2,507,752	630,341	2,221,737
Total.......	1,011,235	$3,318,231	1,106,661	$3,388,735	986,130	$2,964,325

TABLE 4.

COAL.

EXPORTS. NOT THE PRODUCE OF CANADA.

Provinces.	Calendar Year.					
	1895.		1896.		1897.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
Ontario.........	93,027	$ 191,783	112,539	$ 222,484	98,062	$ 178,044
Quebec	2,956	6,139	28	160	1,143	2,101
Nova Scotia....	472	1,791	546	2,064	150	669
New Brunswick	380	1,019	3,661	9,432	2,493	6,891
Manitoba	1	13	......	......	......	......
Total........	96,836	$ 200,745	116,774	$ 234,140	101,848	$ 187,705

For the sake of comparison the exports of Nova Scotia and British Columbia are grouped together in Table 5. It will be seen that, on the average, the exports of Nova Scotia exceeded those of British Columbia until 1882. Since that year, however, the exports of British Columbia have gradually increased until now they are almost double those of Nova Scotia. Nova Scotia exports only about 12 per cent of its production, while British Columbia exports nearly 62 per cent. These exports of course being to foreign countries.

Nearly 44 per cent of the coal produced in Nova Scotia goes to the province of Quebec. (See Table 13).

COAL. Exports Nova Scotia and British Columbia.

TABLE 5.

COAL.

EXPORTS. NOVA SCOTIA AND BRITISH COLUMBIA.

Calendar Year.	Nova Scotia.		*British Columbia.	
	Tons.	Value.	Tons.	Value.
1874	252,124	$647,539	51,001	$ 278,180
1875	179,626	404,351	65,842	356,018
1876	126,520	263,543	116,910	627,754
1877	173,389	352,453	118,252	590,263
1878	154,114	293,795	165,734	698,870
1879	113,742	203,407	186,094	608,845
1880	199,552	344,148	219,878	775,008
1881	193,081	311,721	187,791	622,965
1882	216,954	390,121	179,552	628,437
1883	192,795	336,088	271,214	946,271
1884	222,709	430,330	245,478	901,440
1885	176,287	349,650	250,191	1,000,764
1886	240,459	441,693	274,466	960,649
1887	207,941	390,738	356,657	1,262,552
1888	165,863	330,115	405,071	1,605,650
1889	186,608	396,830	470,683	1,918,263
1890	202,387	426,070	508,882	1,977,191
1891	194,867	417,816	767,734	2,958,695
1892	181,547	407,980	599,716	2,317,734
1893	203,198	470,695	708,228	2,693,747
1894	310,277	633,398	770,439	2,855,216
1895	241,091	534,479	728,283	2,692,562
1896	380,149	787,270	679,799	2,507,752
1897	307,128	642,754	630,341	2,221,737

*See foot-note table 16.

The imports of coal are given in Tables 6, 7 and 8. Bituminous and anthracite coal, it will be seen, have been imported in almost equal quantities, having averaged about one and a half million tons each for the last five or six years.*

*In Table 7, Imports of Anthracite Coal, a very considerable increase will be noticed in 1888 over 1887, an increase of over ninety-four per cent, the falling off again in 1889 being quite as remarkable. The average value per ton for the three years 1887, 1888 and 1889, were $4.02, $2.47 and $4.03 respectively. Although a duty of fifty cents per ton on anthracite coal was removed May 13, 1887, it is hardly thought this would account for the changes indicated, and unless some error may possibly have crept into the Trade and Navigation Report, no explanation is available.

COAL.
Imports.

TABLE 6.

COAL.

IMPORTS OF BITUMINOUS COAL.

Fiscal Year.	Tons.	Value.
1880	457,049	$1,220,761
1881	587,024	1,741,568
1882	636,374	1,992,081
1883	911,629	2,996,198
1884	1,118,615	3,613,470
1885	1,011,875	3,197,539
1886	930,949	2,591,554
1887	1,149,792	3,126,225
1888	1,231,234	3,451,661
1889	1,248,540	3,255,171
1890	1,409,282	3,528,959
1891	1,598,855	4,060,896
1892	1,615,220	4,099,221
1893	1,603,154	3,967,764
1894	1,359,509	3,315,094
1895	1,444,928	3,321,387
1896	1,538,489	3,299,025
1897	1,543,476	3,254,217

TABLE 7.

COAL.

IMPORTS OF ANTHRACITE COAL.

Fiscal Year.	Tons.	Value.
1880	516,729	$1,509,960
1881	572,092	2,325,937
1882	638,273	2,666,356
1883	754,891	3,344,936
1884	868,000	3,831,283
1885	910,324	3,909,844
1886	995,425	4,028,050
1887	1,100,165	4,423,062
1888	2,138,627	5,291,875
1889	1,291,705	5,199,481
1890	1,201,335	4,595,727
1891	1,399,067	5,224,452
1892	1,479,106	5,640,346
1893	1,500,550	6,355,285
1894	1,530,522	6,354,040
1895	1,404,342	5,350,627
1896	1,574,355	5,667,096
*1897	1,457,295	5,695,168

* Coal, anthracite, and anthracite coal dust.

TABLE 8.

COAL.

IMPORTS OF COAL DUST.

COAL. Imports.

Fiscal Year.	Tons.	Value.
1880....................	3,565	$ 8,877
1881....................	337	666
1882....................	471	900
1883....................	8,154	10,082
1884....................	12,782	14,600
1885....................	20,185	20,412
1886....................	36,230	36,996
1887....................	31,401	33,178
1888....................	28,808	34,730
1889....................	39,980	47,139
1890....................	53,104	29,818
1891....................	60,127	36,130
1892....................	82,091	39,840
1893....................	109,585	44,474
1894....................	117,573	49,510
1895....................	181,318	52,221
1896....................	210,386	53,742
1897....................	225,562	59,609

Knowing the production, the imports and the exports, we should be able to arrive at a fair approximation of the consumption of coal in Canada. Assuming that the figures of imports for the fiscal year, as given in Tables 6, 7 and 8 above, represent closely enough the importation of coal during the calendar year, we have the consumption of the country for 1897 as follows :— Home consumption.

	Tons.	
Production, Table A.................	3,786,107	
Exports of coal the produce of Canada, Table C........................	986,130	
Home consumption of Canadian coal.............		2,799,977
Imports of bituminous, anthracite and coal dust, Tables 6, 7 and 8	3,226,333	
Exports of coal not the produce of Canada, Table D.................	101,848	
Home consumption of imported coal.............		3,124,485
Total consumption of coal in Canada, home and imported..............................		5,924,462

In Table 9 will be found the results of similar calculations for each year since 1886. There is here shown the consumption of Canadian and

COAL.
Home consumption.

imported coal and the percentage of each, as well as the total consumption per capita. It will be seen that with the exception of 1888* (See note, page 35 s) the relative proportion of Canadian and imported coal consumed has remained fairly uniform. An exmination of the table shows a considerable increase from 1886 to 1890, viz, about 36 per cent, while the changes since 1890 have been almost as much on the negative side as on the positive. The consumption per capita in 1891 showed an increase of over 11 per cent above that of 1890, while the increase of 1897 over the same year was slightly less than 11 per cent.

TABLE 9.

COAL.

CONSUMPTION OF COAL IN CANADA.

Calendar Year.	Canadian.	Imported.	Total.	Percentage Canadian.	Percentage Imported.	Consumption per capita.*
	Tons.	Tons.	Tons.			Tons.
1886.....	1,595,950	1,884,161	3,480,111	45·9	54·1	·758
1887.....	1,848,365	2,192,260	4,040,625	45·7	54·3	·871
1888.....	2,013,925	3,314,353	5,328,278	37·8	62·2	1·137
1889.....	1,992,988	2,490,931	4,483,919	44·4	55·6	·946
1890.....	2,360,196	2,581,187	4,941 383	47·8	52·2	1·031
1891.....	2,606,490	2,980,222	5,586,712	46·7	53·3	1·153
1892.....	2,464,012	3,082,429	5,546,441	44·4	55·6	1·133
1893.....	2,823,187	3,110,462	5,933,649	47·6	52·4	1·198
1894.....	2,743,376	2,917,818	5,661,194	48·5	51·5	1·130
1895.....	2,467,109	2,933,752	5,400,861	45·7	54·3	1·066
1896.....	2,639,055	3,206,456	5,845,511	45·1	54·9	1·140
1897.....	2,799,977	3,124,485	5,924,462	47·3	52·7	1·143

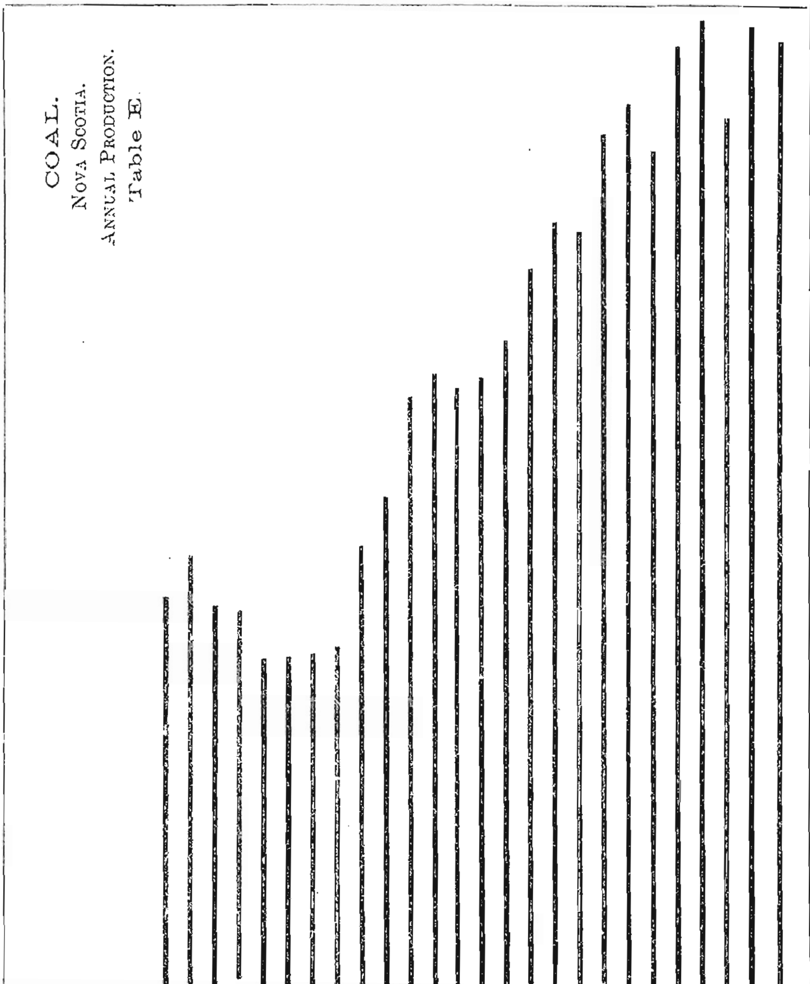
Another interesting result is afforded by a comparison of the total consumption of coal in the country with the total amount produced. In 1897, the consumption (Table 9) was 5,924,462 tons, and the production (Table A) 3,786,107 tons, or 63·9 per cent of the consumption. In 1886 the proportion of production to consumption was 60·8 per cent, and in 1890 it was 62·4 per cent.

NOVA SCOTIA.

The statistics of production of coal in Nova Scotia are given in graphic Table E and in Tables 10, 11, 12 and 13 below.

* The figures for the population used in each year have been estimated and furnished by the Department of Agriculture.

The yearly production since 1872 is well illustrated graphically in Table E :— COAL. Nova Scotia.



Calendar Year.	Tons.
1872	1,003,806
1873	1,108,245
1874	972,954
1875	930,613
1876	837,755
1877	880,215
1878	875,994
1879	865,220
1880	1,177,669
1881	1,280,050
1882	1,524,947
1883	1,578,609
1884	1,543,829
1885	1,547,990
1886	1,698,018
1887	1,858,596
1888	1,942,231
1889	1,918,827
1890	2,181,033
1891	2,267,919
1892	2,159,389
1893	2,444,924
1894	2,527,982
1895	2,225,145
1896	2,508,579
1897	2,493,554

Coal. Nova Scotia.

Table 10 shows the output, the sales and the colliery consumption in both tons of 2,240 lbs. and tons of 2,000 lbs.

TABLE 10.

COAL.

NOVA SCOTIA :—OUTPUT, SALES, COLLIERY CONSUMPTION AND PRODUCTION.

Calendar Year.	Output, Tons, 2,240 Lbs.	Sales, Tons. 2,240 Lbs.	Colliery Consumption, Tons, 2,240 Lbs.	Production* Tons, 2,240 Lbs.	Output, Tons, 2,000 Lbs.	Sales, Tons, 2,000 Lbs.	Colliery Consumption, Tons, 2,000 Lbs.	Production* Tons, 2,000 Lbs.	Price per Ton, 2,240 Lbs.	Value of Production.
1872	880,950	785,914	110,341	896,255	986,664	880,224	123,582	1,003,806	$1.75	$1,568,446
1873	1,051,467	881,106	108,398	989,504	1,177,643	986,839	121,406	1,108,245	1.75	1,731,632
1874	872,720	749,127	119,582	868,709	977,446	839,022	133,932	972,954	1.75	1,520,240
1875	781,165	706,795	124,110	830,905	874,905	791,610	139,003	930,613	1.75	1,454,084
1876	709,646	634,207	113,788	747,995	794,804	710,312	127,443	837,755	1.75	1,308,991
1877	757,496	687,065	98,841	785,906	848,396	769,513	110,702	880,215	1.75	1,375,339
1878	770,603	693,511	88,627	782,138	863,075	776,732	99,262	875,994	1.75	1,368,741
1879	788,271	688,624	84,787	773,411	882,863	771,259	94,961	866,220	1.75	1,353,469
1880	1,032,710	954,659	96,831	1,051,490	1,156,635	1,069,218	108,451	1,177,669	1.75	1,840,108
1881	1,124,270	1,035,014	107,888	1,142,902	1,259,183	1,159,216	120,834	1,280,050	1.75	2,000,079
1882	1,365,811	1,250,179	111,381	1,361,560	1,529,708	1,400,200	124,747	1,524,947	1.75	2,382,730
1883	1,422,553	1,297,523	111,949	1,409,472	1,593,259	1,453,226	125,383	1,578,609	1.75	2,466,576
1884	1,389,295	1,261,650	116,769	1,378,419	1,556,011	1,413,048	130,781	1,543,829	1.75	2,412,233
1885	1,352,205	1,254,510	127,624	1,382,134	1,514,470	1,405,051	142,939	1,547,990	1.75	2,418,735
1886	1,502,611	1,373,666	142,421	1,516,087	1,682,924	1,538,506	159,512	1,698,018	1.75	2,653,152
1887	1,670,830	1,519,684	139,777	1,659,461	1,871,330	1,702,046	156,550	1,858,596	1.75	2,904,057
1888	1,776,128	1,576,692	157,443	1,734,135	1,989,263	1,765,895	176,336	1,942,231	1.75	3,034,735
1889	1,756,279	1,555,107	158,131	1,713,238	1,967,032	1,741,720	177,107	1,918,827	1.75	2,998,167
1890	1,984,001	1,786,111	161,240	1,947,351	2,222,081	2,000,444	180,589	2,181,033	1.75	3,407,864
1891	2,044,784	1,849,945	174,983	2,024,928	2,290,158	2,071,938	195,981	2,267,919	1.75	3,543,624
1892	1,942,780	1,752,934	175,092	1,928,026	2,175,913	1,963,286	196,103	2,159,389	1.75	3,374,046
1893	2,223,042	1,977,543	205,425	2,182,968	2,489,807	2,214,848	230,076	2,444,924	1.75	3,820,194
1894	2,250,631	2,060,920	196,206	2,257,126	2,520,707	2,308,231	219,751	2,527,982	1.75	3,949,970
1895	1,999,756	1,793,098	193,639	1,986,737	2,239,727	2,008,270	216,875	2,225,145	1.75	3,476,790
1896	2,292,675	2,046,828	192,975	2,239,803	2,567,796	2,292,447	216,132	2,508,579	1.75	3,919,655
1897	2,340,031	2,044,672	181,716	2,226,388	2,620,835	2,290,032	203,522	2,493,554	1.75	3,896,179

* This Production is obtained by adding Sales and Colliery Consumption. For Sales previous to 1872, see report of the Department of Mines, Nova Scotia, 1883, page 68.

The coal trade quarterly and by counties is exhibited in Table 11, and the output by collieries in Table 12. COAL. Nova Scotia.

TABLE 11.

COAL.

NOVA SCOTIA:—COAL TRADE BY COUNTIES.

Calendar Year 1897.	Cumberland.		Pictou.		Cape Breton.		Other Counties.	
	Raised.	Sold.	Raised.	Sold.	Raised.	Sold.	Rais'd	Sold.
	Tons, 2000 lbs.	Tons, 2000 lbs.	Tons, 2000 lbs.	Tons, 2000 lbs.	Tons, 2000 lbs.	Tons, 2000 lbs.	Tons, 2000 lbs.	Tons, 2000 lbs.
1st quarter...	86,616	76,796	104,296	85,997	162,266	94,565	1,425	506
2nd " ..	121,911	101,387	93,127	81,500	449,445	372,496	5,499	4,581
3rd " ..	98,925	82,924	129,855	120,635	714,183	670,357	6,328	4,407
4th " ..	115,704	91,437	146,180	129,933	384,906	372,491	170	20
Totals, 1897.	423,156	352,544	473,458	418,065	1,710,800	1,509,909	13,422	9,514
" 1896.	518,051	452,315	425,568	374,890	1,603,644	1,447,208	20,531	18,034

TABLE 12.

COAL.

NOVA SCOTIA:—OUTPUT BY COLLIERIES DURING THE CALENDAR YEAR 1897.

Colliery.	Tons, 2000 lbs.	Colliery.	Tons, 2000 lbs.
Cumberland Co.		*Victoria Co*	
		Cape Breton......	12,171
Chignecto........	......	*Cape Breton Co.*	
Joggins	83,442		
Minudie.........	......	Sydney....	300,865
Scotia...........	780	Dom. Coal Co.—	
Springhill	338,890	Old Bridgeport.	145,503
Jubilee	44	Caledonia	292,743
		Glace Bay. ...	......
Pictou County.		Gowrie	46,898
		International...	125,543
Acadia...........	246,039	Reserve	298,350
Intercolonial.	227,418	Victoria........	116,840
		Hub...........	112 400
Inverness County.		Dominion No. 1	263,174
		Greener....	8,484
Broad Cove	1,027		
Mabou	224	Total.........	2,620,835

The market for Nova Scotia coal is illustrated in Table 13, in which the distribution of coal sold in 1896 and 1897 is shown. Comparing the latter with the former year, it will be seen that in 1897 a larger

COAL. Nova Scotia.

proportion of the coal sold went to Quebec while a less proportion went to the United States.

TABLE 13.

COAL.

NOVA SCOTIA :—DISTRIBUTION OF COAL SOLD.

Market.	Calendar Years.			
	1896.		1897.	
	Tons, 2000 lbs.	Per cent.	Tons, 2000 lbs.	Per cent.
Nova Scotia, transported by land.....	378,500	16·5	366,801	16·0
" " sea.....	359,231	15·7	363,166	15·9
Total, Nova Scotia	737,731	32·2	729,967	31·9
New Brunswick	284,144	12·4	280,812	12·3
Prince Edward Island................	69,547	3·0	73,132	3·2
Quebec.	882,672	38·5	1,003,920	43·8
Newfoundland....	104,048	4·5	99,495	4·3
West Indies.................... ...	11,324	·5	103	......
United States........	202,981	8·9	102,604	4·5
Total..	2,292,447	100·0	2,290,033	100·0

New Brunswick.

NEW BRUNSWICK.

The coal mining industry of New Brunswick, though varying considerably from year to year, is of small extent. A large proportion of the coal is sold locally, and accurate statistics are difficult to obtain. The production in 1897 shows a decrease of 20 per cent as compared with 1896.

The production since 1887 is shown in Table 14 below :—

TABLE 14.

COAL.

NEW BRUNSWICK :—PRODUCTION.

Calendar Year.	Tons.	Value.	Value per Ton.
1887.............	10,040	$ 23,607	$2·35
1888.............	5,730	11,050	1·93
1889.............	5,673	11,733	2·07
1890......... ...	7,110	13,850	1·95
1891.............	5,422	11,030	2·03
1892....	6,768	9,375	1·39
1893.............	6,200	9,837	1·59
1894.....	6,469	10,264	1·59
1895........ ...	9,500	14,250	1·50
1896.	7,500	11,250	1·50
1897...........	6,000	9,000	1·50

North-west Territories.

Coal.
North-west Territories.

The chief points of production of coal in the North-west Territories are at the Souris coalfields in the east, and in Alberta at Lethbridge, Anthracite, Canmore and Edmonton. About one-half the total production is taken by the Canadian Pacific Railway. Table 15 shows the output since 1887. Compared with 1896 it will be seen that the production of 1897 increased about eighteen per cent.

Table 15.

Coal.

North-west Territories:—Production.

Calendar Year.	Tons.	Value.	Value per Ton.
1887	74,152	$ 157,577	$ 2·13
1888	115,124	183,354	1·59
1889	97,364	179,640	1·85
1890	128,953	198,498	1·54
1891	174,131	437,243	2·51
1892	184,370	469,930	2·55
1893	238,395	598,745	2.51
1894	199,991	488,980	2·45
1895	185,654	414,064	2·23
1896	225,868	606,891	2·69
1897	267,163	667,908	2·50

British Columbia.

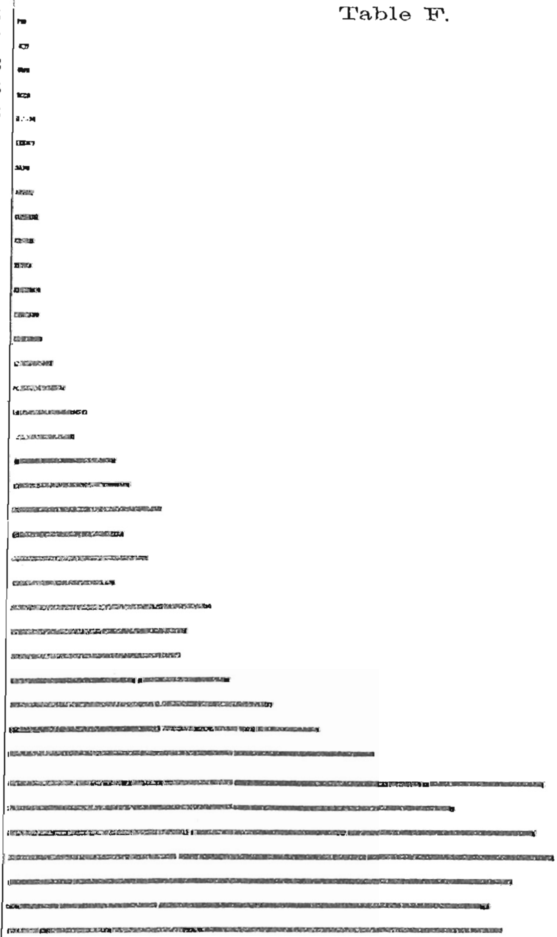
British Columbia.

Table F, exhibits graphically the coal production of British Columbia, and indicates a fairly steady growth in the industry up to 1891. Since that year the output has declined somewhat, the production of 1897 being less than that of 1891 by nearly 10 per cent, although showing an increase over 1896 of 16,621 tons, or 1·5 per cent.

COAL.
British Columbia.

COAL.
BRITISH COLUMBIA.
ANNUAL PRODUCTION.
Table F.

Calendar Year.	Tons, 2000 lbs.
1836-52	11,200
1852-59	28,444
*1859	2,228
1860	15,956
1861	15,427
1862	20,292
1863	23,906
1864	32,068
1865	36,757
1866	28,129
1867	34,988
1868	49,286
1869	40,098
1870	33,424
1871	
1872	166,274
1873	
1874	90,788
1875	109,361
1876	157,007
1877	156,455
1878	213,750
1879	260,277
1880	305,045
1881	257,056
1882	323,201
1883	240,075
1884	441,130
1885	372,987
1886	375,415
1887	486,142
1888	539,467
1889	636,439
1890	767,586
1891	1,130,277
1892	937,218
1893	1,093,980
1894	1,112,628
1895	1,058,045
1896	1,003,769
1897	1,019,390



* Two months only.

The output, home consumption and quantity sold for export are shown in Table 16, and the colliery details for 1897 and 1896 in Table 17, compiled from the Report of the Minister of Mines for British Columbia.

COAL.
British Columbia.

TABLE 16.

COAL.

BRITISH COLUMBIA:—PRODUCTION.

Calendar Year.	Output, Tons, 2,240 lbs.	Home Consumption, Tons, 2,240 lbs.	Sold for Export, Tons, 2,240 lbs. ‡	Production.* Tons, 2,240 lbs.	Production.* Tons, 2,000 lbs.	Price per ton, 2,240 lbs.	Value.
						$	$
1836-52..	10,000	From 1836 to 1873 inclusive the output is taken as production.			11,200	4 00	40,000
1852-59..	25,[illegible]98				28,446	4 00	101,592
**1859....	1,989				2,228	4 00	7,956
1860.....	14,247				15,957	4 00	56,988
1861.....	13,774				15,427	4 00	55,096
1862.....	18,118				20,292	4 00	72,472
1863.....	21,345				23,906	4 00	85,380
1864.....	28,632				32,068	4 00	114,528
1865.....	32,819				36,757	4 00	131,276
1866.....	25,115				28,129	4 00	100,460
1867. ..	31,239				34,988	4 00	124,956
1868.....	44,005				49,286	4 00	176,020
1869.....	35,802				40,098	4 00	143,208
1870.....	29,843				33,424	4 00	119,372
1871-2-3.	148,459				166,274	4 00	593,836
1874.....	81,547	25,023	56,038	81,061	90,788	3 00	243,183
1875.....	110,145	31,252	66,392	97,644	109,361	3 00	292,932
1876.....	139,192	17,856	†122,329	140,185	157,007	3 00	420,555
1877.....	154,052	24,311	115,381	139,692	156,455	3 00	419,076
1878.. ..	170,846	26,166	164,682	190,848	213,750	3 00	572,544
1879.....	241,301	40,294	192,096	232,390	260,277	3 00	697,170
1880. ...	267,595	46,513	225,849	272,362	305,045	3 00	817 086
1881.....	228,357	40,191	189,323	229,514	257,056	3 00	688,542
1882.....	282,139	56,161	232,411	288,572	323,201	3 00	865,716
1883.....	213,299	64,786	149,567	214,353	240,075	3 00	643,059
1884. ...	394,070	87,388	306,478	393,866	441,130	3 00	1,181,598
1885.....	365,596	95,227	237,797	333,024	372,987	3 00	999,072
1886.....	326,636	85,987	249,205	335,192	375,415	3 00	1,005,576
1887....	413,360	99,216	334,839	434,055	486,142	3 00	1,302,165
1888.....	489,301	115,953	365,714	481,667	539,467	3 00	1,445,001
1889.....	579,830	124,574	443,675	568,249	636,439	3 00	1,704,747
1890.....	678,140	177,075	508,270	685,345	767,586	3 00	2,056,035
1891.....	1,029,097	202,697	806,479	1,009,176	1,130,277	3 00	3,027,528
1892	826,335	196,223	640,579	836,802	937,218	3 00	2,510,406
1893.....	978,294	207,851	768,917	976,768	1,093,980	3 00	2,930,304
1894.....	1,012,953	165,776	827,642	993,418	1,112,628	3 00	[illegible],980,254
1895.....	939,654	188,349	756,334	944,683	1,058,045	3 00	2,834,049
1896.....	894,882	261,984	634,238	896,222	1,003,769	3 00	2,688,666
1897.....	892,296	290,310	619,860	910,170	1,019,390	3 00	2,730,510

* This production is obtained by adding "Home Consumption" and "Sold for Export."

† 52,935 of this amount was reported as sales without the division into "Home Consumption" and "Sold for Export."

‡ The figures in the "Sold for Export" column do not agree as they should with those given in Table 5, the only explanation being that the data in the two cases are from different sources, and it has not been possibile to find out the cause of the difference.

* Two months only.

COAL.

British Columbia.

TABLE 17.

COAL.

BRITISH COLUMBIA :—PRODUCTION, SALES, &C., CALENDAR YEAR 1897.

Name of Colliery.	Coal raised.	Sold for Home Consumption.	Sold for Exportation.	On hand Jan. 1st, 1897.	On hand Jan. 1st, 1898.	Number of men employed.
	Tons.	Tons.	Tons.	Tons.	Tons.	
Nanaimo	357,665	95,965	259,825	3,435	5,310	796
E. Wellington..	333,325	102,196	237,062	16,391	10,458	797
Union.........	297,519	110,530	197,357	16,139	5,771	754
Wellington	6,720	....	....	4,480	11,200	21
Alexandria	3,780	16,100	....	13,440	1,120	37
W. Wellington.	362	355	....	....	7	8
Total	999,371	325,146	694,244	53,885	33,866	2,413

PRODUCTION, SALES, &C., CALENDAR YEAR 1896.

Name of Colliery.	Coal raised.	Sold for Home Consumption.	Sold for Exportation.	On hand Jan. 1st, 1896.	On hand Jan. 1st, 1897.	Number of men employed.
	Tons.	Tons.	Tons.	Tons.	Tons.	
Nanaimo	359,044	102,375	260,328	7,094	3,435	981
Wellington. ...	380,684	115,504	264,226	15,549	16,390	959
Union.........	261,643	74,646	185,791	14,933	16,139	798
W. Wellington.	896	896	....	....	....	15
Total	1,002,267	293,421	710,345	37,576	35,964	2,753

An examination of Table 16 will show that there is more than twice as much coal sold for export as is sold for home consumption, the proportions in 1897 being approximately 68 per cent for export, and 32 per cent for home consumption, and in 1896 about 71 per cent and 29 per cent respectively.

Owing to the large amount of British Columbia coal exported to California, the following figures, giving the imports of coal into the Californian market during 1897, will be of interest:

COAL IMPORTED INTO CALIFORNIA, 1896 AND 1897.

COAL.
British Columbia.

	1896. Tons of 2,000 lbs.	1897. Tons of 2,000 lbs.
British Columbia	618,074	625,377
Australia	306,707	315,466
English and Welsh	175,132	120,925
Scotch	9,359	4,571
Eastern (Cumberland and Anthracite)	20,056	23,895
Seattle, Franklin and Green River	144,387	246,596
Carbon Hill and South Prairie	285,928	320,550
Mount Diablo and Coos Bay	123,465	128,968
Japan	2,516	7,377
Total	1,685,624	1,793,725

Descriptions of the coal fields of Nova Scotia, New Brunswick, the North-west Territories and British Columbia having been given in numerous places in Reports of the Geological Survey of Canada, it is only necessary in this connection to draw attention to the work now being done on the latest addition to the explored coal areas.

Crow's Nest Pass coal field.

With the opening up of railway communication into the Kootenay mining district by the Canadian Pacific Railway Company, a company has been formed to develop the coal fields in the Crow's Nest Pass. Reports by Dr. Dawson and Dr. Selwyn on these coal fields are to be found in G. S. C. Report for 1885, part B, p. 69, and in Report for 1890-91, part A, p. 13 (Summary, 1891), respectively, in which publications they have drawn attention to the great importance of these fields. It is only necessary at this place to give the further details comprised in the following quotation from the Report of the Minister of Mines for British Columbia:

"The great coal-fields of the Crow's Nest Pass are now being opened up in two places where the seams of high grade coking coal are each from 6 to 7 feet thick. The work is in charge of Mr. Blakemore, M.E., who is opening up the properties so as to admit of a large production of coal on the completion of the railway, and is also erecting coke ovens, so that when the railway reaches the heart of West Kootenay, coal and coke can be at once delivered, at greatly reduced prices, at the smelting centres there, the price of coke, delivered, to be about $6 per ton, the present price varying from $12 to $14.

"These fields were examined by Geo. S. Ramsay, M.E., who says: 'It is my opinion that the Kootenay coal-field is the greatest in the Rocky Mountains series. I must say that I know of no coal field in the West where the evidence, indicating large tonnage per acre, is so prominent as I find in the Kootenay field.' He also gives the following comparative table:—

COAL.
British Columbia.

STEAM AND COKING COAL.

—	Fixed Carbon.	Volatile Matter.	Water.	Ash.
Crow's Nest No. 1 (entire vein)...........	73·04	21·13	2·75	3·08
Crow's Nest No. 2 (lower part of vein)......	68·04	19·46	4·04	7·66
Crested Butte, Colorado..	56·93	37·23	4·12	5·50
Sunshine, Colorado	56·16	34·22	4·12	5·50

"Mr. Ramsay also gives the next table:—

COMPARATIVE ANALYSES OF COKE.

—	Carbon.	Ash.
Crow's Nest, B.C.................	91·97	8·03
Crested Butte, Colo.	89·00	11·00
Cardiff and Sunshine, Colo.......	87·13	12·82
Belt, Mont. (washed coal).........	91·00	9·00
Connelsville, Penn.	86·88	11·54
Trinidad, Colo. (washed coal)......	85·00	15·00

"The 'Crow's Nest Pass Coal Co.' is opening coal mines to the north and south sides of Coal Creek, in Crow's Nest Pass, and about 35 feet above the level of the grade for the railway.

"On the north side of the above named creek, they have what is known as No. 1 tunnel. This is now in 190 feet, and 30 of this is in what is termed the 6-foot seam. This coal is hard and clean; what they have tried makes a good hard coke.

"On the south side of Coal Creek, they have what is called No. 2 tunnel, now in 220 feet, in coal all the distance. This seam is 7 feet thick, and is termed the Jaffray seam. This is softer than the coal mined in No. 1 tunnel. In addition to its coking qualities, it is good for blacksmith purposes. The coal now being worked in No. 2 tunnel is 40 feet above (overlying) that worked in No. 1."

The following are analyses of fuels from the Rocky Mountain coal-fields, exclusive of the foot-hill region to the east of the mountains proper, in which coals of a bituminous character also frequently occur. The first four analyses represent coals from the Crow's Nest Pass field, Nos. 5, 6, 7 and 8, coals from the Canmore and Anthracite field, or "Cascade Basin." The remaining analyses are from other more or less separated coal-fields in the mountains, the seams in which have not been worked, but of which specimens have been collected from natural outcrops. Nos. 7, 8, 11, 12, 13 and 14 were collected by Dr.

G. M. Dawson, and the occurrences are described in the G.S.C. Report, vol. I. (N.S.) part B. COAL.

ANALYSES OF COAL FROM THE ROCKY MOUNTAIN FIELDS. Analyses.

Locality.	Hygroscopic Water.	Volatile Combustible Matter.	Fixed Carbon.	Ash.	Coke, p.c.	Remarks.
1—Marten Creek—Crow's Nest Pass, B.C., Peter Seam	1.79	25·45	69·14	3.62	72 76	Slow coking, non-coherent coke.
	1·79	33·04	61·55	3·62	65·17	Fast coking, firm coherent coke.
2—Marten Creek—Crow's Nest Pass, B.C., Jubilee Seam	1·89	24·88	68·86	4·37	73·23	Slow coking, non-coherent coke.
	1.89	30·41	63·33	4·37	67·70	Fast coking, firm coherent coke.
3—Marten Creek—Crow's Nest Pass, B.C.	2·10	44·41	43·63	9·86	53·49	Slow coking, a bulky coherent coke.
	2·10	57 71	30·33	9·86	40·19	Fast coking, a fine and lustrous coke.
4—Elk River—Crow's Nest Pass, B. C.	....	21·76	68·20	10·04	78 24	Non-coherent coke.
5—Cascade River—two and three-quarter miles from its confluence with the Bow—Bow River Pass, Alberta	2·07	15·84	74·35	7·74	82·09	Fast coking, non-coherent coke.
6—Cascade River—Bow River Pass, Alberta	·71	10 58	81·14	7·57	88·71	Slow coking, non-coherent coke.
	·71	10·79	80·93	7·57	88·50	Fast coking, non-coherent coke.
7—Bow River, right bank (1½ mile from Canmore Station) Alberta	1·60	12·23	82·32	3·85	86·17	Non-coherent coke.
8—Cascade River, near Bow River (about ¼ mile from C.P.R.) Alberta	1·04	9·15	87 18	2·63	89·81	" "
9—Main Red Deer River—near base of Rocky Mountains, Alberta	....	13·98	81·94	4.08	......	" "
10—Panther or Little Red Deer River, Alberta	1·87	13·74	79·55	4·84	84 39	Coke firm and coherent.
11—Red Deer River, Alberta	2·90	29·26	62·95	4·89	67·84	Coke compact and coherent.
12—South Fork of Old Man River, Alberta	1·93	23·23	57·50	17·34	74·84	Coke firm and coherent.
13—Oyster, Creek, North Fork Old Man River, Alberta	4·03	31·82	39·46	24·69	64·15	" "
14—N.W. branch of North Fork, Old Man River, Alberta	1·24	24·62	66·61	7·53	74·14	" "

1 and 2........................G.S.C. Report, vol. III., pp. 12-15 T.
3........................ " " vol. IV., pp. 7-8 R.
4 and 10........................ " " vol. VI., pp. 10-11 R.
5 and 6........................ " " 1882-83-84, pp. 41-42 M
7, 8, 11, 12, 13, 14........................ " " vol. VI., pp. 7-11 M.
9........................ " " vol. V., p. 70 R.

COAL.

COKE.

Coke Production.

The production of coke in 1897 was 60,686 tons valued at $176,457, made up as follows :—

	Tons.	Value.
Nova Scotia	41,532	$90,950
British Columbia	19,154	85,507
	60,686	$176,457

With the exception of 1893, this is the largest production recorded, the figures since 1886 being shown in Table 1 below. The increase over 1896 was 11,067 tons, or 22 per cent, and in value $66,400, or 60 per cent. This increase is entirely due to the production in British Columbia, Nova Scotia having shown a falling away of about 16 per cent. It will be noticed that the increase per cent in the value is very much larger than in the quantity. This is to be accounted for by the large increase in the production of British Columbia coke, which has a local value per ton of over twice that of the Nova Scotia product.

TABLE 1.

COKE.

ANNUAL PRODUCTION.

Calendar Year.	Tons.	Value.	Value per Ton.
1886	35,396	$101,940	$2·88
1887	40,428	135,951	3·36
1888	45,373	134,181	2·96
1889	54,539	155,043	2·84
1890	56,450	166,298	2·95
1891	57,084	175,592	3·08
1892	56,135	160,249	2·85
1893	61,078	161,790	2·65
1894	58,044	148,551	2·56
1895	53,356	143,047	2·68
1896	49,619	110,257	2·22
1897	60,686	176,457	2·91

The decreased production in Nova Scotia is probably a result of the closing down of the blast furnace of the Londonderry Iron Co. Almost all of the product is used in the iron and steel furnaces, though in 1897 a small shipment was made by the People's Heat and Light Co., of Halifax, to Boston.

In British Columbia, owing to the largely increasing demand for coke for smelting purposes, the industry of coke manufacture has begun to assert itself. Prior to 1893 there was no production of coke reported from this province. In 1896 it was less than 500 tons, while in the year under consideration it had mounted to no less than 19,154 tons. As yet this is all the product of the Union Colliery Co., manufactured at the Union Colliery, Comox. Concerning the industry the inspector of coal mines for British Columbia reports as follows:— COAL. Coke.

"In connection with this colliery there are one hundred ovens of the bee-hive pattern, which are all at work turning out a first-class coke, for which there is a good market both in British Columbia and in San Francisco, and also wherever it has been tried. Now the Union Colliery Company is building a second hundred ovens for the coke-making business; these are on the same pattern as the first, and are all expected to be in operation early in the summer. The company will be in a position to fill orders that they now have to refuse. The time has arrived when it is not necessary to send out of the country for a first-class coke, this being now manufactured in British Columbia, and equal to any that can be imported." *

In Tables 2 and 3, below, the imports of oven coke are exhibited:—

TABLE 2.

COKE.

IMPORTS OF OVEN COKE. Imports.

Fiscal Year.	Tons.	Value.
1880	3,837	$ 19,353
1881	5,492	26,123
1882	8,157	36,670
1883	8,943	38,588
1884	11,207	44,518
1885	11,564	41,391
1886	11,858	39,756
1887	15,110	56,222
1888	25,487	102,334
1889	29,557	91,902
1890	36,564	133,344
1891	38,533	177,605
1892	43,499	194,429
1893	41,821	156,277
1894	42,864	176,996
1895	43,235	149,434
1896	61,612	203,826
1897	83,330	267,540

* Report of the Minister of Mines for British Columbia, 1897, p. 620.

COAL.
Coke.
Imports by Provinces.

TABLE 3.

COKE.

IMPORTS OF OVEN COKE—FISCAL YEARS 1896 AND 1897.

Province.	1896.		1897.	
	Tons.	Value.	Tons.	Value.
		$		$
New Brunswick........	....	....	13	130
Quebec	6,433	21,307	7,526	26,496
Ontario...............	45,852	143,259	60,255	160,367
Manitoba.....	195	980	186	1,163
British Columbia......	9,132	38,280	15,350	79,384
Total...........	61,612	203,826	83,330	267,540

Comparing Tables 2 and 3 with Table 1, it will be seen that previous to 1896 the home production had always exceeded the imports ; in the latter year, however, a reversal of this condition of affairs took place, and although the production of 1897 increased 22 per cent over that of 1896, the imports for the same time increased over 35 per cent. If, then, we ignore the exports, which are small, the consumption in the country in 1897 was composed approximately of 42 per cent home product and 58 per cent imported.

COPPER.

COPPER.
Production.

In common with the other metals, the production of copper in the Dominion in 1897 shows a very considerable increase over 1896. In 1897 the production was 13,300,802 lbs., valued at $1,501,660, or 11·29 cts. per lb., the average market price for the year for fine copper in New York. The increase over 1896 was thus 3,907,790 lbs. and $479,700 in value, being nearly 42 per cent and 47 per cent respectively. Three provinces contributed to the total output, the relative proportions being about as follows: Ontario, 41 per cent., British Columbia 40 per cent, and Quebec 19 per cent.

Table 1, below, gives the production of the metal since 1886, and shows the yearly increases and decreases in percentages as well as in totals.

TABLE 1.

COPPER.

ANNUAL PRODUCTION.*

Year.	Lbs.	Increase or Decrease.		Value.	Increase or Decrease.		Average Price per Pound.
		Lbs.	%		$	%	Cts.
1886	3,505,000	....	....	$ 385,550	....	....	11·00
1887	3,260,424	244,576	6·99	366,798	18,752	4·86	11·25
1888	5,562,864	2,302,440	70·60	927,107	560,309	152·70	16·66
1889	6,809,752	1,246,888	22·40	936,341	9,234	0·99	13·75
1890	6,013,671	796,081	11·69	947,153	10,812	1·15	15·75
1891	8,928,921	2,915,250	48·40	1,149,598	202,445	21·37	12·87
1892	7,087,275	1,841,646	20·62	818,580	331,018	28·79	11·55
1893	8,109,856	1,022,381	14·40	871,809	53,229	6·50	10·75
1894	7,737,016	372,840	4·81	739,659	132,150	15·15	9·56
1895	8,789,162	1,052,146	13·59	945,714	206,055	27·85	10·76
1896	9,393,012	603,850	6·87	1,021,960	76,246	8·06	10·88
1897	13,300,802	3,907,790	41·60	1,501,660	479,700	46·94	11·29

* The production is altogether represented by the copper contained in ore, matte, &c., produced and shipped, valued at the average market price for the year for fine copper in New York.

NOTE.—In the above table increases are shown underlined, and decreases in the ordinary way.

COPPER.
Production.

Prior to 1894, the production came entirely from the eastern provinces, chiefly from Ontario and Quebec, copper mining only having begun in British Columbia in that year, and although the increase of 1897 over 1896 was well distributed among the three centres of production, at the same time the total increase since 1893 must be attributed to the development of the copper-bearing ores of the Pacific province. The total increase since 1893 was 5,190,946 lbs., while the increase in British Columbia alone during the same period, represented by the production of 1897, was 5,325,180 lbs.

In Table 2, the exports of copper in ore, matte, etc., by provinces, are given, but as these figures are somewhat at variance with the figures of production, it being remembered that practically all the copper is exported, no comparison between the two tables is possible.*

*The discrepancies between the two tables result from differences in both quantities and values. The values in Table 1 are similar to those adopted throughout the Report for metallic products, viz: the final market value of the metal, while in the table of exports (Table 2) the values are apparently the spot values placed upon the metal at the point of shipment, although they will be seen to vary very considerably; as for instance, in 1897, ranging from less than half a cent per pound in Ontario to nearly nine cents per pound in British Columbia. The figures of quantity, however, also show large discrepancies, and for this we can offer no explanation, except to make the suggestion that the returns to some of the customs officers are not as correct as they might be.

COPPER.
Exports.

TABLE 2.
COPPER.
EXPORTS OF COPPER IN ORE, MATTE, ETC.

Calendar Year.	Nova Scotia.		Ontario.		Quebec.		British Columbia.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
		$		$		$		$		$
1885	......	......	......	......	......	262,600	......	......	......	262,600
1886	......	......	......	16,404	......	232,855	......	......	......	249,259
1887	......	......	......	3,416	......	134,550	......	......	......	137,966
1888	......	......	......	......	......	257,260	......	......	......	257,260
1889	......	......	......	......	......	168,457	......	......	......	168,457
1890	......	......	......	2,219	......	396,278	......	......	......	398,497
1891	......	......	......	64,719	......	283,385	......	......	......	348,104
1892	......	100	......	79,141	......	198,391	......	......	......	277,632
1893	......	......	3,599,066	212,314	1,193,135	56,846	......	......	4,792,201	269,160
1894	......	......	242,804	25,029	285,009	12,005	1,097,576	54,883	1,625,339	91,917
1895	......	......	1,359,684	123,997	412,305	15,692	1,970,363	97,276	3,742,352	236,965
1896	......	......	49,000	1,100	290,845	12,368	5,122,207	267,602	5,462,052	281,070
1897	......	......	4,382,170	19,566	553,569	17,109	9,086,871	813,661	14,022,610	850,336

COPPER.
Imports.

Tables 3 and 4 give the imports of copper for the fiscal year, the two tables illustrating respectively the consumption of the crude metal and the manufactured product. A perusal of the figures shows very considerable variations in Canadian consumption of copper, the period of greatest importation being about 1891, while the last two or three years have averaged only about one-half the maximum. These tables do not, of course, necessarily include all the copper imported into or consumed in the country; the metal enters largely into the construction of electrical and other machinery, the value of which, owing to the limited nature of the data available, it would be impossible to estimate.

TABLE 3.

COPPER.

IMPORTS OF PIGS, OLD, SCRAP, ETC.

Fiscal Year.	Lbs.	Value.
1880.	31,900	$ 2,130
1881.	9,800	1,157
1882.	20,200	1,984
1883.	124,500	20,273
1884.	40,200	3,180
1885.	28,600	2,016
1886.	82,000	6,969
1887.	40,100	2,507
1888.	32,300	2,322
1889.	32,300	3,288
1890.	112,200	11,521
1891.	107,800	10,452
1892.	343,600	14,894
1893.	168,300	16,331
1894.	101,200	7,397
1895.	72,062	6,770
1896.	86,905	9,226
1897 { Copper, old and scrap	42,100	4,565
1897 { Copper in pigs	6,900	884
Total, 1897	49,000	$ 5,449

TABLE 4.

COPPER.

IMPORTS OF MANUFACTURES.

COPPER. Imports.

Fiscal Year.		Value.
1880		$ 123,061
1881		159,163
1882		220,235
1883		247,141
1884		134,534
1885		181,469
1886		219,420
1887		325,365
1888		303,459
1889		402,216
1890		472,668
1891		563,522
1892		422,870
1893		458,715
1894		175,404
1895		251,615
1896		285,220
	Pounds.	
1897 — Copper, ingots, sheets, plates and sheathing, not planished or coated	1,725,100	$ 160,321
1897 — Copper nails, rivets and burrs		3,023
1897 — " wire	228,415	29,330
1897 — " wire-cloth		1,326
1897 — " all other manufactures of, N.E.S.		26,528
1897 — " seamless drawn tubing		14,027
1897 — " in bars, rods and bolts in lengths not less than six feet	230,900	30,030
1897 — " rollers for use in calico printing		2
Total, 1897		$ 264,587

COPPER.

ONTARIO.

Production by Provinces.

The production of copper in Ontario, as given in the Report of the Bureau of Mines for 1897, is as follows :—

TABLE 5.

COPPER.

ONTARIO :—PRODUCTION.

YEAR.	POUNDS.	SPOT VALUE.		FINAL VALUE.	
		Total.	Per lb.	Total.	Per lb.
		$	cts.	$	cts.
1892	3,872,000	232,135	6·00	447,216	11·55
1893	2,862,000	115,200	4·03	307,865	10·75
1894	5,496,000	195,750	3·56	525,418	9·56
1895	4,731,000	160,913	3·40	509,056	10·76
1896	3,736,000	130,660	3·50	406,477	10·88
1897	5,500,000	200,067	3·63	620,950	11·29

The production of 1897 is thus seen to be the largest on record, although only exceeding that of 1894 by two tons. The increase over 1896 was about 47 per cent. The average yearly production for the six years tabulated is 4,366,166 lbs., the production of 1896 being less, and that of 1898 greater, than the average. The spot values given in the table are the values placed upon the ore by the operators at the point of production, and vary from one-third to one-half of the final market value of the metal.

The quantity of ore smelted in 1897, according to the Report of the Ontario Bureau of Mines, was 96,093 tons, and the copper contents 2,750 tons, or 2·86 per cent.

BRITISH COLUMBIA.

Although copper is produced in British Columbia chiefly in connection with the mining of the precious metals, its output had risen from practically nothing, previous to 1894, to over 40 per cent of the Dominion total in 1896. The increase of the production of 1897 over 1896, *viz.*, 1,506,624 lbs., or 39 per cent, though still quite considerable, is yet much less than that recorded for the previous year and is not quite equal to the increase in either quantity or percentage in Ontario for the same period, so that the relative proportion contributed by British Columbia to the grand total still remains in 1897 about the same as it was in 1896. COPPER.

Production by Provinces.

The statistical details are given below in Table 6, the figures of production and spot values being taken from the report of the Minister of Mines, and the final values given in the last column calculated at the same rate per lb. as the value in Table 1.

TABLE 6.

COPPER.

BRITISH COLUMBIA :—PRODUCTION.

Calendar Year.	Copper contained in ores, matte, &c.	Increase.		Spot Value.	Final Value.
	Lbs.	Lbs.	%		
1894	324,680	....	....	$ 16,234	$ 31,039
1895	952,840	628,160	193	47,642	102,526
1896	3,818,556	2,865,716	301	190,926	415,459
1897	5,325,180	1,506,624	39	266,258	601,213

NOVA SCOTIA AND NEW BRUNSWICK.

Discovery and development.

In Nova Scotia the copper deposits which have attracted most attention are those of Coxheath, near Sydney, Cape Breton Island. The ore in this case occurs as deposits of copper-pyrites in pre-Cambrian felsites. Considerable development has been done on these deposits, but since 1894 work has been at a standstill.

At Lochaber, in Antigonish County, veins of spar occur, holding crystals of copper-pyrites, mixed with carbonates and erubescite. These were tested some years ago, and several veins from one and a half to five feet wide were opened up.

Other occurrences of copper ores are known both in Nova Scotia and New Brunswick, on some of which more or less work has been done, but so far these developments have not resulted in the inauguration of any operations of economic importance.

COPPER.

QUEBEC.

Discovery and development.

The production of copper in the province of Quebec is derived from the pyrites deposits of the "Eastern Townships."

The two producers are the Capelton Mine and the Eustis Mine, to which reference is made under the heading Pyrites.

ONTARIO.

The copper produced in Ontario is all derived from the Sudbury deposit, the ore of which is, however, primarily treated for nickel.

In 1897 mining operations have been carried on by the Canadian Copper Co., and the Trill Mining & Manufacturing Co.

These nickel-copper deposits have been studied and described, and a summary of these descriptions appeared in the Report of this Section for 1890 and 1891.

Another copper property is being developed in the township of Gould on the Mississaga River. A shaft 100 feet deep has been sunk with drifts at the bottom. The ore is said to carry 8 per cent in copper, running much higher in places.*

BRITISH COLUMBIA.

In British Columbia, the copper production came almost entirely from Rossland and the Hall Mines at Nelson. The first-mentioned locality, Trail Creek division, contributed, in 1897, 1,819,586 lbs. of copper. The ore of this camp is mainly a pyrrhotite which yielded an average of 1·32 per cent of copper, by smelter returns, the main value of the ore being derived from the gold and silver.

The contribution of the Nelson division to the production of copper in 1897 was 2,237,921 lbs., extracted from an ore consisting of chalcopyrite, bornite, and tetrahedrite, in a varied gangue with an average copper content of 4 per cent. In this case the main value is derived from the silver content of the ore.

Besides these two camps, in which are located the most extensively worked mines of the province, considerable prospecting work was done at various other places. The following notes concerning some of the new discoveries have been summarized from the Report of the Minister of Mines of British Columbia for 1897.

*Report on Bureau of Mines, 1897.

Several copper-bearing deposits, which are at present low grade, have been brought to light in the Boundary Creek district, and a good deal of prospecting was done at Kamloops, in East Kootenay and in Vancouver Island and adjacent islands. COPPER.

Mr. McConnell in the Summary Report of the Geological Survey for 1897 reports as follows :— Discovery and development.

"West of the main Salmon, near the head of a branch of Baratt Creek, is the Porto-Rico claim. It consists of a quartz vein averaging about two feet in width and traceable for 700 feet, carrying pyrites, pyrrhotite, chalcopyrite and mispickel. * * * It is situated west of the Nisconlith slates in the basic eruptive series.

"West of the summit between Salmon and Kootenay rivers, and close to the International boundary, is situated what is known as Copper Camp. A number of claims have been located here along the bands of dolomite included in the Selkirk series. The leads consist of quartz veins like the North Star, and more or less silicified bands in the dolomite, like those of the Hanna and B.C. claims. No large ore-bodies have so far been opened up, and very little development work was being done at the time of my visit. * * * The ore consists of gray copper (tennantite) and galena, distributed irregularly through the vein. The pay-ore, free from gangue, is stated to run $260 in copper, silver and gold.

"In the eastern part of the district numerous claims have been located on Goat, La France, Lockhart, Crawford and other creeks flowing into Kootenay Lake, but I had no opportunity to examine them."

Kamloops Division.—Prospecting for copper and some development have occurred in this division, at Coal Hill and vicinity.—The ore is a gabbro, in parts impregnated with chalcopyrite, iron-pyrites and magnetite; an occasional good body or shoot is encountered.—The development work done so far has not proved the ore to be high enough in gold and silver to justify extensive exploitation. —More extended work may probably, however, bring to light, ore of better value.

East Kootenay.—St. Mary River.—Several finds of copper ores are reported by men employed as prospectors by Captain Petty, on Pyramid Creek.—Some of these are being opened up.—Among the claims are :—*Kerrin.*—Altitude 6550 feet.—On a vein of milky-white quartz, 2 to 4 feet wide, changing to resin-coloured quartz, with calcite and a small amount of copper-pyrites.—*Comstock.*—Altitude 6600 feet.—The same vein enters this property. Very little was show-

COPPER.

Discovery and development.

ing at the surface, but a pit was sunk on a small decomposed vein which at 15 feet had widened to 15 and 20 inches of galena, chalcopyrite and pyrrhotite. At 27 feet, the vein, after narrowing to nothing, has widened to 5 feet.—*Bayley.*—Altitude 5900 feet.—Lower down the bluff, to the west of the Comstock, is another vein of reddish brown quartz carrying a little copper-pyrites.—*Walsingham.*—Altitude 5,950 feet.—Lying east of the Bayley is a small vein of calcite 18 to 30 inches wide, in which some copper-pyrites was found near the surface but none below the small test shaft 15 feet deep.—On the opposite bluff, prospecting was being done on several claims, on which the veins, though as yet small in size, carried copper sulphides and in one case beautiful samples of metallic copper in quartz, but the amount was very limited.—Among these claims are the *Albert*, *Milton* and *Stella.*

Texada Island.—This is situated in the Strait of Georgia and is about 30 miles long, with an extreme width of five and a half miles.—The following copper deposits are specially noted here:—*Copper Queen* or *Van-Anda Mine.*—This ore-body consists of bornite and some chalcopyrite, with gold and silver, in a felspathic, calcareous and garnetiferous gangue. There has been developed so far, on this property, an ore-shoot 80 to 100 feet long, and one to seven feet thick.—Several hundred tons were shipped in 1897.—*Raven.*—On this property, a shaft sunk 98 feet, and a drift, have revealed five feet of chalcopyrite mixed through the greenish altered eruptive rock lying next to crystalline limestone.

Vancouver Island.—During the past year a large amount of prospecting has been in progress, at different points of the Island more especially on the west coast. Here the mountains contiguous to Barclay and Clayoquot Sounds and Sidney Inlet have been attracting much attention because of the discovery of copper-bearing ores, upon some of which work is now in progress.—The ores are both massive deposits of, and rocks heavily impregnated with, chalcopyrite and iron-pyrites carrying low values in silver and gold. These have not yet passed the developing stage.—No shipments have been reported.

GRAPHITE.

GRAPHITE.

Production.

The history of the graphite mining industry of Canada is well illustrated by the figures given in Table 1 below. The total values of the different grades of product have varied much year by year, and up to 1896, it will be noted that the total production for any given year never attained $10,000 in value. Great variation is evident also in the average value per ton. This has been owing to the varying quantity of the products of different years. Because of the confidential nature of the returns made to this office only the gross totals can be given, there being but few producers. Thus the values of all grades of product from the lowest to the highest have had to be lumped together, from material used for paint valued at $5 per ton to the highest grade of finished graphite.

A large increase is noticeable in the figures for 1897, as compared with 1896, amounting to nearly 215 per cent in the quantity and nearly 72 per cent in the value, the average value per ton being less than half that given for the previous year.

TABLE 1.

GRAPHITE.

ANNUAL PRODUCTION.

Calendar Year.	Tons.	Value.
1886	500	$4,000
1887	300	2,400
1888	150	1,200
1889	242	3,160
1890	175	5,200
1891	260	1,560
1892	167	3,763
1893	nil.	nil.
1894*	3	223
1895	220	6,150
1896	139	9,455
1897	436	16,240

* Exports.

GRAPHITE.

Tables 2 and 3, following, are self explanatory, but the data given are too imperfect to enable one to arrive at any close estimates of the home consumption of the finished but unmanufactured products, such as would be turned out by our own mines.

Exports.

TABLE 2.

GRAPHITE.

EXPORTS.

Calendar Year.	New Brunswick		Ontario.		Quebec.		Nova Scotia.	
	Cwt.	Value.	Cwt.	Value.	Cwt.	Value.	Cwt.	Value.
		$		$		$		$
1886	8,142	3,586	....	....	....	....	....	....
1887	6,294	3,017	....	....	....	....	....	....
1888	2,700	1,080	....	....	....	....	....	....
1889	660	422	22	116	....	....	....	....
1890	400	160	329	1,369	....	....	....	....
1891	464	72	....	....	....	....	....	....
1892	1,224	449	5	60	4,590	3,443	....	....
1893	....	....	12	38	....	....	....	....
1894	....	....	69	223	....	....	....	....
1895	1	8	1,087	4,825	....	....	....	....
1896	270	106	2,285	7,418	....	351	160	1,605
1897 { Crude.	....	....	850	1,286	....	....	3,240	1,702
1897 { Manufactu'd	....	....	....	....	....	1,332	....	5
	....	....	850	1,286	....	1,332	3,240	1,707

TABLE 3.

GRAPHITE.

IMPORTS OF RAW AND MANUFACTURED PLUMBAGO.

GRAPHITE. Imports.

Fiscal Year.	Plumbago.	Manufactures of plumbago.	
		Black-lead.	Other Manufactures.
1880	$1,677	$18,055	$2,738
1881	2,479	26,544	1,202
1882	1,028	25,132	2,181
1883	3,147	21,151	2,141
1884	2,891	24,002	2,152
1885	3,729	24,487	2,805
1886	5,522	23,211	1,408
1887	4,020	25,766	2,830
1888	3,802	7,824	22,604
1889	3,546	11,852	21,789
1890	3,441	10,276	26,605
1891	7,217	8,292	26,201
1892	2,988	13,560	23,085
1893	3,293	16,595	23,051
1894	2,177	17,614	16,686
1895	2,586	13,922	21,988
1896	2,865	18,434	19,497
1897 Plumbago, crude	$1,406	....	....
1897 Black-lead	....	$17,863	....
1897 Plumbago, crucibles	....	....	$ 5,906
1897 Plumbago, manufactures of, N.E.S.	....	....	14,768
Total, 1897	$1,406	$17,863	$20,674

New Brunswick, Quebec and Ontario were the three contributors to the total production for the Dominion. The production in New Brunswick was of low-grade material used in the manufacture of mineral pigments. In Quebec two mines and works were operated in the Buckingham district in Labelle county. These were the North American Graphite Company and the Buckingham Company.

The mines of these two concerns are situated close together near Donaldson Lake in Buckingham township. They are both provided with mills for extracting the graphite from the rock in which it occurs, and produce a number of different grades of finished graphite for foundry facings, paint stock and the manufacture of crucibles, lubricants, etc.

In Ontario, the only operator making any return was the Ontario Graphite Co. with mine in Brougham township, Renfrew county, and works at Ottawa.

GRAPHITE. Mr. A. A. Cole, B.A.Sc., made a preliminary study of the occurrence of the graphitic deposits in Quebec. His results are given in the subjoined short report by him. To arrive at any final conclusion would require, however, a much more complete study than the time at his disposal would allow, especially in view of the obstacles to complete investigation presented by the cover of bush and soil.

During the autumn of 1897 the graphite properties of three companies were visited, situated in Buckingham township, Labelle county, Quebec. These were the North American Graphite Company, the Buckingham Company, and the Walker Mining Company. At each point surveys were made connecting the principal graphite pits, and where possible the general geological relations were investigated.

North American Graphite Company.—This company's works are situated near the north-east corner of lot 28, range VI. of Buckingham, eight miles from the Canadian Pacific Railway station at Buckingham village. This is the nearest point of shipment. The mill is the principal building of the group and with it are connected the dryer and engine houses. The other buildings are storehouses, repair shops, boarding house, etc. Water to supply the boilers, etc., is obtained from a small pond to the west of the mill. The works are lighted throughout by electricity. The ore passes successively through the crusher and stamps and then to the buddles, where most of the foreign matter is separated from the graphite. This impure graphite is then dried, ground and final separation is made by means of bolts, fans and air chambers in which the different grades of graphite settle by gravity.

Pit No. 1.—This pit is close to the mill with which it is connected by a tramway. It is an open-cut for about 100 feet, and is then continued into the hill as a drift for 30 feet. At the southern end of this drift a small shaft was sunk on the deposit, but this could not be seen when visited as the pit was full of water. The walls of the pit are of rock composed for the most part of bluish-gray quartz containing small particles of pyrite, which on decomposition produce a rusty appearance. This rock has in some places a well developed jointing, causing it to break into rectangular blocks. The ore taken from this excavation was what is known as "disseminated," but very little graphite could be seen as the pit was flooded when visited. The pit runs in the direction N. 10° E.*

Pit No. 2.—Pit No. 2, is above No. 1 and a little to the west of it at the entrance, but it runs in the direction of N. 5° W. so that it passes over part of No. 1.

*The bearings given throughout this description are all magnetic.

It is an open cutting, 110 feet long, at the southern end of which two drifts have been run into the eastern face. The southern end and both of the drifts show considerable "disseminated" ore. The graphite is found in highly quartzose rock as in No. 1. The ore is richest in certain streaks which show no definite lines of demarcation from the surrounding rock, but gradually merge from rich to poor and then to barren. Still the richest of the ore sometimes passes suddenly into rock that is quite barren, so that it is beneficial to prepare all ores, for the mill, even the richest, by careful cobbing. On the western side of this pit some much contorted gneiss occurs, which does not appear on the eastern side. GRAPHITE.

Pit No. 3.—This is an exposure of "disseminated" ore which occurs about 200 yards to the south of No. 2. The ore has been followed continuously for about 60 feet and is contained in a band from two to three feet wide. The deposit has been uncovered, but very little other work has been done. The general run of the deposit is N. 35° E., with a steep dip to the south. Well banded gneiss appears to the west of this pit with a strike N. 40° E. dip 63° to the S.E. The band containing the graphite seems to lie on the top of this gneiss, and to follow its strike and dip.

Pits No. 4, 5 and 6.—About half a mile to the south of the mill and pits already described, other pits and workings (Nos. 4 to 8) are found. They are situated at the top of a steep rocky bluff rising to a height of several hundred feet a short distance from the north-east shore of Twin Lake. These pits were opened in prospecting for the outcrop of the ore-body. They are shallow openings, and very little ore seems to have been found.

Pit No. 7.—To the south of No. 6, on the brow of the hill, the "Big Pit" No. 7 has been run in as an open-cut towards the north. The ore found in this pit was "disseminated." The deposit was only a few inches wide at the surface, but it gradually increased in width, it is said, to 12 or 15 feet. At the mouth of the drift leading to the pit, a shaft was sunk 45 feet, in which ore was said to be found all the way down. At the north-west corner of this pit, the rocks are seen to form an anticlinal fold, the dip showing to the east and west on either side of the axis of the fold, which axis seems to have a dip of about 28° in a southerly direction. Owing to this structure the graphite band shows as a sort of cloak overlying a boss of massive quartzose rock similar to that found in pit No. 1. Gneiss containing mica and graphite and weathering rusty overlies the ore. The ore-band where exposed to the weather is very much decomposed. The general run of the opening is N. 10° E. with a dip of 45° toward the

GRAPHITE.

east, and this may be taken as representing the strike and dip of the deposit worked, as the opening followed the ore. A cross-cut has been carried a few feet into the eastern wall about 100 feet in from the mouth of the main opening. The ore is here mostly "disseminated," but some pure graphite also occurs. At the mouth of the pit a trap dyke was cut through. No connection, however, between this and the graphite deposit was observed. Two little pits about 25 yards to the west of No. 7 show crests of very sharp anticlinal folds. Here also the ore overlies the massive quartzose rock.

Pit No. 8.—To the east of No. 7 is a pit, opened on a cross vein of pure graphite, that runs in the direction S. 80° E., and is nearly vertical. The south wall is gneiss lying almost flat, while the north wall is composed of a massive quartzose rock, probably a granite. The vein was worked out pretty thoroughly as far as followed, and all the graphite that is now to be seen, as far down as the water, is a thin coating on the north wall. At both ends of the opening the contact could not be seen on account of the loose rock and rubbish. Apparently, therefore, the ore occurs in this instance either immediately at the contact of the massive rock with the gneiss, or within three feet of it.

Buckingham Company.—The mill of the Buckingham Company is situated on lot 26, range VI. of Buckingham, seven miles from the Canadian Pacific Railway station. At this mill the ore is first roasted, to drive off moisture and sulphur and to make the rock easier to crush. The subsequent process of treatment for the separation of the graphite is entirely a dry method. After roasting and crushing the ore passes through rolls and then to the bolts, etc., where the final separation is performed. The pits of this company are located on lots 26 and 27, range VI., Buckingham, and are numbered from nine to eighteen in the following description:—

Pit No. 9.—A small opening was made at the side of the road between the North American Graphite Company's and the Buckingham Company's mills. Two narrow streaks of graphite were found on the surface, but at a depth of 3 feet these met and then disappeared, so sinking was discontinued.

Pit No. 10.—To the south of No. 9 and about a quarter of a mile from the main road, a vein of pure graphite was found, which was said to be eighteen inches wide at the surface. A pit has been sunk on this vein, but at its present depth of 70 feet the graphite has separated into several seams only a few inches wide. The strike of the pit which has followed down on the vein is N. 85° W. with a dip of 75° to the south. The rock forming the north wall of this pit is a massive granite. To the north and east of the pit at the surface, the exposures that were found consisted of rusty-weathering gneiss. The relations between the granitic and gneissic rocks were not determined. The present walls of the pit show a thin coating of calcite in many places, and on the southern wall, near the present working face, a number of small apatite crystals are to be seen in the calcite. From an examination of the dump a light-coloured felspar appears to be the principal gangue rock. The pit is 54 feet long, from 5 to 20 feet broad, and its greatest depth is 70 feet. GRAPHITE.

Pit No. 11.—This is a small opening about 10 feet square and 8 feet deep. The ore is "disseminated" and the ore-zone varies from 2 to 18 inches in width, following roughly the strike of the surrounding rocks, viz., N. 25° E. with a dip of 60° S. E.

Pits Nos. 12-15.—These four pits from which some "disseminated" ore was taken several years ago, are situated close to the mill, but they have not been worked lately. Nos. 12, 14 and 15 were full of water, and the rocks at all were much decomposed, so that their structure could not be definitely determined.

Pit No. 16.—The pit in which the most work has been done lately is the "Big Pit" No. 16 on the side of the slope to the south-west of the mill. The opening is about 70 feet long, running in the direction of N. 50° E. The south-east side is composed of a granite, which at the surface is very coarse grained and contains a large amount of felspar. The ore-band was found to slope gently towards the east showing folds of which the axes run east-and-west. The pit was sunk through the deposit, which could thus be seen in section in the sides. On the eas face ore shows in section from 2 to 4 feet in thickness. It runs alon at the bottom of the pit, and then turns up almost perpendicularly fo about 12 feet, when it suddenly narrows to about an inch, twisting t the south into a horizontal attitude for several feet. It then graduall widens and reassumes a perpendicular position. A small graphite-bearing zone can be followed all along the north-west side of the opening where it is underlain by the granite and overlain by the rusty gneiss. A few feet to the east of the main opening a shaft has been sunk 35 feet, which shows a continuation of the graphite zone towards the mill. The ore is "disseminated" as in the main pit. The shaft is about 8 feet in diameter.

Pit No. 17.—To the south-west of No. 16 and at the brow of the southern slope of the same hill towards Donaldson Lake, pits Nos. 17 and 18 have been opened. No. 17 is about sixty feet long and varies

GRAPHITE. in depth from twenty to forty feet. The ore is "disseminated" and the ore-body varies in width from two to three feet, dipping steeply towards the west. The exposed surface of the ore is much decomposed and forms a loose ochrey sand. The gneiss to the west of the deposit has a strike of N. 25° E. dipping westerly at 70°.

Pit No. 18.—Pit No. 18 is an open cutting to the south-east of No. 17. It is about thirty feet square and from ten feet deep at its southern extremity increasing to thirty feet towards the north as it runs into the hill. The rusty-weathering gneiss is the principal rock to be seen at this opening, but both it and the ore-zone are so much decomposed that the strike and dip could not be determined with any degree of certainty.

Walker Mine. *Walker Mining Company.*—The works of the Walker Mining Company are situated on the southern half of lot 19, range VIII. of Buckingham, seven miles to the north-west of the Canadian Pacific Railway station at Buckingham. The mill is well located in the valley of a small stream, which gives a constant supply of water for boilers, buddles, etc. The method of working the ore is a wet process. After crushing and stamping, the ore passes to the buddles. The final separation is made dry, by bolts, etc.

Thirty-one pits or openings noted were numbered from the north-east towards the south-west.

Pit No 1.—In the northern half of lot 19, range VIII., a small deposit of pure graphite was found, eighteen inches square with two small veins leading from it. A shaft was sunk eight feet deep, at which depth the graphite gave out and the sinking was discontinued. An exposure of white crystalline limestone was found a few yards to the N. E. of this pit.

Pits Nos. 2 to 6.—These are small prospecting openings showing some rich "disseminated" ore in rusty-weathering gneiss.

Pit No. 7.—An opening five feet square and three feet deep, in which several small vens of pure graphite occur.

Pit No. 8.—This is the largest pit on the property. The pit lies to the west of the mill with which it is connected by a tramway 1100 feet long. A drift has been run into the side of a hill, in which the tramway has been laid for sixty feet. This leads into a large chamber from which most of the ore that has been treated at the mill was obtained. The chamber is about seventy-five feet long, from ten to twenty feet wide and from twenty to thirty feet high. The ore is a rich "disseminated" graphite and occurs in a gabbro for the most part. Small patches of pyrite are frequently found in this gabbro. On the north side of the pit a mass of crystalline limestone was found, associated with which was graphitic gneiss weathering rusty. All the rocks at this pit are much contorted. GRAPHITE.

Pit No. 9.—This is a shallow stripping one hundred and twenty feet long down the slope of a hill to the south of No. 8. The rock encountered was a rusty-weathering gneiss, rich enough in graphite to be worked as a "disseminated" ore. The opening was made on the apex of a small anticlinal fold, and ore was found on both sides of the stripping.

Pit No. 10.—To the north-west of No. 9 a small pit was opened several years ago from which some pure graphite was taken. No work has been done here recently, and the graphite could not be seen in place.

Pit No. 11.—The ore at this opening was pure graphite, and was found spread over the surface of a granite mass rising abruptly out of a swamp. Immediately to the north of this opening is a large mass of crystalline limestone, which can be followed almost continuously to the south shore of Devine Lake. The little rocky island in the middle of this lake is also limestone, apparently a continuation of the same band. This same limestone band was followed south between the groups 12 to 15 and 17 to 20. Beyond No. 20, there was an outcrop of limestone which was thickly studded with inclusions. One of these inclusions was particularly noted. It was three feet long and from one to two feet thick, and was similar in structure and appearance to the rusty gneiss so frequently found associated with the graphite. Around this inclusion was wrapped a thick coating of almost pure graphite.

Nos. 12 to 20.—Pits No. 12 to 15 inclusive are all small prospecting openings in rusty-weathering graphitic gneiss, while No. 16 to 20 are small openings on little veins of graphite with a little disseminated ore.

Pit No. 21.—At No. 21 the surface drift has been removed, uncovering several small graphite veins running in different directions through the rusty gneiss.

Pits Nos. 22 to 27.—Nos. 22 to 27 form a group of pits on which considerable work has been done. The depth of these pits ranges from five to twenty feet. The ore obtained was all pure vein-graphite.

Pits Nos. 28 to 31.—These four pits are also openings on pure graphite veins, and are very similar to those of the last-mentioned group. The

GRAPHITE. best showing of pure vein-graphite seen on the whole property was in pit No. 28. Here the vein varies in thickness from four to six inches of pure graphite of the columnar variety.

General Remarks.—The properties of the North American Graphite Company and the Buckingham Company were so covered by underbrush, that it was hard to work out the geological relations in much detail. At the Walker Mining Company's property, however, there are more clearings, and rock exposures are there more readily accessible. The country is hilly, but in few places is it greatly elevated. Small valleys alternate with hills often several hundred feet high. The general trend of the small hill ranges on this property is north-and-south. The zone in which the graphite is found has been traced across the property of this company from the north-east to the south-west, from Devine Lake to the north-east corner of lot 22, range VII. of Buckingham. It is bounded on the north-west and south-east by bands of limestone which were traced more or less continuously along its whole course. Beyond the limestone the usual gneiss and massive granite of the Laurentian are found, free from limestone for the most part.

Sillimanite gneiss is the prominent feature of the graphite-bearing rocks. This gneiss in places becomes thickly impregnated with flakes of graphite forming a graphitic gneiss, which can often be worked as a "disseminated" ore of graphite. This graphitic enrichment always occurs, so far as observed, where the gneiss comes in contact with massive igneous rocks, such as granites and gabbros. The graphite is not confined to the gneissic bands, but often extends into the adjacent rock, as in the case of the "Big Pit," No. 8, of the Walker Mining Company, where it is found most abundantly in a gabbro, though it is also found in this pit in the gneiss. In some places the gneiss is found lying flat, but generally it is much contorted, disclosing sharp, quickly alternating anticlinal and synclinal folds. The "disseminated" ore often contains small amounts of pyrite which on exposure to the atmosphere readily decompose, making the rock disintegrate and imparting to it a rusty appearance. This will explain, in part at least, why the graphite-bearing rock at the surface is almost always more decomposed than the surrounding rocks. This fact is made use of by prospectors who are always on the lookout for these much weathered bands. This decomposed ore when struck with a hammer or pick feels greasy, showing a steel-gray metallic streak of graphite, and cuts out like cheese, having lost its hardness and brittleness.

In the case of the veins of pure graphite, the associated rocks are the same as found with the "disseminated" ore, viz., rusty gneiss and such igneous rocks as granites and gabbros. These veins, in most of the instances observed, were in an almost perpendicular position. Sometimes the vein divides up into several smaller veins, and in this case it seems to be the granite that is cut into, and the rock included between the veins is a very pure bluish-gray transparent or translucent felspar. The pure vein-graphite sometimes has a flaky structure, but is generally fibrous or columnar, the fibres running across the vein at right angles to the walls. The graphite found in these veins is almost free from impurities. GRAPHITE.

A few small crystals of apatite were found at the pure graphite pit of the Buckingham Company (No. 10), and also at a similar pit of the Walker Mining Company. Otherwise, wherever apatite was found in more considerable quantity, the rocks were entirely different in character from those always found in association with the graphite deposits.

A trap dyke was noted at the entrance of Pit No. 7 of the North American Graphite Company, running east-and-west, and was again seen on the road to the east. A similar exposure was found in front of the mill of the Buckingham Company, possibly a continuation of the same. The only trap dyke found on the Walker Mining Company's property was on the southern shore of McLean Lake, on lot 19, range IX., Buckingham, but this was quite beyond the rocks in which the graphite deposits occur. As far as could be determined, therefore, these dykes do not appear to have any necessary connection with the graphite deposits.

GYPSUM.

GYPSUM.

The mining of gypsum in Canada during the year 1897, has been still confined to the provinces of New Brunswick, Nova Scotia and Ontario. According to the returns received from the various operators, there was produced last year, including the various products, viz., crude gypsum, calcined plaster, land plaster, plaster of Paris and terra alba, a total of 239,691 tons, valued at $244,531, as compared with 207,032 tons and $178,061 in 1896. The increases were 32,659 tons or 15·7 per cent, and $66,470 or 37·3 per cent respectively, the greater increase in the value being accounted for by the larger proportion of the more highly manufactured material, plaster of Paris, included in the 1897 total. Production.

The statistics of production for the past twelve years are given in Table 1, below, and a column has been added showing the average price per ton for each year. In considering these average prices,

GYPSUM.

however, it must be remembered that each year's total is made up of products of different values, so that the average price would vary not only with the market price of the material, but also according to the proportion of the differently valued products entering into the total.

Production.

TABLE 1.

GYPSUM.

ANNUAL PRODUCTION.

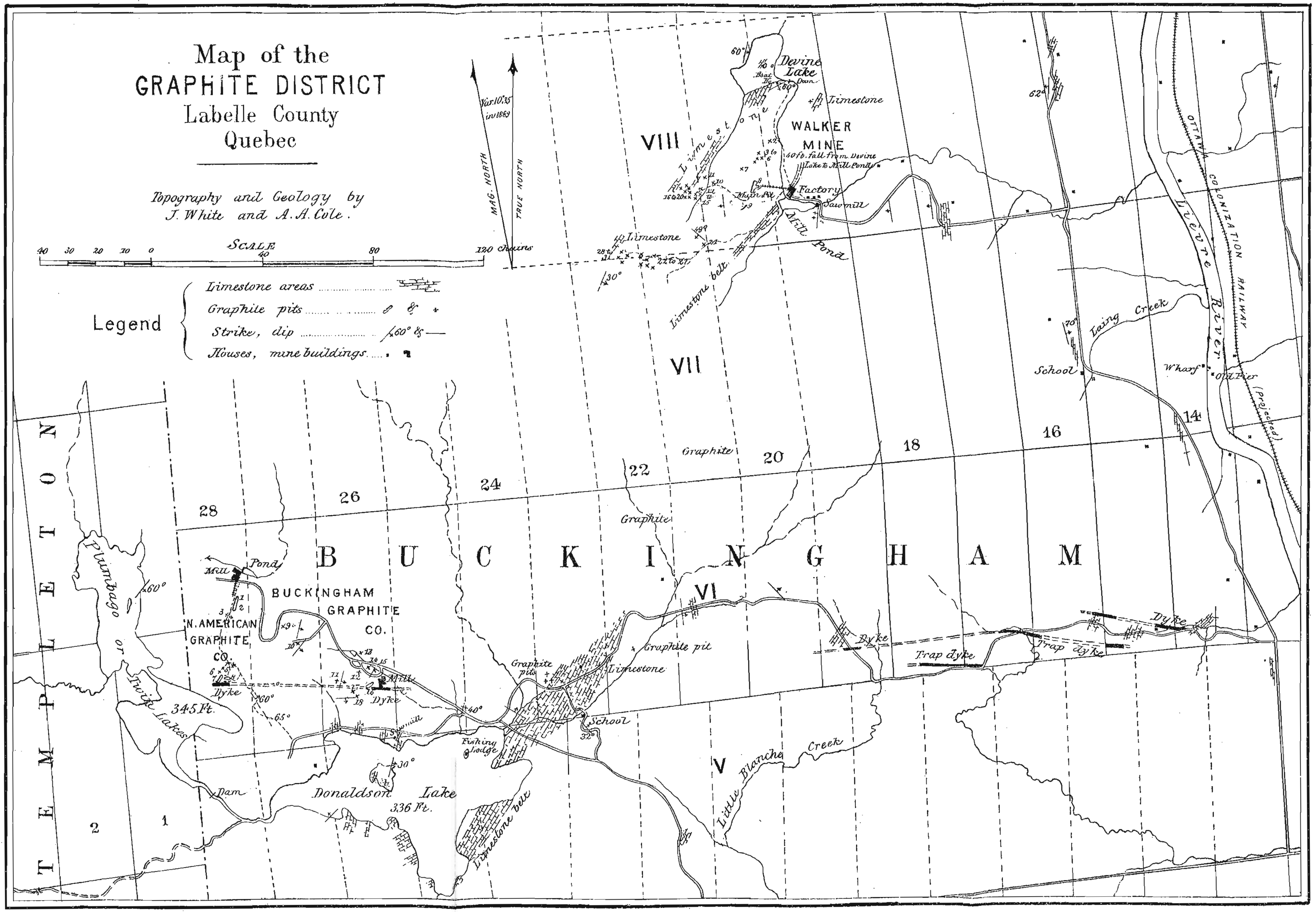
Calendar Year.	Tons.	Value.	Average price per ton.
1886	162,000	$178,742	$ 1.10
1887	154,008	157,277	1.02
1888	175,887	179,393	1.01
1889	213,273	205,108	0.96
1890	226,509	194,033	0.86
1891	203,605	206,251	1.01
1892	241,048	241,127	1.00
1893	192,568	196,150	1.02
1894	223,631	202,031	0.90
1895	226,178	202,608	0.89
1896	207,032	178,061	0.86
1897 Nova Scotia	155,572	121,754	0.78
1897 New Brunswick	82,658	118,116	1.43
1897 Ontario	1,461	4,661	3.19
Total, 1897	239,691	$244,531	$1.02

So far as the production of 1897 is concerned, somewhat more detailed information is available, and the output of the various products, together with the average price per ton of each, may be stated as follows :—

Product.	Tons.	Value.	Value per Ton.
Crude gypsum	228,416	$187,918	$0 82
Calcined and land-plaster	1,956	4,753	2 43
Plaster of Paris and terra alba	9,319	51,860	5 56
	239,691	$244,531	$1 02

In connection with the above production, a consideration of the labour-cost may be of interest, though, unfortunately, a statement of the actual amount paid in wages is not available. Few, if any, of the quarries are worked during the whole year and many of them for a few months only. If then the work of a man for a month be taken as a unit, the labour cost may be stated as about 5,748 units, which

GEOLOGICAL SURVEY OF CANADA
G. M. DAWSON, C.M.G., LL.D., F.R.S., DIRECTOR
1899



Autographed by C. O. Senécal

To accompany Part S, Vol. X

is equivalent to saying that the mining of the gypsum would require the labour of 497 men working continuously during the year. GYPSUM.

Table 2 is given as supplementing Table 1, and shows the annual production by provinces. Nova Scotia, it will be seen, has by far the largest output, although in point of value it is very closely approached in 1897 by New Brunswick. The production in Ontario is comparatively small.

TABLE 2.

GYPSUM.

ANNUAL PRODUCTION BY PROVINCES.

Production by provinces.

Calendar Year.	Nova Scotia.		New Brunswick.		Ontario.		Total.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.
		$		$		$		$
1886......	....	....	....	....	...	....	162,000	178,742
1887......	116,346	116,346	29,102	29,216	8.560	11,715	154,008	157,277
1888 .. .	124,818	120,429	44,369	48,764	6,700	10,200	175,887	179,393
1889.....	165,025	142,850	40,866	49,130	7,382	13,128	213,273	205,108
1890......	181,285	154,972	39,024	30,986	6,200	8,075	226,509	194,033
1891......	161,934	153,955	36,011	33,996	5,660	18,300	203,605	206,251
1892......	197,019	170,021	39,709	65,707	4,320	5,399	241,048	241,127
1893......	152,754	144,111	36,916	41,846	2,898	10,193	192,568	196,150
1894......	168,300	147,644	52,962	48,200	2,369	6,187	223,631	202,031
1895 ..	156,809	133,929	66,949	63,839	2,420	4,840	226,178	202,608
1896	136,590	111,251	67,137	59,024	3,305	7,786	207,032	178,061
1897......	155,572	121,754	82,658	118,116	1,461	4,661	239,691	244,531

The exports of crude and ground gypsum are given in Tables 3 and 4 respectively. Comparing with Table 2 it will be immediately evident that a large proportion of the product of Nova Scotia and New Brunswick is exported, the crude material being sent to the United States to be manufactured into plaster of Paris, etc.

Gypsum.

Exports.

TABLE 3.

GYPSUM.

EXPORTS OF CRUDE GYPSUM.

Calendar Year.	Nova Scotia.		New Brunswick.		Ontario.		Total.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.
1874	67,830	$ 68,164	....	....	......	....	67,830	$ 68,164
1875	86,065	86,193	5,420	$ 5,420	......	....	91,485	91,613
1876	87,720	87,590	4,925	6,616	120	$ 180	92,765	94,386
1877	106,950	93,867	5,030	5,030	......	....	111,980	98,897
1878	88,631	76,695	16,335	16,435	489	675	105,455	93,805
1879	95,623	71,353	8,791	8,791	579	720	104,993	80,864
1880	125,685	111,833	10,375	10,987	875	1,240	136,935	124,060
1881	110,303	100,284	10,310	15,025	657	1,040	121,270	116,349
1882	133,426	121,070	15,597	24,581	1,249	1,946	150,272	147,597
1883	145,448	132,834	20,242	35,557	462	837	166,152	169,228
1884	107,653	100,446	21,800	32,751	688	1,254	130,141	134,451
1885	81,887	77,898	15,140	27,730	525	787	97,552	106,415
1886	118,985	114,116	23,498	40,559	350	538	142,833	155,213
1887	112,557	106,910	19,942	39,295	225	337	132,724	146,542
1888	124,818	120,429	20	50	670	910	125,508	121,389
1889	146,204	142,850	31,495	50,862	483	692	178,182	194,404
1890	145,452	139,707	30,034	52,291	205	256	175,691	192,254
1891	143,770	140,438	27,536	41,350	5	7	171,311	181,795
1892	162,372	157,463	27,488	43,623	......	....	189,860	201,086
1893	132,131	122,556	30,061	36,706	......	....	162,192	159,262
1894	119,569	111,586	40,843	46,538	......	....	160,412	158,124
1895	133,369	125,651	56,117	67,593	......	....	189,486	193,244
1896	116,331	109,054	64,946	77,535	......	....	181,277	186,589
1897	122,984	116,665	66,222	80,485	......	....	189,206	197,150

TABLE 4.

GYPSUM.

EXPORTS OF GROUND GYPSUM.

Calendar Year.	Nova Scotia.	New Brunswick.	Ontario.	Total.
	$	$	$	$
1890	....	....	....	105
1891	....	....	....	588
1892	....	....	....	20,255
1893	....	....	....	22,132
1894	2,124	17,930	....	20,054
1895	3,364	18,827	42	22,233
1896	1,270	19,246	751	21,267
1897	1,655	5,024	84	6,763

The imports of gypsum and plaster of Paris into Canada have fallen away considerably during the last few years, and are very small compared with the production. The figures are given in Table 5, below :— GYPSUM.

TABLE 5.

GYPSUM.

IMPORTS OF GYPSUM, ETC. Imports.

Fiscal Year.	Crude Gypsum.		Ground Gypsum.		Plaster of Paris.	
	Tons.	Value.	Pounds.	Value.	Pounds.	Value.
1880......	1,854	$3,203	1,606,578	$ 5,948	667,676	$ 2,376
1881......	1,731	3,442	1,514,714	4,676	574,006	2,864
1882......	2,132	3,761	759,460	2,576	751,147	4,184
1883	1,384	3,001	1,017,905	2,579	1,448,650	7,867
1884......	....	3,416	687,432	1,936	782,920	5,226
1885......	1,353	2,354	461,400	1,177	689,521	4,809
1886	1,870	2,429	224,119	675	820,273	5,463
1887......	1,557	2,492	13,266	73	594,146	4,342
1888......	1,236	2,193	106,068	558	942,338	6,662
1889......	1,360	2,472	74,390	372	1,173,996	8,513
1890......	1,050	1,928	434,400	2,136	693,435	6,004
1891......	376	640	36,500	215	1,035,605	8,412
1892......	626	1,182	310,250	2,149	1,166,200	5,595
1893......	496	1,014	140,830	442	552,130	3,143
1894......	....	1,660	23,270	198	422,700	2,386
1895......	603	960	20,700	88	259,200	1,619
1896......	1,045	848	64,500	198	297,000	2,000
1897......	......	772	*45,000	123	†969,900	4,489

* 150 brls. † 3,233 brls.

Deposits of gypsum are numerous in Canada, but often too remote from means of communication to allow of being worked economically. When pure, gypsum is burnt for plaster of Paris, and when impure, its only use is as land-plaster. The market for this low grade is necessarily local, as the value of land-plaster cannot bear high freight charges.

NOVA SCOTIA.

The deposits of Nova Scotia occur in the Lower Carboniferous formation, in thick beds, often associated with limestones. The deposits often attain a thickness of sixty to one hundred feet, forming high cliffs. All the work is done by open quarrying; drifting needs not be resorted to. Gypsum is widely distributed throughout the province, but only the deposits which are most favourably situated for means of transportation are worked, the most important producers being in Hants county. Nova Scotia.

Gypsum.
Nova Scotia.

The main deposits of the province are :

Hants County.—Windsor and Cheverie.

Cumberland County.—Pugwash, Wallace Harbour, River Philip.

Cape Breton Island.—Gypsum deposits form high cliffs at several places on the shores of Bras d'Or Lake.

Victoria County.—Baddeck Bay, Port Bevis.

Other deposits have been noted in the counties of Pictou, Colchester and Antigonish.

Analyses.

ANALYSES OF GYPSUM ROCKS.

NOVA SCOTIA.

Locality.	Sulphuric Acid.	Lime.	Water.	Carbonic Acid.	
Baddeck Bay, Vic. Co. .	46·44	32·58	20·43	·47	(1)
Mabou	45·75	31·75	. . . .	Trace	(2)
Wentworth, Hants Co. .	46·28	32·72	20·38	·25	(3)
Windsor " . .	46·12	32·47	20·62		(3)
Newport " . .	46·25	32·38	20·20		(3)

(1) Prof. Chapman.
(2) Mr. F. T. Shutt, Experimental Farm, Ottawa.
(3) Nova Scotia Mines Report, 1892.

New Brunswick.

NEW BRUNSWICK.

The deposits of New Brunswick occur, like the Nova Scotia ones, in the Lower Carboniferous. They are practically confined to the southern part of the province.

The most important occurrence is at Hillsborough, in Albert county. This deposit was opened nearly forty years ago, and has been worked ever since more or less actively. Another deposit of excellent quality occurs at Fawcett Brook, Westmorland county, two and a half miles north-west of Petitcodiac station.

Gypsum deposits form cliffs on the shore of the Tobique River, Victoria county, some being one hundred and thirty feet high. These are the only ones in the northern part of the province. They consist of alternating bands of pale green and of reddish coloured materials with small beds of purer gypsum. This occurrence is greatly inferior to the Hillsborough deposit in purity, and is used for land-plaster. *

* Report of Progress Geol. Surv. Can., 1885, p. 30 G.

Other extensive beds have been noticed in Sussex, Upham, and Salisbury. All these, however, have proved less pure than the Hillsborough deposits. GYPSUM.

QUEBEC. Quebec.

No gypsum deposits are worked in this province. The only economic occurrences known are on the Magdalen Islands, in the Gulf of St. Lawrence. They are referred to in the report of the Geological Survey for 1880. They are well exposed along the sea-shore, and pure material could be obtained from them.

The main deposits have been observed at Amherst, Grindstone and Alright islands.

ONTARIO. Ontario

Gypsum occurs in S.W. Ontario on the Grand River, and in northern Ontario on Moose River*.

The deposits of S.W. Ontario occur in the Onondaga formation, and are found interstratified in many cases with argillaceous dolomites. Those on Grand River are the only ones which have been worked to any extent. They consist of seams, about five feet thick, which are usually more or less lenticular.

The greater part of the production is converted into plaster of Paris, a very appreciable quantity being used in the manufacture of the product known as "alabastine."

IRON.

IRON

The production of iron ore in Canada in 1897 was but 50,705 short tons, which, by a reference to Graphic Table A, below, will be seen to be the smallest recorded. The value of the above production at the mines was $130,290. Compared with the production of 1896, viz. 91,906 tons valued at $191,557, the decrease was 41,201 tons, or 44·83 per cent and in value $61,267 or 31·98 per cent. The average price per ton of the ore mined in 1896 was about $2.08, and in 1897, $2.57 the increase of the latter year over the former being 49 cents, or 23·5 per cent. Production

On referring to Graphic Table A it will be seen that a maximum output was reached in 1893, when 125,602 short tons of ore were produced; since that year there has been a steady decline. Previous to 1890 the average price per ton of the ore varied from $1.80 to $1.94 the subsequent variation has been from $2.03 in 1890 to $2.57 in 1897.

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* Report of Progress Geol. Surv. Can., 1875-76, pp. 321-322.

IRON.

Production of ore.

IRON.
ANNUAL PRODUCTION OF ORE.
Table A.

Calendar Year.	Tons.	Value.
1886	69,708	$126,982
1887	76,330	146,197
1888	78,587	152,068
1889	84,181	151,640
1890	76,511	155,380
1891	68,979	142,005
1892	103,248	263,866
1893	125,602	299,368
1894	109,991	226,611
1895	102,797	238,070
1896	91,906	191,557
1897	50,705	130,290

The production of ore by provinces is given in Table 1 from which it will be seen that Nova Scotia has supplied much the larger proportion, ranging from 50 to 80 per cent, of the whole, though in 1897 it dropped to 46·15 per cent. IRON.

TABLE 1.

IRON.

PRODUCTION OF ORE BY PROVINCES.

Production of ore.

Province.	1886.	1887.	1888.	1889.	1890.	1891.
	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
Nova Scotia	44,388	43,532	42,611	54,161	49,206	53,649
Quebec	....	13,404	10,710	14,533	22,305	14,380
Ontario	16,032	16,598	16,894	....	5,000	.....
British Columbia	3,941	2,796	8,372	15,487	....	950
Total	64,361	76,330	78,587	84,181	76,511	68,979

Province.	1892.	1893.	1894.	1895.	1896.	1897.
	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
Nova Scotia	78,258	102,201	89,379	83,792	58,810	23,400
Quebec	22,690	22,076	19,492	17,783	17,630	22,436
Ontario	....	....	....	....	15,270	2,770
British Columbia	2,300	1,325	1,120	1,222	196	2,099
Total	103,248	125,602	109,991	102,797	91,906	50,705

The relative proportion of the output of ore by the different provinces in each of the last four years is shown in the following table :—

Province.	1894.	1895.	1896.	1897.
	%	%	%	%
Nova Scotia	81·26	81·51	63·99	46·15
Quebec	17·72	17·30	19·18	44·25
Ontario	.....	.....	16·62	5·46
British Columbia	1·02	1·19	0·21	4·14
	100·00	100·00	100·00	100·00

IRON.

Table 2, below, shows the annual production of ore in Nova Scotia since 1876 :—

Production of Ore, Nova Scotia.

TABLE 2.

IRON.

NOVA SCOTIA :—ANNUAL PRODUCTION OF ORE.

Calendar Year.	Tons.
1876	15,274
1877	16,879
1878	36,600
1879	29,889
1880	51,193
1881	39,843
1882	42,135
1883	52,410
1884	54,885
1885	48,129
1886	44,388
1887	43,532
1888	42,611
1889	54,161
1890	49,206
1891	53,649
1892	78,258
1893	102,201
1894	89,379
1895	83,792
1896	58,810
1897	23,400

There has been a considerable falling away in the output during the last two years, the decrease of 1896 from 1895 having been 24,982 tons, or 29·8 per cent, while the production of 1897 is only 39·8 per cent of that of the previous year. This falling away is to be accounted for partly by the lesser number of furnaces in blast and partly also by the largely increased use of foreign ores by the Nova Scotia Steel Co. of New Glasgow in their furnace at Ferrona. The latter was the only furnace in blast during the year in the province. Of the total ore charged, 52·7 per cent was mined in the province, and the remainder, 47·3 per cent, imported. The furnaces of the Londonderry Iron Co. and the Pictou Charcoal Iron Co., Limited, were idle during the year; the furnace charcoal kilns, plant, etc., of the latter company having been leased to the Mineral Products Co. of New York, who purpose making ferro-manganese. Additional buildings, coal kilns, etc., have been erected and the furnace is expected to be in operation at an early date. Manganese is to be obtained at Hillsborough, N.B., from the bog-ore deposits existing there and having been compressed into briquettes will be shipped in that form to Bridgeville, N.S., for treatment. IRON.

TABLE 3.

IRON.

EXPORTS OF ORE.

Exports of Ore.

Province.	CALENDAR YEARS.							
	1894.		1895.		1896.		1897.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.
Ontario	23	$ 93	....	....	*1,033	$ 1,911	....	....
Quebec	....	13,813	....	....	....	....	151	$ 286
Nova Scotia	....	....	....	....	....	....		....
Manitoba	....	....	....	....	....	....		....
British Columbia	878	7,388	1,571	$ 3,909	....	....	252	525
Total	....	$21,294	1,571	$ 3,909	1,033	$1,911	403	$ 811

* Probably the product of the Province of Quebec, shipped via Ontario.

The production of pig iron in Canada in 1897 is shown in Table 4, in which are given the statistics of the pig iron industry for the past eleven years. It will be seen that a maximum production was reached in 1896, when the total output was 62,268 tons, valued at an average value per ton of $13.74. In 1897 the output had fallen to 58,007 tons, at an average value per ton of $12.73, the smallest value recorded: the decrease being in quantity 9,261 tons or 13·77 per cent, and 7·35 per cent in the average value per ton.

IRON.

Production of Pig Iron.

TABLE 4.
IRON.
PIG IRON PRODUCTION: CONSUMPTION OF ORE, FUEL, ETC.

Calendar Year.	Iron Ore Consumed.		Fuel Consumed. Charcoal.		Fuel Consumed. Coke.		Fuel Consumed. Coal.		Flux Consumed.		Pig Iron Made.		
	Tons.	Value.	Bushel.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.	Value per ton.
		$		$		$		$		$		$	$
1887	60,434	130,808	940,400	48,593	30,248	89,123	3,333	5,877	17,171	17,500	24,827	366,192	14.75
1888	54,956	102,343	804,286	41,800	28,031	82,986	2,197	4,709	16,857	16,533	21,799	313,235	14.37
1889	65,670	126,064	755,800	41,568	33,289	94,791	3,044	6,525	22,122	21,909	25,921	499,872	19.28
1890	57,304	117,880	589,860	29,493	32,832	97,659	1,241	2,638	18,478	18,361	21,772	331,688	15.23
1891	60,933	130,955	441,812	22,091	30,626	98,402	2,170	2,868	11,377	11,546	23,891	368,901	15.44
1892	96,948	250,966	1,121,365	78,291	50,882	152,311	1,740	1,797	22,967	21,687	42,443	637,421	15.02
1893	124,053	296,979	1,302,720	90,976	58,711	163,849	6,621	13,539	27,797	27,519	55,947	790,283	14.13
1894	108,871	223,861	1,173,970	53,958	52,373	142,303	7,653	14,571	35,101	34,347	49,967	646,447	12.94
1895	93,208	218,336	789,561	31,582	48,540	139,475	3,089	5,396	31,585	29,922	52,454	696,440	13.28
1896	(a) 96,560	200,887			(a) 48,660	106,939							
	(b) 46,300	100,205	756,600	32,256	(b) 33,990	109,253	1,407	2,288	37,462	36,140	67,268	924,129	13.74
1897	(a) 53,658	131,705			(a) 35,800	71,600							
	(b) 55,722	138,504	1,031,800	43,230	(b) 27,810	94,553	....	....	31,273	30,258	58,007	738,701	12.73

(a) Canadian; (b) Foreign.

Previous to 1896 Canadian pig iron was produced entirely from native raw materials. In that year, however, operations were begun by the Hamilton Blast Furnace Co., at Hamilton, which imported and used a considerable quantity of ore from the United States; the coke used in this furnace also had to be imported. In Nova Scotia, too, some Newfoundland and Spanish ores were used. The proportion of foreign ore of the total quantity used in making pig iron in Canada in 1896 was 32·5 per cent, this in 1897 had increased to 51 per cent. IRON.

TABLE 5.

IRON.

EXPORTS OF IRON AND STEEL GOODS, THE PRODUCT OF CANADA. Exports.

CALENDAR YEAR 1897.

Province.	Scrap Iron.	Iron Stoves.	Iron Castings.	Pig Iron.	* Iron, all other, and Hardware.	Steel and manufactures of.	Totals.
	$	$	$	$	$	$	$
Ontario	1,112	379	84,420	.....	105,573	25,680	217,164
Quebec	9,339	947	36,331	81,381	182,197	1,087	311,282
Nova Scotia	.....	2,540	4,627	3,238	18,201	13,587	42,193
New Brunswick	416	.....	....	.....	12,266	285	12,967
Prince Edward Island	...	20	....	.....	517	.....	537
Manitoba	.....	.....	....	.....	3,453	613	4,066
North-West Territories	311	.....	....	.....	55	48	414
British Columbia	1,629	4	2	.....	2,353	238	4,226
Total	12,807	3,890	125,380	84,619	324,615	41,538	592,849

* Machinery, N.E.S., sewing machines and hardware, N.E.S.

IRON.

The imports of iron in its cruder forms are shown in Tables 6, 7 and 8. These tables, as well as 9*a* and 9*b* following, are made up from the Trade and Navigation Reports and are for the fiscal year.

TABLE 6.

IRON.

Imports.

IMPORTS OF IRON, PIG, SCRAP, ETC.

Fiscal Year.	Pig Iron.		Charcoal Pig Iron.		Old and Scrap Iron.		Wrought Scrap and Scrap Steel.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.
		$		$		$		$
1880	23,159	(a) 371,956	....	....	928	14,042	....	....
1881	43,630	(a) 715,997	....	....	584	8,807	....	....
1882	56,594	811,221	6,837	211,791	1,327	20,406	....	....
1883	75,295	1,085,755	2,198	58,994	709	7,776	....	....
1884	49,291	653,708	2,893	66,602	3,136	44,223	....	....
1885	42,279	545,426	1,119	27,333	3,552	46,275	....	....
1886	42,463	528,483	3,185	60,086	10,151	158,100	....	....
1887	46,295	554,388	3,919	77,420	17,612	220,167	(b) 79	1,086
	Pig Iron, etc. (c)							
	Tons.	Value.						
		$						
1888	48,973	648,012	....	....	....	....	23,293	297,496
1889	72,115	864,752	....	....	....	....	26,794	335,090
1890	87,613	1,148,078	....	....	....	....	47,846	678,574
1891	81,317	1,085,929	....	....	....	....	43,967	652,842
1892	68,918	886,485	....	....	....	....	32,627	433,695
	Pig Iron.		Charcoal Pig Iron.		Cast Scrap Iron.			
	Tons.	Value.	Tons.	Value.	Tons.	Value.		
		$		$		$		
1893	56,849	682,209	5,944	84,358	729	9,317	45,459	574,809
1894	42,376	483,787	2,906	34,968	78	771	30,850	369,682
1895	(d) 31,637	341,259	2,780	31,171	643	4,347	23,390	244,388
1896	(d) 36,131	394,591	917	11,726	93	741	(e) 13,607	157,996
1897	(d) 25,766	291,788	2,936	35,373	238	1,362	7,903	93,541

(a) Comprises pig-iron of all kinds.
(b) From 13th May only.
(c) These figures appear in Customs reports under heading "Iron in pigs, iron kentledge and cast scrap-iron."
(d) Includes iron kentledge.
(e) Scrap-iron and scrap-steel, old, and fit only to be re-manufactured, being part of or recovered from any vessel wrecked in waters subject to the jurisdiction of Canada.

Wrought scrap-iron and scrap-steel, being waste or refuse fit only to be re-manufactured, the same having been in actual use, not to include cuttings or clippings which can be used as iron or steel without re-manufacture, and steel bloom ends and crop ends of steel rails.

Iron or steel, being pieces, punchings or clippings of boiler plate or other plates, sheets or bars of iron or steel, whether the same have had the ragged or cropped ends or edges sheared off or not, and crops from iron or steel rails having both ends sawn or sheared off, the same not having been in actual use and being fit for re-rolling or re-manufacturing only.

IRON.

Imports.

TABLE 7.

IRON.

IMPORTS OF FERRO-MANGANESE, ETC.

Fiscal Year.	Tons.	Value.
*1887	123	$ 1,435
*1888	1,883	29,812
*1889	5,868	72,108
*1890	696	18,895
*1891	2,707	40,711
*1892	1,311	23,930
*1893	529	15,858
*1894	284	9,885
†1895	164	5,408
†1896	652	12,811
†1897	426	9,233

* These amounts include :—ferro-manganese, ferro-silicon, spiegel, steel bloom ends, and crop ends of steel rails, for the manufacture of iron or steel.

† Ferro-silicon, spiegeleisen and ferro-manganese.

TABLE 8.

IRON.

IMPORTS : IRON IN SLABS, BLOOMS, LOOPS AND PUDDLED BARS, ETC.*

Fiscal Year.	Cwt.	Value.
1880	195,572	$244,601
1881	111 666	111,374
1882	203,888	222,056
1883	258,639	269,818
1884	252,310	264,045
1885	312.329	287,734
1886	273,316	248,461
1887	522,853	421,598
1888	110,279	93,377
1889	80,383	67,181
1890	15,041	45,923
1891	41,567	38,931
1892	64,397	56,186
1893	65,269	58,533
1894	50,891	45,018
1895	78,639	67,321
1896	128,535	110,757
1897	56,560	48,954

* Iron in slabs, blooms, billets, loops, puddled bars, or other forms less finished than iron in bars, and more advanced than pig iron, except castings.

IRON.

Tables 9*a* and 9*b* are intended to show the importations of partially manufactured and of more highly finished iron and steel goods respectively, though the distinction cannot be very definitely drawn.

TABLE 9*a*.

IRON.

Imports.

IMPORTS OF IRON AND STEEL GOODS.

Fiscal Year 1897.		Quantity.	Value.
			$
Swedish rolled iron rods, under ½ inch in diameter and not less than 1⅜c. per lb. value	Cwt.	483	1,048
Swedish rolled iron nail rods under half an inch in diameter, for manufacture of horse-shoe nails..	"	18,054	29,971
Switches, frogs, crossings and intersections for railways	"	1,202	3,770
Steel rails weighing not less than 45 lbs. per lineal yard, for use in railway tracks...	"	1,823,889	1,443,857
Iron or steel railway bars or rails of any form, punched or not punched, N.E.S., for railways, which term for the purposes of this item shall include all kinds of railways, street railways and tramways, even although the same are used for private purposes only, and even although they are not used or intended to be used in connection with the business of common carrying of goods or passengers	Tons.	4,095	82,354
Railway fish-plates and tie-plates	"	3,226	67,511
Rolled iron or steel angles, channels, and other sections, weighing less than 35 lbs. per lineal yard, N.E.S....	Cwt.	54,968	60,960
Rolled iron or steel angles, channels, and special sections, weighing not less than 35 lbs. per lineal yard	"	140,740	156,671
Rolled iron or steel beams, joists, girders, column sections, trough sections, and other building or bridge structural sections, weighing not less than 25 lbs. per lineal yard, and rolled iron or steel bridge plate not less than ⅜ of an inch thick or less than 15 inches wide, and flat eye bar blanksnot punched or drilled............	"	102,457	120,508
Iron or steel beams, sheets, plates, angles and knees for iron, steel or composite ships or vessels	"	31,654	42,542
Locomotive and car-wheel tires of steel in the rough	"	9,518	30,212
Bar iron, rolled or hammered; comprising rounds, squares, shapes of rolled iron not more than four inches in diameter, and flats not thinner than No. 16 gauge, whether in coils, bundles, rods or bars, N.E.S..........	"	74,375	139,212
Iron steel plates or sheets, sheared or unsheared, and skelp iron or steel, sheared or rolled in grooves, and iron or steel of all widths thicker than No. 17 gauge, N.E.S	"	42,364	69,360
Iron bridges and structural iron work	Lbs.	670,525	19,317
Carried forward		....	$ 2,267,293

IRON.

TABLE 9a *Con.*

IRON.

IMPORTS OF IRON AND STEEL GOODS.

Imports.

Fiscal Year, 1897.		Quantity.	Value.
			$
Brought forward			2,267,293
Hoop iron, not exceeding three-eighths of an inch in width, and being No. 25 gauge or thinner, used for the manufacture of tubular rivets	Cwt.	78	316
Iron or steel hoops, bands and strips, 8 inches and less in width, No. 18 gauge and thicker	"	15,250	23,816
Iron or steel sheets, or other iron or steel of all widths, sheet iron, common or black, smoothed polished, coated or galvanized, and Canada plates, No. 17 gauge and thinner, and hoop, band or strip, iron or steel, N.E.S	"	101,235	810,175
Plough plates, mould boards, land sides and other plates for agricultural implements, when cut to shape from rolled plates of steel, but not moulded, punched, polished or otherwise manufactured, and being of a greater value than 4 cts. a lb	"	7,387	37,134
Steel, valued at 2½ cts. per lb. and upwards, for manufacture of skates	"	1,485	5,264
Steel for saws and straw cutters, cut to shape but not further manufactured	"	10,117	59,884
Steel for the manufacture of hammers, augers and auger bits, when imported by the manufacturers of such articles, for use in their factories only	"	3,039	6,121
Steel of No. 24 and 17 gauge, in sheets 63 inches long and from 18 inches to 32 inches wide, for the manufacture of tubular bow sockets, when imported by the manufacturers of such articles, for use in their own factories only	"	7,334	9,380
Crucible sheet steel, 11 to 16 gauge, 2½ to 18 inches wide, imported by manufacturers of mower and reaper knives for manufacture of such knives in their own factories	"	7,315	26,246
Steel, rolled rods of, under ½ inch in diameter, or under ½ inch square, imported by knob or lock manufacturers or cutlers for use exclusively in such manufactures in their own factories	"	225	746
Steel of No. 20 gauge, and thinner, but not thinner than No. 30 gauge, to be used in the manufacture of corset steels, clock springs, and shoe shanks; and flat wire of steel of No. 16 gauge or thinner to be used in the manufacture of crinoline or corset wire and dress stays, when imported by the manufacturers of such articles for use in their factories	"	3,575	15,263
Steel of No. 12 gauge and thinner, but not thinner than No. 30 gauge, imported by manufacturers of buckle clasps and ice-creepers	"	469	1,823
Steel for the manufacture of files, when imported by file manufacturers for use in their factories	"	5,810	14,636
Steel, chrome steel	"	1,028	5,141
Carried forward			$ 3,283,238

IRON.

Imports.

TABLE 9a—*Con.*

IRON.

IMPORTS OF IRON AND STEEL GOODS.

Fiscal Year, 1897.		Quantity.	Value.
			$
Brought forward		....	3,283,238
Steel ingots, cogged ingots, blooms and slabs, or other forms less finished than steel bars, N.E.S.	Cwt.	37,537	42,588
Steel bars, rolled or hammered, comprising rounds and squares, shapes of rolled steel not more than 4 inches in diameter, and flats not thinner than No. 16 gauge, whether in coils, bundles, rods or bars, N.E.S.	"	179,574	320,704
Steel plate, universal mill or rolled edge, less than thirty inches wide, and plates or sheets of iron or steel thirty inches wide and over, and one-quarter of an inch and over in thickness	"	142,957	174,131
Malleable iron castings and iron or steel castings, N.E.S.	"	29,823	97,721
Iron sand or globules and dry putty for polishing glass or granite	"	376	1,624
Rolls of chilled iron or steel	"	513	1,846
Total		....	$ 3,921,852

IRON.

Imports.

TABLE 9b.
IRON.
IMPORTS OF IRON AND STEEL GOODS.

Fiscal Year, 1897.		Quantity.	Value.
			$
Wire, covered with cotton, linen, silk or other material	Lbs.	584,656	62,106
Wire, galvanized-iron, Nos. 6, 9, 12 and 14 gauge, when imported by makers of wire fencing, for use in their factories only	Cwt.	43,859	68,672
Steel wire, Bessemer soft drawn spring, of Nos. 10, 12 and 13 gauge, respectively, and homo steel spring wire of Nos. 11 and 12 gauge, respectively, when imported by manufacturers of wire mattresses, to be used in their own factories in the manufacture of such articles	"	1,853	5,049
Wire of all kinds, N.E.S.	"	84,274	133,762
Wire rope, of iron or steel, N.O.P.	"	8,185	39,313
Wire of iron or steel, No. 13 and 14 gauge, flattened and corrugated, used in connection with the wire grip and champion nailing machines for the manufacture of boots and shoes and leather belting	Lbs.	43,374	5,106
Wire rigging for ships and vessels	Cwt.	2,388	12,548
Wire fencing, barbed, of iron or steel	Lbs.	5,034,499	80,467
Wire fencing, buckthorn, and strip of iron or steel	"	33,090	868
Steel strip and flat steel wire when imported into Canada by manufacturers of buckthorns, plain strip or other fencing, and safety barb wire fencing for use in their own factories in the manufacture thereof	Cwt.	1,413	2,095
Wire, crucible cast steel	Lbs.	328,018	22,694
Bar and round rods, galvanized	Cwt.	55	247
Chains, iron or steel, $\frac{5}{16}$ of an inch in diameter and over	"	25,720	55,667
Chains, N.E.S	"	5,389	12,357
Forgings of iron and steel, of whatever shape or size, or in whatever stage of manufacture, N.E.S	Lbs.	762,473	35,572
Nails, spikes and sheathing nails, composition	"	54,862	4,377
Nails and spikes, wrought and pressed, galavnized or not, horse-shoe nails, and all wrought-iron or steel and other nails, N.E.S., and horse, mule and ox-shoes	"	509,528	18,634
Nails and spikes, cut, including railway spikes	"	468,478	9,537
Nails, wire	"	749,944	14,705
Tacks, shoe, ½ oz. to 4 oz. to the thousand	M.	36,444	744
Cut tacks, brads or sprigs, not exceeding 16 oz. to the thousand	"	53,052	2,545
Cut tacks, exceeding 16 oz. to the thousand	Lbs.	22,738	1,233
Wrought Iron or steel nuts and washers, iron or steel rivets, bolts with or without threads, nuts and bolt blanks, T and strap hinges and hinge blanks, N.E.S	"	903,628	33,771
Wrought iron or steel nuts and washers, iron or steel rivets, bolts with or without threads, nut and bolt blanks, less than three-eighths of an inch in diameter	"	277,159	13,717
Screws, iron and steel, commonly called "wood screws":—			
2 inches and over in length	"	21,713	2,411
1 inch and less than 2 inches	"	15,662	1,581
Less than 1 inch	"	12,819	2,396
Carried forward		....	$ 642,174

IRON.

Imports.

TABLE 9b— *Con.*

IRON.

IMPORTS OF IRON AND STEEL GOODS.

Fiscal Year, 1897.		Quantity.	Value.
			$
Brought forward		....	642,174
Tubing—			
Boiler tubes of wrought iron or steel, including corrugated tubes or flues for marine boilers	Feet.	1,534,490	92,605
Lap-welded iron or steel tubing, threaded and coupled or not, one and one-quarter to two inches inclusive in diameter, for use exclusively in artesian wells, petroleum pipe lines, and petroleum refineries	"	355,632	21,919
Tubes, not welded, not more than 1½ inches in diameter, of rolled steel	"	864,745	103,865
Tubing, wrought iron or steel, threaded and coupled or not, over 2 inches in diameter	"	1,970,829	169,066
Other wrought iron or steel tubes or pipes	Lbs.	6,548,488	135,323
Rolled iron tubes not welded, under 1½ inch in diameter, angle iron 9 and 10 gauge, not over 1½ inch wide, iron tubing lacquered or brass covered, not over 1½ inch diameter, all of which are to be cut to lengths for the manufacture of bedsteads, and to be used for no other purpose, when imported for the manufacturers of iron bedsteads, to be used for these purposes only, in their own factories	Cwt.	4,610	8,988
Cast-iron pipes of every description	"	28,382	34,103
Fittings of wrought iron or steel pipe	Lbs.	1,471,999	68,861
Tools and implements—			
Axes of all kinds, N.E.S	Doz.	7,753	33,021
Saws	$	....	77,363
Carpenters', coopers', cabinetmakers' and all other mechanics' tools, N.E.S	"	....	199,439
Files and rasps	"	....	52,688
Picks, mattocks, grub hoes, adzes, hatchets and eyes or poles for same	"	....	9,127
Tools of all descriptions, N.E.S	"	....	66,561
Track tools, wedges, crow-bars and sledges	"	....	5,213
Forks, table, cast iron, not handled, ground or otherwise manufactured	No.	103,482	862
Knife blades, or knife blanks, in the rough, for use by electro-platers	$	....	1,226
Manufactures, articles or wares not specially enumerated or provided for, composed wholly or in part of iron or steel, and whether partly or wholly manufactured	"	....	728,180
Pen knives, jack knives and pocket knives of all kinds	"	....	84,764
Table cutlery, N.E.S	"	....	58,862
All other cutlery, N.E.S	"	....	87,728
Muskets, rifles and other fire-arms	"	....	93,015
Needles, sewing machine, and all other, N.O.P.	"	....	34,376
Needles, knitting	"	....	1,922
Surgical and dental instruments	"	....	49,941
Hardware, viz.: Builders', cabinetmakers', upholsterers', harness makers' and saddlers', including curry combs, carriage hardware, &c.	"	....	289,435
Scales, balances and weighing beams	"	....	24,037
Carried forward		....	$ 3,174,664

TABLE 96—*Con.*
IRON.
IMPORTS OF IRON AND STEEL GOODS.

IRON.
Imports.

Fiscal Year, 1897.		Quantity.	Value.
			$
Brought forward			3,174,664
Skates, of all kinds	Pairs.	65,301	25,455
Stoves	$		67,724
Butts and hinges, N.E.S.	"		11,296
Cast iron vessels, plates, stove plates and irons, sad irons, hatters' irons, tailors' irons	"		9,836
Locks, of all kinds	"		59,563
Safes, and doors for safes and vaults	"		5,643
Ware—stamped tinware, japanned-ware, galvanized iron ware, including signs made from these materials	"		31,677
Ware, enamelled iron or steel ware, including signs and letters enamelled on any metal and granite or agate ware	"		53,606
Machines and machinery, &c.:			
Windmills	No.	369	16,148
Fanning mills	"	5	148
Portable machines:			
Horse-powers	"	53	4,424
Portable steam-engines	"	48	26,608
Portable saw mills and planing mills	"	13	1,811
Threshers and separators	"	113	28,913
All other portable machines	"	3,760	65,282
Parts of above articles	$		25,136
Sewing machines, or parts of	No.	3,982	103,644
Machines, type-writing	"	1,251	60,657
All other machinery composed wholly or in part of iron or steel, N.E.S.	$		1,336,517
Agricultural implements, N.E.S., viz.:			
Binding attachments	No.	48	5,212
Cultivators	"	2,850	19,820
Drills, grain seed	"	1,052	32,020
Forks, pronged	"	36,760	8,078
Harrows	"	4,232	30,272
Harvesters, self-binding and without binders	"	1,943	203,231
Hoes	"	7,004	1,267
Horse rakes	"	946	16,377
Knives, hay	"	7	45
Lawn mowers	"	1,225	3,064
Mowing machines	"	2,754	94,118
Ploughs, sulky and walking	"	4,550	75,680
Rakes, N.E.S.	"	11,038	1,942
Reapers	"	67	4,614
Scythes	Doz.	4,041	17,854
Spades and shovels, and spade and shovel blanks, and iron or steel cut to shape for the same	"	5,220	22,878
Steel bowls, for cream separators	$		35,435
All other agricultural tools or implements, N.E.S	"		39,636
Axles, springs and parts thereof, axle bars and axle blanks of iron or steel, N.E.S.	Lbs.	528,631	22,610
Axles, springs and parts thereof, axle bars and axle blanks of iron or steel, for railway or tramway vehicles	Cwt.	7,304	18,446
Carried forward			$ 5,761,351

IRON.

Imports.

TABLE 9b—*Con.*

IRON.

IMPORTS OF IRON AND STEEL GOODS.

Fiscal Year, 1897.		Quantity.	Value.
			$
Brought forward			5,761,351
Engines, locomotives and parts thereof, for railways	No.	18	118,463
Fire	$		250
Other, and boilers, N.E.S.	"		44,841
Fire extinguishers	"		5,963
Pumps, N.E.S	"		62,548
Pumps, steam	No.	184	24,860
Mining and smelting machinery which is, at the time of its importation, of a class or kind not manufactured in Canada	$		128,780
Anchors	Cwt.	2,491	8,557
Steel used in construction of arch bridge, O.C., July 8, 1896	Lbs.	3,193,720	66,095
Total			$ 6,221,708

TABLE 10.

IRON.

IMPORTS OF PIG IRON, IRON AND STEEL GOODS, ETC., FISCAL YEAR 1896-1897.

RECAPITULATION OF TABLES 6, 7, 8, 9a AND 9b.

——	Tons.	Value.
Pig iron and iron kentledge	25,766	$ 291,788
" charcoal	2,936	35,373
Scrap iron, cast	238	1,362
" steel, wrought	7,903	93,541
Ferro-manganese, etc	426	9,233
Iron in slabs, blooms, puddled bars, etc	2,828	48,954
Iron and steel goods, manufactured		3,921,852
" highly manufactured *		6,221,708
Total		$10,623,811

* Machinery, etc., classed under iron and steel goods, in Customs report.

The following analysis of the condition of the Iron and Steel industry of Canada for 1897 is quoted from the Bulletin of the American Iron and Steel Association for October 15th, 1898 :—

"On December 31st, 1897, the unsold stocks of pig iron in Canada which were in the hands of the manufacturers or their agents amounted to 20,265 tons, as compared with 29,320 tons on December 31st, 1896, and 17,800 tons on December 31st, 1895. Of the unsold iron on hand on December 31st, 1897, about one-third was charcoal pig iron, the remainder being coke iron. IRON

"On December 31st, 1897, there were eight completed blast furnaces in the Dominion, and of this number four were in blast and four were out of blast on the date named. On December 31st, 1896, there were also eight completed furnaces, but only two were in blast, six being idle. In the spring of 1898 the Deseronto Iron Company, Limited, began building a charcoal furnace at Deseronto, in the province of Ontario. This furnace, which will be 60x10 feet and which will produce malleable and car-wheel pig iron from American Lake Superior and local Canadian ores, is now practically completed, and the company expects to turn on the blast early in November. The annual capacity of the furnace will be about 12,000 gross tons. Since last spring the company has made several changes in its officers, who are now as follows: President, William Gerhauser; vice-president, F. A. Goodrich; secretary-treasurer, and manager, F. B. Gaylord. The company also has an office at Detroit, Michigan.

"The production of crude steel and of all kinds of iron and steel rolled into finished forms in Canada in 1897 is given approximately below, full reports or careful estimates having been received by us from all the manufacturers in the Dominion. The production of basic and acid open-hearth steel ingots in 1897 was 18,400 gross tons, against 16,000 tons in 1896 and 17,000 tons in 1895. Of the total production of open-hearth steel in 1897 a little less than three-fifths was made by tho acid process. The production of open-hearth steel rails in 1897 amounted to 500 tons, against 600 tons in 1896; structural shapes, 4,300 tons, against 4,540 tons in 1896; cut nails made by rolling mills and steel works, having cut-nail factories connected with their plants, 202,939 kegs of 100 pounds, against 196,971 kegs in 1896; plates and sheets about 2,000 tons, against 1,820 tons in 1896; all other rolled products, excluding muck and scrap bar, blooms, billets, sheet bars, etc., 61,161 tons against 59,290 tons in 1896. Changing the cut-nail production from kegs of 100 pounds to gross tons of 2,240 pounds, the total quantity of all kinds of iron and steel rolled into finished products in the Dominion in 1897, excluding muck and scrap bar, billets, etc., amounted to 77,021 tons, against 75,043 tons in 1896 and 66,402 tons in 1895.

"The total number of rolling mills and steel works in Canada on December 31st, 1897, was 17. Of this number at least three were idle during the whole of 1897."

IRON ORES OF NOVA SCOTIA.

IRON.

ANNOTATED TABLE OF ANALYSES.

Nova Scotia.

The following annotated table of analyses has been compiled with a view to give in a condensed form information regarding the iron ore deposits of Nova Scotia as gleaned from the available sources of information. These are designated in the text by capital letters in brackets so that any one desiring to consult the original reports for further information can do so. The letters adopted in the notes on pp 108 *et seq.* are as follows:—

(A.) Report of the Geological Survey. (Year in figures.)

(B.) Report of the Department of Mines of Nova Scotia. (Year in figures.)

(C.) Mines of Nova Scotia, by Ed. Gilpin, jr.

(D.) Trans. Canadian Society of Civil Engineers, 1891.
Iron Ores of Nova Scotia, by Ed. Gilpin.

The authorities for the analyses, when obtainable, have been designated, in the table, by italic letters as follows:—

(*a*) Geological Survey of Canada Laboratory.

(*b*) Steel Company of Canada.

(*c*) Dr. Howe.

(*d*) Dr. Hayes.

(*e*) G. F. Dowing.

(*f*) E. Gilpin.

(*g*) J. H. Huxley.

(*h*) Dr. Macadam.

(*i*) Dr. T. E. Thorpe.

(*k*) Dr. Noad.

(*m*) Nova Scotia Iron and Coal Company through whose courtsey it has been possible to include in the Tables a considerable number of analyses not before published.

NOTE.—In the following tables bracketed figures in the columns correspond to similarly bracketed items in the headings, and sub-headings in the columns show where items are included other than those in the column heading.

IRON.

Nova Scotia

TABLE of Analyses of

	Locality.	Ref. Analyst List.	Ore.	Metallic Iron.	Ferric Oxide, Fe_2O_3 (Ferrous Oxide, FeO).	Iron Carbonate $FeCO_3$.	(Manganese Mn) Manganese Oxide MnO.
	Annapolis County.						
1	North Mountain........	c	Magnetite	68·33	93·27	.....	....
2	"	c	"	65·03	90·22	.....	....
3	Torbrook...............	..	"	57·93	....	.....	....
4	"	..	"	59·11	....	.....	....
5	"	..	Hæmatite.........	59·86	....	.....	....
6	"	..	"	60.00	....	.....	....
7	Nictaux	a	Hæmatite and Mag	50·09	69·17	.....	....
8	Cleveland Ores..........	..	Magnetite	54·57	....	.....	....
9	Nictaux	..	Red Hæmatite.....	50·27	71·81	...	·28
10	Torbrook...............	..	"	52·44	74·63	.....	....
11	"	..	"	60·72	86·74	.....	....
12	"	..	"	59·00	84·29	.....	....
13	"	..	"	47·50	....	.....	3·02
14	"	..	"	55·74	....	.....	Trace.
	Antigonish County.						
15	Arisaig Pier............	..	Hæmatite.........	52·34	74·77	.....	Trace.
16	Polson Lake............	..	Limonite	48·00	....	.....	4·73
17	....	..	Bog Iron Ore	45·00	....	.....	....
18	Arisaig.................	m	Hæmatite..........	34·55	49·35	.....	(·93)
19	"	m	....	43·97	62·81	.....	(.02)
20	"	m	....	51·61	73·73	.....	....
21	" Doctor Brook...	m	....	46·62	66·60	.....	Trace.
22	" Ross Mine.....	m	....	32·81	46·87	.....	·50
	Cape Breton Island.						
23	Whycocomagh.........	c	Magnetite	46·16	63·74	.....	....
24	"	c	Hæmatite........	56·00	80·13	.....	....
25	"	k	"	57·20	80·00	.....	·40
26	"	k	"	60·00	85·70	.....	·20
27	"	k	"	36·67	52·40	.....	....
28	"	d	"	60·90	84·20	.....	....
29	"	c	"	48·25	....	.....	....
30	Big Pond..............	a	"	61·39	88·21	.....	....

Nova Scotia Iron Ores.

Titanic Acid TiO_2.	Phosphorus P (Phosphoric Acid P_2O_5).	Sulphur S (Sulphuric Acid H_2SO_4)	Lime CaO.	Magnesia MgO.	Carbonic Acid CO_2.	Alumina Al_2O_3.	Silica SiO_2 (Siliceous Matter).	Insoluble Matter.	Water.	
...	...	...	...	1·27	...	...	5·46	...	...	1
...	...	...	...	4·84	...	...	4·94	...	...	2
...	·16	·036	...	...	...	...	17·21	...	...	3
...	·17	·09	2·70	·41	...	5·53	14·97	...	...	4
...	None.	·11	2·16	...	...	3·14	5·93	...	...	5
...	·13 (·30)	Trace.	4·50	...	...	...	9·50	...	...	6
...	·79 (1·82)	0·05	...	...	...	...	...	18·94	...	7
...	·23	0·08	...	...	...	...	...	...	...	8
...	...	...	2·30	1·00	...	3·59	...	18·13	...	9
...	1·66 (3·80)	...	...	...	...	...	...	11·00	...	10
...	·17 (·399)	...	...	...	...	...	...	10·28	...	11
...	...	...	...	...	...	...	...	12·87	...	12
...	...	.23 (·57)	...	...	...	5·00	...	26·50	...	13
None.	·18 (·414)	·08 (·20)	...	...	...	...	...	10·12	...	14
...	.37	...	CaO & MgO 8·76		...	...	None.	...	...	15
...	Trace.	Trace.	...	...	...	...	(3·86)	...	11·12	16
Not unusually large % of Phos.				...	...	...	...	7·00	18·30	17
...	...	...	$CaCO_3$ 20·91	...	...	8·65	(19·40)	...	...	18
...	·50	...	4·20	...	...	4·89	(14·40)	...	...	19
...	·39	·19	3.50	...	...	7·73	(9·40)	...	...	20
...	·549	·493	3·10	Trace.	...	13·44	(11·60)	...	...	21
...	...	...	10·30	...	...	9·17	(22·00)	...	...	22
...	Trace.	·51	CaO & MgO 3·12		...	5·52	24·34	...	2·77	23
...	Trace.	·14	2·49		...	5·85	10 04	...	1·29	24
...	·44 (1·00)	...	...	2·75	...	...	14·80	...	...	25
...	1·55 (3·56)	...	...	2·40	...	...	6·00	...	2·00	26
...	·66 (1·50)	...	...	3·30	...	...	42·80	...	...	27
...	Trace.	·11	1·85	1·64	...	1·40	10·80	...	...	28
...	Trace.	Trace.	1·18	1·09	...	2·72	24·78	...	1·30	29
...	Trace.	Trace.	CaO & MgO 1·22		...	...	9·04	...	1·53	30

IRON.

Nova Scotia.

TABLE of Analyses of Nova

	Locality.	Ref. Analyst List.	Ore.	Metallic Iron.	Ferric Oxide, Fe_2O_3 (Ferrous Oxide, FeO).	Iron Carbonate $FeCO_3$.	(Manganese Mn) Manganese Oxide MnO.
	Cape Breton Island—Con.						
31	East Bay..............	*b*	Hæmatite.........	57·92	82·75	.....	·26
32	" (French Vale)..	*a*	"	59·53	85·04	......	....
33	Loch Lomond.	*a*	"	64·49	83·65 (7·64)	....	·29
34	Loran	*e*	"	63·09	....	......	....
35	George River............	*f*	"	62·50	....	... .	....
36	George River.......	*m*	....	49·18	70·26	......	(·58)
37	McLean Mine...........	*m*	....	49·06	70·08	.....	Trace.
38	St. Peter...........	*m*	....	47·88	68·40	......	Trace.
39	Robinson Cove...... ...	*m*	Magnetite	35·98	39·26 (10·93)	....	Trace.
40	Cheticamp..............	*m*	Hæmatite.	58·82	84·03	.....	·90
41	Whycocomagh.....	*m*	Magnetite	55·70	....	......	....
	Colchester County.						
42	Lower Economy	..	Magnetite	60·69	......	....	....
43	Five Islands	..	"	63·23	63·79 (23·88)	....	·08
44	Brookfield.............	..	Hæmatite.	44·18	....	......	....
45	West Mine, average of pile	..	"	36·01	51·44	.....	·871
46	Totten Hill ore	..	"	26·45	....	.....	1·81
47	Newton Mills..........	..	"	42·27	60·38	.	Trace.
48	Brookfield	..	Limonite...........	58·95	....	..	....
49	Kemptown.	..	"	53·04	....	.. ...	....
50	Brookfield	.	"	48·50	....	......	....
51	Ross Farm..	*a*	"	59·31	84·73 (trace)	....	·23
52	P. Tottens Lot.	..	"	48·91	69·86	.....	2·25
53	Martin's Brook...... ...	..	"	58·30	83·29	....	·41
54	"	*a*	"	57·85	82·65 (traces)	....	·25
55	West Mines	*b*	"	44·24	....	..	.. ....
56	Folly Mountains........	..	"	58·68	83·79	....	2·05
57	Cumberland Brook	..	"	57·25	81·78	.....	·21
58	" N. vein	*a*	"	58·27	82·13 (1·00)	....	·72
59	" S. vein.	*a*	"	55·77	79·68	.....	2·51
60	Cooks Brook	*a*	Specular ore.	67·85	96·93	......	Traces.
61	Londonderry...........	*a*	Ankerite (white)...	11·20	....	23·20	....
62	"	*a*	" (yellow)..	11·31	....	23·45	$MnCO_3$ ·80

Scotia Iron Ores—*Continued.*

Titanic Acid TiO_2.	Phosphorus P (Phosphoric Acid P_2O_5).	Sulphur S (Sulphuric Acid H_2SO_4)	Lime CaO.	Magnesia MgO,	Carbonic Acid CO_2.	Alumina Al_2O_3.	Silica SiO_2 (Siliceous Matter).	Insoluble Matter.	Water.	
......	·07	Trace.	1·20	·66	....	1·55	....	12·80	1·30	31
......	·014	·075	....	....	....	....	(5·13)	..	.....	32
......	·033	·078	....	....	.....	....	....	7·77	·34	33
......	(·11)	·10	....	4·20	.....	....	5·45	......	......	34
......	·09	Trace.	·67	·88	.....	....	7·82	.....	1·10	35
......	....	....	3·70	1·12	......	2·44	(22·00)	.....	......	36
......	....	....	....	....	......	10·72	(8·60)	......	......	37
....	....	....	....	....	......	11·60	(12·60)	....	......	38
.....	·51	1·82	$CaCO_3$ 21·34	....	......	7·15	(15·90)	.....	......	39
......	·24	....	5·20	....	......	·62	(3·30)	.....	1.20	4
......	Trace.	·68	....	....	......	....	(13·00)	.....	.....	
.....	·01 (·03)	......	....	....	......	....	....	12·90	...	2
.....	Trace.	Trace	·11	3.27	.....	......	....	8·83	....	43
.....	....	....	....	....	......	....	....	24·29	6·73	44
.....	·46 (1·05)	·05 (·12)	·18	·13	......	6·70	....	25·00	10·11	45
.....	Trace.	....	22 90	2·88	....	3·71	....	3·00	....	46
.....	·018	·164	·34	Trace.	....	6·64	27·97	.....	1·31	47
......	·023	....	....	....	..	....	....	...	......	48
......	·112	·022	....	....	.....	....	7·49	.....	......	49
.....	....	....	....	....	......	....	19·00	.....	11·01	50
....	·083 (·19)	·004	·14	·14	....	·23	....	2·67	11·40	51
...	None.	·015	11·70	·42	9·20	Traces.	·07	.....	7·07	52
......	·13 (·32)	·001	·39	·25	.....	Traces.	4·30	....	11·21	53
......	·17 (·38)	·008	·15	·10	......	·56	4·79	....	10·82	54
......	....	....	....	.....	......	.....	(15·35)	......	..	55
.....	Trace.	·04	·52	·62	......	1·16	·52	.....	11·25	56
......	·06 (·14)	Trace.	·52	·12	.....	·86	5·37	......	10·68	57
...	·37 (·86)	·016	·88	·25	......	·66	1·93	......	11·51	58
......	·19 (·44)	·004	·57	·34	......	·63	3·05	.....	12·43	59
......	·003 (·007)	None.	·04	·11	....	·32	....	1·26	·82	60
....	....	....	$CaCO_3$ 54·00	$MgCO_3$ 22·00	..	.....	(·50)	......	.....	61
......	·035	....	43·80	30·80	......	....	(·10)	......	....	62

IRON.

Nova Scotia.

TABLE of Analyses of Nova

	Locality.	Ref. Analyst List.	Ore.	Metallic Iron.	Ferric Oxide, Fe_2O_3; (Ferrous Oxide, FeO).	Iron Carbonate $FeCO_3$.	(Manganese Mn) Manganese Oxide MnO.
63	Londonderry	*a*	Ankerite (brown)	9·80	....	20·30	....
64	"	*a*	" "	9·46	....	19·59	....
65	Totten's Lot—E. Mines	..	Ank. and Spec.	39·08	54·18	......	Mn_3O_4 1·36
66	" "	..	" "	46·73	65·64	......	1·55
67	West Mines (14 samples)	..	Specular	59·10	....	......	....
	Cumberland County.						
68	Canfield Creek	..	Limonite	46·68	68·01	....	5·67
69	Parrsborough	..	Specular	35·25	50·35	......	....
	Digby County.						
70	Digby Neck	..	Magnetite	60·43	....	......	....
71	"	..	"	49·29	....	......	....
72	"	..	"	68·33	....	......	....
73	St. Marys Bay	..	Iron sand	....	....	......	..... {
	Guysborough County.						
74	Goshen	*c*	Limonite	45·69	....	......	·55
75	"	*c*	"	50·79	....	......	1·11
76	"	..	Ank. and Lim.	35·10	....	......	24·74
77	Guysborough	*m*	Specular	58·51	83·16	......	(.50)
78	"	*m*	"	47·35	67·64	......	(·64)
79	"	..	"	39·48	56·40	......	(·72)
80	Salmon River	*m*	....	45·11	{ 62·00 (·35) }	....	·03
	Hants County.						
81	Selma—Shubenacadie R.	..	Hæmatite	46·02	....	.....	......
82	Stewiacke River	..	"	42·27	60·38	.....	....
83	Cambridge	..	"	54·54	77·91	.....	....
84	Stewiacke	*m*	....	......	......	.....	Trace.
85	"	*m*	....	42·27	60·38	.....	Trace.
	Pictou County.						
86	Pictou River	..	Red Hæmatite	34·11	48·72	....	·15
87	East River	..	Brown Hæmatite	49·22	....	.....	....
88	" Webster vein	*a*	Hæmatite	54·36	75·67	......	·52
89	" "	*g*	"	43·40	65·26	....	Trace.
90	" "	*a*	"	36·61	52·30	...	·15
91	" Blanchard	*a*	"	42·50	60·71	.....	·18
92	" Fraser, saddler	*a*	Limonite	59·50	85·01	....	·38

Scotia Iron Ores—*Continued.*

Titanic Acid TiO_2.	Phosphorus P (Phosphoric Acid P_2O_5).	Sulphur S (Sulphuric Acid H_2SO_4).	Lime CaO.	Magnesia, MgO.	Carbonic Acid CO_2.	Alumina Al_2O_3.	Silica SiO_2 (Siliceous Matter).	Insoluble Matter.	Water.	
....	....	....	$CaCO_3$. 49·20	$MgCO_3$. 30·20	....	....	....	....	....	63
....	....	....	51.61	28·60	....	....	(·13)	....	....	64
....	....	....	12·76	2·10	....	....	....	5·48	18·04	65
....	....	....	5·05	·80	....	3·90	....	11·97	10·24	66
....	....	{·54 (1·26)}	....	....	....	....	....	3·50	5·20	67
....	....	....	2·50	....	....	....	....	5·40	16·30	68
....	....	....	....	....	....	....	....	35·80	....	69
Trace.	·036	·046	....	....	....	....	14·32	....	....	70
Trace.	·031	·021	....	....	....	....	26·87	....	....	71
....	....	....	....	1·27	....	....	5·46	....	....	72
Iserine 30 Ilm 56	....	....	....	....	....	....	(·14)	....	....	73
....	{·035 (·08)}	....	....	....	....	....	17·82	....	10·98	74
....	{·035 (·08)}	....	....	....	....	....	19·59	....	9·73	75
....	{·09 (·21)}	·08	·35	4·76	....	3·68	4·81	....	11·10	76
....	....	....	1·90	Trace.	....	10·94	(4·00)	....	....	77
....	....	....	·08	Trace.	....	·96	(30·50)	....	....	78
....	....	....	....	....	....	3·30	(20·40)	....	....	79
None.	·034	1·54	·49	·18	None.	1·05	29·93	....	2·73	80
....	·037	·02	....	....	....	....	(12·61)	....	....	81
....	·02	·16	·34	....	....	6·64	(27·97)	....	1·31	82
....	....	....	....	....	....	....	....	9·00	....	83
None.	0·01	·15	·49	·28	....	5·81	22·70	....	....	84
....	·018	·164	·34	Trace.	....	6·64	27·97	....	1·31	85
....	....	....	10·44	·78	....	5·90	....	23·96	8·52	86
....	....	....	....	....	....	....	....	16·54	5·63	87
Trace.	{·10 (·22)}	·29	1·37	·46	1·59	·45	19·43	....	....	88
....	....	....	1·88	1·05	....	5·59	25·68	....	....	89
....	{·08 (·19)}	·34	....	....	....	....	....	....	....	90
....	{·26 (·63)}	·09	....	....	....	....	29·97	....	1·98	91
....	Trace.	·02	·49	·19	....	·69	2·14	....	11·13	92

IRON.

Nova Scotia.

TABLE of Analyses of Nova

	Locality.	Ref. Analyst List.	Ore.	Metallic Iron.	Ferric Oxide, Fe_2O_3 (Ferrous Oxide, FeO).	Iron Carbonate $FeCO_3$.	(Manganese Mn) Manganese Oxide MnO.
93	East Riv., Fraser, saddler	..	Limonite	62·24	88·92	...	·78
94	" "	*i*	"	65·20	93·09	...	1·10
95	" "	..	"	59·17	84·54	...	·76
96	" Cullen's, Drug Brook	*a*	"	57·71	76·93 (4·97)	...	·06
97	" "	*i*	"	56·83	81·19	...	·20
98	" "	*f*	"	33·83	48·22	...	14·41
99	E. Riv., McDonald's Farm	..	"	51·63	...	...	...
100	E. Riv., McDonald's Farm (washed ore)	..	"	58·41	...	...	(1·88)
101	E. Riv., McDonald's Farm (clay washed from ore)	..	"	38·58	...	...	...
102	E. Riv., McDonald's Farm	..	"	52·92	...	...	(4·43)
103	East River, Grant Farm.	*m*	Hæmatite.	56·57	...	...	...
104	" Black Rock.	..	Limonite	41·70	...	...	(1·01)
105	" "	..	Washed ore	45·27	...	...	(1·08)
106	" "	*m*	...	...	64·19	...	1·97
107	" "	*m*	...	43·81	62·58	...	·31
108	" "	*m*	...	42·83	61·19	...	·21
109	" "	*m*	Washed ore	49·84	71·20	...	...
110	" "	*m*	Lump ore	43·59	62·27	...	(2·16)
							$MnCo_3$.
111	" "	*m*	Carbonate	35·34	...	73·15	3·65
112	Sutherland River	*a*	Spathic ore	43·56	16·98	65·61	7·98
113	"	*a*	"	42·07	20·52	57·40	8·29
114	"	*a*	"	42·80	...	88·48	1·85
115	"	*i*	"	42·76	...	88·59	2·85
116	"	*g*	"	39·64	...	82·11	4·70
117	E. Riv. { McDonald's or	*h*	Specular ore.	64·41	92·01	...	2·16
118	" { Weaver's	*a*	"	68·83	96·63	...	...
119	" Weaver	*m*	...	67·18	95·98	...	·14
120	" Watson	.	Specular ore	65·60	93·80	...	...
121	Coal Measures	*f*	Black Band	28·00	(36·00)	...	4·45
122	"	..	Clay Iron Stone	35·00	(45·36)	...	...
123	Merigonish	*f*	Bog Iron Ore	46·56	(66·51)	...	5·89
124	"	*m*	...	33·51	47·88	...	(2·37)
125	"	*m*	...	35·62	42·87	...	(2·31)
126	Grant Farm—Bridgeville	..	Hæmatite	48·72	...	...	(1·87)
127	" "	..	Brown Hæmatite	45·02	...	...	(1·56)

Scotia Iron Ores—*Continued.*

Titanic Acid TiO_2.	Phosphorus P (Phosphoric Acid P_2O_5).	Sulphur S (Sulphuric Acid H_2SO_4).	Lime CaO.	Magnesia, MgO.	Carbonic Acid CO_2.	Alumina Al_2O_3.	Silica SiO_2 (Siliceous Matter).	Insoluble Matter.	Water.	
...	·14 (·31)	·24	1·44	·82	...	·71	2·14	...	4·61	93
...	...	·002	·91	...	...	...	4·80	...	...	94
...	...	...	...	·43	...	·19	2·22	...	11·41	95
...	·43 (·99)	·04	·32	·05	...	1·02	5·84	...	9·46	96
...	·065 (·15)	traces	...	...	...	...	4·26	...	13·60	97
...	·02	·48	·015	Trace.	...	...	25·13	...	12·53	98
...	...	...	...	...	...	...	(9·38)	...	...	99
...	·016	...	...	...	...	...	(6·75)	...	11·02	100
...	...	...	...	...	...	...	(28·67)	...	...	101
...	·019	·069	...	...	...	...	(8·18)	...	10·50	102
...	·213	·096	...	...	...	...	(5·58)	...	10·90	103
...	·043	...	...	...	...	...	(24·48)	...	...	104
...	·045	...	...	...	...	...	(19·78)	...	11·10	105
...	·044	·019	None.	Trace.	...	4·51	17·36	...	10·77	106
...	·083 (·19)	...	·62	1·86	...	1·32	(19·90)	...	12·70	107
...	·08 (·19)	...	·42	1·33	...	1 71	(23·40)	...	11·55	108
...	...	...	...	...	...	4·60	(14·30)	...	...	109
...	...	...	·08	...	...	2·43	(18·30)	...	...	110
...	·015 (·036)	·13	1·17	3·87	3·15	·62	(12·75)	...	1·26	111
			$CaCO_3$	$MgCO_3$						
...	·013	None.	2·67	3·23	...	...	3·76	...	·76	112
...	Undet.	Undet.	4·02	5·66	...	...	2·38	...	1·43	113
...	...	...	2·34	5·82	...	...	1·51	...	...	114
		$CaSO_4$								
...	None.	·55	1·53	3·48	...	...	...	2·70	...	115
...	None.	·10	2·37	9·06	...	...	1·69	...	...	116
Trace.	·034 (·08)	·16	·71	·20	·79	·21	3·68	...	...	117
...	...	None.	·06	...	...	...	3·20	...	...	118
...	Trace.	2·61	·11	·18	...	·36	(·84)	...	...	119
...	Trace.	·68	...	...	...	...	3·40	...	...	120
...	·24 (·59)	·21	3·78	·78	27·59	3·18	16·55	...	...	121
...	Trace.	·61	Trace.	1·66	...	16·96	·78	...	2·13	122
...	·17 (·38)	·21	Trace.	Tra ce.	...	3·11	12·32	...	6·10	123
...	...	...	...	...	...	...	(3·60)	...	...	124
...	...	...	...	...	...	...	(5·70)	...	...	125
...	·081	(·36)	1·57	·57	...	·81	(12·80)	...	·11·60	126
...	·12	·03	...	...	...	...	...	12·80	9·45	127

IRON.
Nova Scotia.

TABLE of Analyses of Nova

	Locality.	Ref. Adalyst List.	Ore.	Metallic Iron.	Ferric Oxide, Fe_2O_3 (Ferrous Oxide, FeO).	Iron Carbonate $FeCO_3$.	(Manganese Mn) Manganese Oxide MnO.
128	Grant Farm—Bridgeville	..	Brown Hæmatite..	53·41	....	......	(1·88)
129	" " ..	..	" ...	54·83	....	....	(·20)
130	Bridgeville—East River.	m	Hæmatite.........	44·76	63·95	......	Trace.
131	" " ..	m	"	41·98	59·98	...	Trace.
132	" " ..	m	Limonite..........	50·14	71·63	......	·19
133	" " ..	m	"	51·41	73·30	......	·40
134	" " ..	m	"	49·16	70·23	.....	·18
135	" " ..	m	Washed ore......	46·30	66·14	.....	(1·94)
136	" " ..	m	....	47·01	67·14	......	(1·30)
137	" " ..	m	Specular ore....	55·64	79·48	......	·30
138	" " .	m	....	41·37	59·10	......	(5·47)
139	" " ..	m	....	42·08	....	.....	(2·38)
140	" " ..	m	....	34·80	....	.....	(2·72)
141	" " ..	m	....	43·98	63·00	.....	(3·16)
142	" " ..	m	....	47·90	68·43	....	(1·02)
143	" " ..	m	....	40·95	....	......	(3·91)
144	" " ..	m	....	43·10	61·57	....	(3·12)
145	" " ..	m	....	44·42	63·46	...	(3·55)
146	East River ore.........	m	....	34·49	49·27	....	(1·94)
147	"	m	....	29·70	42·43	...	(1·67)
148	Sunnybrae (Cameron)....	m	....	44·82	....	......	(2·74)
149	East River	m	Limonite.........	35·15	51·10	....	6·62
150	"	m	Brown ore.........	51·08	....	.....	(1·79)
151	"	m	"	48.64	....	....	(·98)
152	Lorne	m	"	42·60	....	.....	(·21)

Scotia Iron Ores—*Concluded.*

Titanic Acid TiO_2.	Phosphorus P (Phosphoric Acid P_2O_5).	Sulphur S (Sulphuric Acid H_2SO_4).	Lime CaO.	Magnesia MgO.	Carbonic Acid CO_2.	Alumina Al_2O_3.	Silica SiO_2 (Siliceous Matter).	Insoluble Matter.	Water.	
.....	·02	·04	.....	.....	.....	.....	.....	6·75	11·02	128
.....	·03	·41	.....	.....	.....	.....	.....	8·58	10·00	129
.....	·325 (·78)	.....	1·46	1·24	.....	9·70	(23·10)	.....	.....	130
.....	·348 (·86)	.....	1·20	·89	.....	9·45	(27·34)	.....	.....	131
.....	·048 (·11)	.....	1·47	.....	.....	·90	(13·90)	.....	11·55	132
.....	·047 (·11)	.....	·46	.....	.....	3·41	(8·83)	.....	11·80	133
.....	·048 (·11)	.....	·39	.....	.....	1·49	(14·25)	.....	12·40	134
.....	.....	.....	.....	.....	.....	5·06	(10·00)	.....	.....	135
.....	.....	.....	.....	.....	.....	6·36	(9·50)	.....	.....	136
.....	·23	.....	$CaCO_3$ ·40	.....	.....	6·09	(7·30)	.....	.....	137
.....	.....	.....	.....	.....	.....	7·70	(11·40)	.....	.....	138
.....	.....	$BaSO_4$ 8·50	.....	.....	.....	5·37	(11·93)	.....	9·88	139
.....	.....	10·88	.....	.....	.....	8·83	(15·95)	.....	8·52	140
.....	.....	6·64	.....	.....	.....	5·41	(9·53)	.....	11·10	141
.....	.....	8·41	.....	.....	.....	2·72	(8·34)	.....	10·30	142
.....	.....	8·68	.....	.....	.....	7·75	(8·71)	.....	9·85	143
.....	.....	7·83	.....	.....	.....	5·60	(10·11)	.....	9·86	144
.....	.....	6·30	.....	.....	.....	5·10	(9·43)	.....	10·33	145
.....	.....	Trace.	.....	.....	.....	6·73	(31·60)	.....	.....	146
.....	.....	Trace.	.....	.....	.....	5·80	(27·21)	.....	.....	147
.....	·031	Trace.	·41	·46	.....	2·95	(17·89)	.....	11·22	148
.....	·20 (·457)	·91	·88	.....	.....	18·11	(9·57)	.....	10·70	149
.....	.....	$BaSO_4$ 3·03	.....	.....	.....	1·41	(14·47)	.....	.....	150
.....	.....	7·58	.....	.....	.....	3·46	(7·55)	.....	.....	151
.....	·161	·082	1·20	.....	.....	.....	24·70	.....	.....	152

IRON.

Nova Scotia.

Annapolis County.

Cleveland Deposits.—Explored by Messrs. Stearns and Page in 1870, who found several beds of magnetite varying in width up to ten and twelve feet. (B. 1877.) Analysis No. 8.

North Mountain.—Vein of magnetite, from six to nine inches wide in trap rock.—Slightly worked in 1871. (A. 1873-74.) Analyses Nos. 1 and 2.

Clementsport.—Devonian formation.—Extensive deposit known as Potter Bed.—Low in phosphorus.—Metallic iron 48°/ₒ. (D.)

Torbrook Deposits.—Hæmatite.—One vein traced for 1350 feet, width six feet. Extensive development work and mining has been done. Main shaft was down 350 feet in 1895 with levels and cross-cuts. Considerable quantities of ore shipped to Londonderry. The mines were idle in 1897. (B. 1888-91-95-97.) Analyses 3 to 6, 10 to 14.

Nictaux River.—Devonian formation.—These beds are of fossiliferous hæmatite.—High in phophorus. Mined in the first part of this century.—Furnace erected some forty years ago to smelt these ores, subsequently abandoned. (A. 1873-74—C.) Analyses 7 and 9.

Clementsport Deposits.—Devonian formation.—Milner Beds. These are several beds of speculur ore, from two to four feet in width, containing 33°/ₒ metallic iron.—some mining has been done by open pits. (D.)

Antigonish County.

Arisaig.—Lower Silurian metamorphic rocks.—On St. Mary's River. Bed of red hæmatite three feet thick.

Ross Brook. Iron Brook. Ore beds opened and trial lots shipped to Ferrona in 1893. (B. 1894—C.)

South River Lake.—In back settlement of Arisaig, on Doctors Brook, bed of red hæmatite six feet thick, running in a north and-south direction. This bed is said to be overlain by another twelve feet thick.

McNeils Brook.—Two important outcrops of red hæmatite, one eight feet thick and the other fifteen feet.

Road between Doctors Brook and Pleasant Valley.—Two beds, six and 12 feet respectively associated with reddish and mottled fragmentary rocks and diorites.—(D.) (A. 1886.)

Arisaig Brook.—At mouth of brook, bed of red hæmatite, two feet thick thinning out to one foot. (A. 1886.) Analyses Nos. 15 and 18 to 21.

Polsons Lake.—Associated with beds of Limestone. Lenticular masses of spathic iron ore, in places decomposed to limonite. (D.) Analysis No. 16. IRON. Nova Scot.

Cape Breton Island.

Whycocomagh Deposits.—Laurentian formation.—Gneisses and Crystalline Limestones.

The ores of this district consist of a mixture of hæmatite and magnetite.—Several important deposits have been noticed, the beds varying from three to nine feet in width. The presence of deep water within a few hundred yards of the deposits would enable ships of large tonnage to load. The ore could also be transported by scows and barges to any place on Bras d'Or Lake. (D.) Analyses Nos. 23 to 29, 41.

French Vale.—At the crossing of French Vale and Bourinot roads, seventeen miles from Londonderry, important deposit of hæmatite, five to nine feet wide.—Has been tested by pits and trenches. (C.) Analysis No. 32.

Long Island.—Two beds of hæmatite of excellent quality, ten feet wide. Situated on side of hill and near deep water. (B. 1886.)

Big Pond Deposits.—On East Bay, Bras d'Or Lake, at contact of Lower Carboniferous and Laurentian, is a deposit of ochreous hæmatite of large extent. (C.) Analysis No. 30.

Loch Lomond.—Deposit favorably situated for mining and shipping. (B. 1881) Analysis No. 33.

Red Island.—Contact deposits of red hæmatite, in veins and pockets (D.)

George River.—In slates and sandstones.—Openings show two deposits from five to ten feet wide, continuous for several hundred feet. (D.) Analyses 35, 36.

East Bay, Smiths Brook.—A bed of hæmatite twelve feet thick has been exposed. (D.) Analysis No. 31.

East Bay, Gillies Lake.—Iron ore bed, varying from one to thirteen feet in thickness traced for two and half miles. (D.)

Boulardrie Island.—Beds of spathic iron ore occur associated with limestone and gypsum at Island Point, on the beach.—Metallic iron 32·58°/ₒ. (A. 1876-77.)

Indian Reserve and Peters Mt'n.—Devonian formation.—Veins of specular ore. Have not been systematically explored. Resemble the

IRON. Nova Scotia.

Guysborough ores. Metallic iron 50 to 60°/₀. At places very sulphurous. (D.)

Lake Ainsley, Mabou, Cheticamp, Hunters Mt., Craginish, Grand Anse.—Deposits of iron ores are known at these places but little attention has yet been paid to them. (D.)

Colchester County.

Newton Mills.—Upper Silurian slates.—Important deposit of red hematite. Opened by the New Glasgow Iron & Railway Co. The analysis given is from a working sample. Analysis No. 47.

Londonderry Deposits.—Running along the southern flank of the Cobequid Mountains, there is a band of strata, carrying for a dis-tance of many miles, a stratum vein composed of carbonates and oxides of iron, with carbonates of lime and magnesia. Its width varies up to two hundred feet, and ore-bodies of fifty feet have been found. There are also large quantities of spathic ores and ankerite.

These deposits have in places been worked on a large scale. The East mines and the West mines yield good ores and indications are that the vein will continue for many years to supply excellent ores. Analyses Nos. 50 to 67.

Old Barnes.—Vein of limonite six feet thick has been noticed.

Kemptown.—Easterly prolongation of the Londonderry vein. Important deposits of limonite, on which development work has been done. Analysis No. 49.

Cumberland County.

Pugwash Deposits.—Testing work has been done by Mr. Leckie on iron deposits at this place. (B. 1891.)

Springhill.—Occurrence of several veins of iron ore has been noticed here. (B. 1875.)

Canfield Creek.—Large bed of limonite, conveniently situated for shipping and mining.—Opened by Mr. R. G. Leckie. (D.) Analysis No. 68.

Digby County.

Digby.—Some prospecting has been done on small veins of magnetite in the vicinity of Digby.—Abandoned. (B. 1884.)

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Digby Neck.—Veins of magnetite and hæmatite. These are very irregular as to width and persistency. Attempts have been made at mining near Rossway, Digby, and Waterford. Analyses 70 to 72.

St. Marys Bay.—Titaniferous ores occur at St. Marys Bay, west of Digby, in irregular layers on the beach. (D.) Analysis No. 73.

Bloomfield.—At this place and vicinity there are beds of bog iron-ore yielding about 25°/$_0$ metallic iron.—Found a few inches below the surface, in layers from half an inch to two feet thick.—A furnace was erected at this place with charcoal as fuel. (D.)

Gugsborough County.

Goshen.—Bed of limonite.—Also a bed of ankerite, forty feet wide, in marine limestone rather phosphatic and manganiferous. Has been opened and an adit driven. (B. 1874, C.) Analyses 74 to 76.

Salmon River Lake, Erinville.—Deposit of specular iron ore.—Lead proved to be twenty-five to sixty feet wide to a considerable depth. —Has been worked by the Crane Iron Co., of Philadelphia.—Shaft sunk fifty feet, drifted at bottom twenty-five feet to wall; other tunnels driven in sixty feet north-east and thirty-five feet south-east. (A. 1886, B. 1882, D.)

Guysborough River.—East of Mink River is another deposit of specular iron ore. (A. 1886.)

Boylston.—East of Milford Haven.—Series of veins of specular iron-ore.—Width four to four and a half feet.—A few tons have been mined and sent to Londondery.—Cost of transportation proved too great. (D.)

Hants County.

Shubenacadie River.—Carboniferous.—Dark laminated limestone.—Small veins consisting of limonite and specular iron-ore, with ankerite, geöthite, etc., (D.)

Selma.—A compact red hæmatite occurs at this place.—A partial test was made by the New Glasgow Coal, Iron and Railway Co., showed eight feet of ore.—Further work may show an important deposit. (D.) Analysis No. 81.

Pictou County.

Geologically the iron district of Pictou county may be said to be made up of Carboniferous resting on Silurian and Cambro-Silurian.

IRON.

Nova Scotia.

—It may be roughly described as a triangle formed by the ore outcrops and the Intercolonial and Cape Breton Railways, the former marking the base and the latter the sides of the triangle, having its apex in the coal-fields at New Glasgow.

In the East River valley the limonite ores rest on Silurian clay-slates and have limestone as hanging wall. They are compact, concretionary and fibrous. They are very pure and free from phosphorus.

Webster Ore.—Compact ore, non-fossiliferous, brick-red in colour. —Thickness fifteen to thirty feet.—Extends three miles. Bed admits of adit drainage to depth of 300 feet. (B. 1874 C, D.) Analyses 88 to 90.

Blanchard Ore.—Has not been traced beyond its natural exposure. —Width varies from thirty to one hundred feet and it is situated on elevated ground.—Large quantities of ore could be obtained, but it is fossiliferous and phosphatic. (A. 1873-74, C.) Analysis 91.

Another range of red hæmatite is found 700 feet higher consisting of several beds of three to eight feet in thickness.—This may be a continuation of the preceding one.

Bridgeville.—Several deposits of brown hæmatite occur here, width ranging from ten to twenty-five feet. Some of the deposits were worked in 1893 by the Glasgow Iron and Coal Co.—In 1897 they were worked very extensively by the Pictou Charcoal and Iron Mining Co. (B. 1887-93-97, A. 1891.) Analyses 126 to 145.

Sutherland River, Wendworth Grant.—A bluff outcrop of hæmatite forty feet wide, running in a north-and-south direction. (D.)

Springville and Sunnybrae.—Limonite deposits.—Some development work was done on them in 1888, when about 3,000 tons were extracted.—(B. 1888.)

At Sunnybrae and for a distance of eight miles down the river, there are numerous exposures of ore occurring in black and gray slates and quartzites. Several have been opened by the New Glasgow Iron and Coal Co.—In places the ore bodies are twenty feet wide.

Springville and vicinity.—At contact of Carboniferous and Silurian in slates.—Limonite.—On the property of D. Fraser, a shaft was sunk forty-two feet, revealing a vein over 22 feet thick. On another vein nearer Springville a pit showed a width of 23 feet. (A. 1873,74, D.)

Watson or Fall Brook.—A bed of red hæmatite, about two miles distant from the Pictou coal-field.—Ore contains 44·5 °/。 Fe. and small amounts of sulphur and phosphorus.—(B. 1881.) This deposit has been opened by trial pits at Fall Brook. Found to be fifteen feet thick, retaining that width for about one mile. (D.) Analysis No. 120. IRON. Nova Scotia.

Cullen's Deposits.—Band of quartzite with numerous limonite veins. These are small, the largest being about one foot in width. (A. 1873.) Analyses 96 to 98.

Fraser (Saddler) Deposits.—Ore exposed on a small brook, showing a thickness of eight feet of fine compact botroydal limonite.—Close to this is another vein found in 1872, fifteen feet thick.—This deposit was worked in 1894. (B. 1894, C.) Analyses 92 to 95.

Black Rock.—Openings on ore-beds have been made on the Shubenacadie River. Rather poor material. Developed and slightly worked in 1894. (A. 1873-74. B. 1894.) Analyses 104 to 111.

McDonald's Deposits.—Specular iron ore. Thickness of the deposit five to twenty feet. Small shafts have been sunk and cross-cuts driven. (A. 1892.) According to Sir William Dawson, the specular ores of the East River valley occur as lodes. (A. 1873-74.) Analyses 117 to 119.

Battery Hill.—Veins of specular iron ore prospected by Mr. J. M. McKay. The thickest is seven feet wide. (A. 1891.)

Sunnybrae.—Bed of specular ore, twenty feet wide, below Sunnybrae. Opened in 1887 by Mr. Holmes.

Glengarry Station.—In the district lying west of Glengarry station there are numerous exposures of ankerite up to three feet thick, occurring in black and gray slates and quartzites. (D.)

Sutherland River Deposits.—In red marls associated with limestone and gypsum, important deposits of siderite. Thickness ten to twenty feet. Free from fossils. (D). Held by the Pictou Coal and Iron Co. Analyses 112 to 116.

McLellan Brook, French River.—Spathic iron ores are met with in this locality. They have not been thoroughly examined. A sample from French River from a vein four feet wide gave 35 per cent Fe. (D.)

LEAD.

LEAD.

Production.

With the exception of a few tons taken out in the course of development work at Calumet Island, in the province of Quebec, the production of lead in Canada, in 1897, came entirely from British Columbia and reached a total of 39,018,219 lbs., or 19,509 tons, which, valued at the average market price of the metal for the year in New York was worth $1,396,853.

Table 1, below, shows the yearly production, price per lb., and calculated value for the past eleven years.

TABLE 1.

LEAD.

ANNUAL PRODUCTION.

Calendar Year.	Pounds.	Price per Pound.	Value.
		c.	
1887..	204,800	4·50	$ 9,216
1888..	674,500	4·42	29,813
1889..	165,100	3·93	6,488
1890..	105,000	4·48	4,704
1891..	88,665	4·35	3,857
1892..	808,420	4·09	33,064
1893..	2,135,023	3·73	79,636
1894..	5,703,222	3·29	187,636
1895..	16,461,794	3·23	531,716
1896..	24,199,977	2·98	721,159
1897..	39,018,219	3·58	1,396,853

There will be seen to have been a steady and considerable increase each year since 1891, although the increase of production of 1896 over 1895 amounted to 7,738,183 lbs., or 47 per cent, that of 1897 over the previous year was still greater, being 14,818,242 lbs. or 61·23 per cent. The average price per pound too in 1897 was greater by 20 per cent than in 1896.

Table 2 shows the value of the exports of lead from the Dominion as per the returns received by the Customs Department. It being remembered that practically all the lead is exported, considerable differences will be evident between the values given in Tables 1 and 2, due to the entirely different basis of valuation adopted in the two tables. In Table 2 the figures represent the value placed upon the lead in the ore by the shippers at the point of export, or the spot value, while, as before explained, the values in Table 1 are calculated at the full and final market prices of the metal. LEAD.

TABLE 2.

LEAD.

EXPORTS.

Exports.

Calendar Year.	Value.
1873	$ 1,993
1874	127
1875	7,510
1876	66
1877	720
1878	....
1879	230
1880	....
1881	....
1882	32
1883	5
1884	36
1885	....
1886	....
1887	724
1888	18
1889	....
1890	....
1891	5,000
1892	2,509
1893	3,099
1894	144,509
1895	435,071
1896	462,095
1897 { Quebec	500
1897 { British Columbia	924,644
Total, 1897	925,144

LEAD.

Tables 3 and 4 show the imports of lead, the aggregate value in 1897 (fiscal year) being $248,291. This, however, does not represent the total value of the lead imported into the country since it does not include dry white and red lead used in mixing paint, etc. In the Trade and Navigation Report for the fiscal year 1896-97, there is shown an importation of various materials entered under the general heading of "dry white and red lead, orange mineral and zinc white" to the value of $347,539. What proportion of this is zinc white and what proportion is lead product, it would be impossible to say, but it will at least be quite evident that the total importation of lead and therefore the home consumption since the production is all exported, was in 1897 of a value less than $600,000.

TABLE 3.

LEAD.

Imports.

IMPORTS OF LEAD.

Fiscal Year.	Old, Scrap and Pig.		Bars, Blocks, Sheets.		Total.	
	Cwt.	Value.	Cwt.	Value.	Cwt.	Value.
1880	....	....	....	....	30,298	$124,117
1881	16,236	$ 56,919	18,222	$70,744	34,458	127,663
1882	36,655	120,870	10,540	35,728	47,195	156,598
1883	48,780	148,759	8,591	28,785	57,371	177,544
1884	39,409	103,413	9,704	28,458	49,113	131,871
1885	36,106	87,038	9,362	24,396	45,468	111,434
1886	39,945	110,947	9,793	28,948	49,738	139,895
1887	61,160	173,477	14,153	41,746	75,313	215,223
1888	68,678	196,845	14,957	45,900	83,635	242,745
1889	74,223	213,132	14,173	43,482	88,396	256,614
1890	101,197	283,096	19,083	59,484	120,280	342,580
1891	86,382	243,033	15,646	48,220	102,028	291,253
1892	97,375	254,384	11,299	32,368	108,674	286,752
1893	94,485	215,521	12,403	32,286	106,888	247,807
1894	70,223	149,440	8,486	20,451	78,709	169,891
1895	67,261	139,290	6,739	16,315	74,000	155,605
1896	72,433	173,162	8,575	23,169	81,008	196,331
1897	65,279	158,381	10,516	29,175	75,795	187,556

Lead.

Imports.

TABLE 4.
LEAD.
IMPORTS OF LEAD MANUFACTURES.

Fiscal Year.	Value.
1880	$15,400
1881	22,629
1882	17,282
1883	25,556
1884	31,361
1885	36,340
1886	33,078
1887	19,140
1888	18,816
1889	16,315
1890	25,600
1891	23,893
1892	22,636
1893	33,783
1894	29,361
1895	38,015
1896	50,722
1897 Lead, Tea	$15,166
1897 " Pipe	4,226
1897 " Shot	1,189
1897 " Manufactures, N.E.S	40,154
Total	$60,735

Imports of Litharge.

TABLE 5.
LEAD.
IMPORTS OF LITHARGE.

Fiscal Year.	Cwt.	Value.
1880	3,041	$14,334
1881	6,126	22,129
1882	4,900	16,651
1883	1,532	6,173
1884	5,235	18,132
1885	4,990	16,156
1886	4,928	16,003
1887	6,397	21,865
1888	7,010	23,808
1889	8,089	31,082
1890	9,453	31,401
1891	7,979	27,613
1892	10,384	34,343
1893	7,685	24,401
1894	38,547	28,685
1895	11,955	32,953
1896	10,710	32,817
1897	12,028	34,538

TABLE 6.

LEAD.

LEAD.

BRITISH COLUMBIA : PRODUCTION.

Calendar Year.	Pounds.	Price per Pound.	Value.
		cts.	
1887	204,800	1·50	$ 9,216
1888	674,500	4·42	29,813
1889	165,100	3·93	6,488
1890	Nil.	....	....
1891	"	....	....
1892	808,420	4·09	33,064
1893	2,131,092	3·73	79,490
1894	5,703,222	3·29	187,636
1895	16,461,794	3.23	531,716
1896	24,199,977	2·98	721,159
1897	38,841,135	3·58	1,390,513

NOVA SCOTIA.

Discovery and development.

Lead ores are known to occur in Nova Scotia, though little attention, so far, seems to have been paid to them.

In Colchester a deposit known as the Smithfield mine was opened a few years ago, but was never worked to any great extent.

The following abstract is taken from the Report of the Minister of Mines of Nova Scotia for 1897 :—

In Northern Inverness, while prospecting for gold a deposit of galena was discovered on Faribault Brook (L'Abime) in the fall of 1896. This has been opened by the Cheticamp Gold Mining Co.—The property so far as developed promises to be very valuable. The face value of the openings are stated to be 20°/₀ galena and 3°/₀ copper.—The ore is said to carry on average one ounce of silver for every unit of lead, and gold in places up to 14 dwt. per ton.

On the following occurrences, development work has been done at different times but these efforts do not seem to have met with success.

Cape Breton Co. . . . . Salmon River.
Victoria Co . . . . St. Anns.
" " . . . . Washaback Mines.

Other deposits, the economic value of which has not been investigated, have been noticed as follows :—

Inverness Co. . . . . . Pleasant Bay, Mackenzie River.
Richmond Co . . . . Arichat.
Hants Co . . . . Nine-mile River.

NEW BRUNSWICK. LEAD.

Discovery and development.

The exploitation of galena deposits in this province does not seem, so far, to have met with success.—The following are some of the occurrences which have been more or less worked at different times :—

Carleton County.

Briton Mine.—Near Woodstock. This deposit has been opened and worked to some extent. The chief value of the ore, however, was derived from the silver contents.

Campobello Island, off Charlotte Co. Coast.—At Welchpool.—An occurrence of galena at this place seemed to be important enough to justify some expenditure.—Some development work was accordingly done on it, but the enterprise was unsuccessful and the mine abandoned.

Frye Island.—At this place small veins of galena have been noticed in quartz lodes cutting limestones.—No work of any importance has been done on this occurrence, so that the economic value is unknown.

St. John County.

Frenchmens Creek.—A discovery of small veins of galena in limestone, has been reported from this place in the summer of 1897.—The work done on it has been limited to stripping.—An assay made in the Geological Survey laboratory gave 25 oz. of silver to the ton.

Gloucester County.

Nigadoo River.—The occurrence at this place was exploited some years ago, but has since been abandoned.—The galena holds about 40 oz. of silver to the ton.

A certain amount of test work has been done on two other properties in this county, viz., at Rocky Brook and at the Elm Tree mine. Both of these as well as the Nigadoo River property are near the town of Bathurst.

QUEBEC.

The only two occurrences of galena on which work has been done of late years, in the province of Quebec, are situated respectively on

LEAD.

Discovery and development.

Calumet Island, Pontiac Co. and on Lake Temiscaming.—A good deal of development has been done on these two mines, which have been worked intermittently for a number of years, and have changed hands several times.—At Calumet Island, the ore is a zinc-blende associated with galena and carrying silver.

An analysis of the ore gave the following results:—

Zinc	40 per cent.
Lead	12 "
Silver	15 oz. per ton. *

The present owners, however, claim to have now ores running much higher.

The Lake Temiscaming mine, is said to have been working in 1896-97,—a dozen men being employed.—No shipments were recorded.

Assays of the ore from this place, made by the Geological Survey, gave respectively, 18·96 oz., 11·06 oz. and 18·23 oz. of silver to the ton of clean galena. In his report for 1889, the Provincial Mining Engineer gives as an average of several assays :

Lead	52 per cent.
Silver	26 oz.

Occurrences of galena have been observed in numerous other places in the province, some of which may prove on further investigation, to have more than a mineralogical interest. They are as follows:—

County.	Township.	Range and Lots.
Arthabaska	Chester	II. 9, IX. 2, 5., X. 19.
Bagot	Acton	V. 22.
Bellechasse	Mailloux	V.
Brome	Potton	XI. 8.
Charlevoix	Seigniory de la cote Beaupré.	
Drummond	Upton	XXI. 51.
Gaspé	Cape Rosier	
Missisquoi	St. Armand	
Labelle	Buckingham	IV. 21.
Wright	Denholm, Lead Island.	
"	Wakefield	II. 6.
Pontiac	Calumet Island	IV. 10 W., IV. 9, 10, 12.
"	Duhamel	Blocks A., B., C., D. (Lake Temiscamingue
"	Guigues	II. 1.
Rimouski	Seigniory Rioux (St. Fabien).	
Shefford	Stukely	VIII. 1.
Sherbrooke	Ascot	IV. 15, IX. 9.

The preceding list has been gleaned from the reports of the Mining Engineer of the Province of Quebec and from previous reports of this Survey.

*Report of Provincial Mining Engineer for 1892.

LEAD.

ONTARIO.

Discovery and development.

Argentiferous galena ores have been known to occur in Ontario for many years. -Several deposits have been opened and extensive work has been done on some of them, but for various reasons these mines were all subsequently closed down; so that lead mining cannot be said to have yet reached a successful stage of development in this province.

The following are some known occurrences:—

The deposit, known as the Frontenac Mine, occurs in a grey pinkish gneiss, and is associated with beds of crystalline limestone.—It is situated on lots 15 and 16, concession IX., Loughborough township, Frontenac county. The ore-bearing vein is twelve to fifteen feet wide, and consists mainly of calcepar.—The galena is found disseminated and in bunches.—Different assays gave twelve to fifteen per cent of galena.

As early as 1867 this deposit had been developed to a considerable extent. Mr. H. G. Vennor, in the Report of the Geological Survey for 1869, says that a shaft had been sunk and two drifts, four hundred feet and fifty feet long respectively, had been run at the bottom of this. In 1879 smelting works were erected in connection with the mine, and operated at intervals for a couple of years.—The enterprise, however, was not successful.

Lanark County, near Carleton Place, Ramsay mine.—This deposit was worked for a time, by open cuts.—An attempt at smelting was made, which, however did not prove successful.—Deposits have also been noticed at Tudor and Limerick, in Hastings county.

Garden River, east of Sault Ste Marie.—Two separate mines, viz., the Victoria and the Cascades, were opened on the same vein.—Each had a mill for concentrating and worked for some years.—Underground, considerable development work was done.—These enterprises, however, did not seem to prove profitable and were closed down about twelve years ago.—An average of different assays gave:—silver 20 oz., lead 60 °/₀.—The galena was associated in the ore with zinc-blende and pyrite.

Galena ores occur also at a number of points between the last-mentioned place and the western limit of the province.—Along the north shore of Lake Superior several deposits have been prospected to a greater or less extent.—At Jackfish Bay, a gold-bearing quartz vein containing galena and chalcopyrite, was worked during the first part

LEAD.

of the year and known as the Empress mine.—The main value, however, in this case was derived from the gold contents.

Discovery and development.

In the vicinity of Black Bay, a fair amount of development work was done in the past at the Enterprise mine and at other points between this and Port Arthur.—Although not to be classed as lead depôsits, a certain amount of galena was found in the silver veins of the Thunder Bay district, a number of which were extensively worked in past years.

BRITISH COLUMBIA.

Almost the whole production of lead in Canada, for the past three years, comes from British Columbia and is represented by the lead contents of argentiferous galena mined in that province.

The shipments in 1897 have been almost exclusively from the West Kootenay district—the mines of East Kootenay having suspended shipments until the completion of the Crow's Nest Pass Railway.

The figures given in the tables represent ninety per cent of the assay value, this being the rate at which the smelters purchase the ore.

Of the West Kootenay district the Slocan division afforded by far the largest shipments, viz., 30,707,000 lbs.

At present, these argentiferous lead ores have to be exported to the United States for treatment; but at the Trail and Nelson smelters, lead furnaces are being erected, and the smelting of high grade ores will be attempted.

Although the value of the lead, in the tables, shows a considerable rise; this was largely offset by the increase of the duty on lead sent into the United States, to 1½ cents per lb. of the gross lead contents of the ore.

The discovery and development of silver-lead ore deposits for 1897 will be treated more at length under the heading "Silver."

MANGANESE.

MANGANESE.

The production of manganese in 1897 consisted of but little more than a few sample shipments; the work of mining this mineral in recent years having been of a desultory and intermittent nature. Though for a number of years previous to 1890, the production amounted to over a thousand tons per annum, the output has of late dwindled away to small proportions. Production.

In 1897 no production whatever was reported from New Brunswick, while from Nova Scotia the exports amounted to but 15¼ tons, valued at $1,166.

The statistics of production, value and average value per ton are given in Table 1, following:—

TABLE 1.

MANGANESE.

ANNUAL PRODUCTION.

Calendar Year.	Tons.	Value.	Value per ton.
1886	1,789	$41,499	$23.20
1887	1,245	43,658	35.07
1888	1,801	47,944	26.62
1889	1,455	32,737	22.50
1890	1,328	32,550	24.51
1891	255	6,694	26.25
1892	115	10,250	89.13
1893	213	14,578	68.44
1894	74	4,180	56.49
1895	125	8,464	67.71
1896*	123½	3,975	32.19
1897*	15¼	1,166	76.46

* Exports.

The average value per ton, it will be seen, took a very sudden upward turn in 1892. This increase, as stated in the report of Mineral Statistics and Mines for that year, was probably due to the reopening of the Tennycape mines and the shipment of high-grade ore therefrom.

MANGANESE.
Exports.

TABLE 2.

MANGANESE.

EXPORTS OF MANGANESE ORE.

Calendar Year.	Nova Scotia.		New Brunswick.		Total.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
1873	....	....	1,031	$20,192	1,031	$20,192
1874	6	$ 12	776	16,961	782	16,973
1875	....	200	194	5,314	203	5,514
1876	21	723	391	7,316	412	8,039
1877	106	3,699	785	12,210	891	15,909
1878	106	4,889	520	5,971	626	10,860
1879	154	7,420	1,732	20,016	1,886	27,436
1880	79	3,090	2,100	31,707	2,179	34,797
1881	200	18,022	1,504	22,532	1,704	40,554
1882	123	11,520	771	14,227	894	25,747
1883	313	8,635	1,013	16,708	1,326	25,343
1884	134	1,054	469	9,035	603	20,089
1885	77	5,054	1,607	29,595	1,684	34,649
1886	(a) 441	854	1,377	27,484	(a)1,818	58,338
1887	578	14,240	837	20,562	1,415	34,802
1888	87	5,759	1,094	16,073	1,181	21,832
1889	59	3,024	1,377	26,326	1,436	29,350
1890	177	2,583	1,729	34,248	1,906	36,831
1891	22	563	233	6,131	255	6,694
1892	84	6,180	59	2,025	143	8,205
1893	123	12,409	10	112	133	12,521
1894	11	720	45	2,400	56	3,120
1895	108	6,348	$\frac{3}{10}$	3	108$\frac{3}{10}$	6,351
1896	123$\frac{1}{2}$	3,975	....	....	123$\frac{1}{2}$	3,975
1897	15$\frac{1}{4}$	1,166	....	....	15$\frac{1}{4}$	1,166

(a) 250 tons from Cornwallis should more correctly be classed under the heading of mineral pigments.

Imports.

TABLE 3.

MANGANESE.

IMPORTS: OXIDE OF MANGANESE.

Fiscal Year.	Pounds.	Value.
1884	3,989	$ 258
1885	36,778	1,794
1886	44,967	1,753
1887	59,655	2,933
1888	65,014	3,022
1889	52,241	2,182
1890	67,452	3,192
1891	92,087	3,743
1892	76,097	3,530
1893	94,116	3,696
1894	101,863	4,522
1895	64,151	2,781
1896	108,590	4,075
1897	70,663	2,741

Descriptions of the different manganese properties in Nova Scotia and New Brunswick were given in the report of Mineral Statistics and Mines for 1890, and need not be further enlarged upon here.

MANGANESE.

Discovery and development.

In New Brunswick the outlook for the future appears to be somewhat encouraging owing to the reopening of the bog manganese deposit at Dawson Settlement, Hillsborough parish, Albert county, by the Mineral Products Company of New York.

This deposit began to attract attention in 1887, when in that and the following year some development work was done and trial shipments were made. In 1890 the property was taken over by the Crimora Manganese Company, a plant was erected for drying the ore and preparations were made for working the property on a large scale. Operations, however, do not seem to have been very successful, as in the following year the works closed down and have so remained until taken up by the present owners.

Mr. Chalmers writes concerning this deposit as follows* :—

"Bog manganese occurs in an extensive deposit near Dawson Settlement, Albert county, N.B., on a branch of Weldon Creek, covering an area of about twenty-five acres. In the centre it was found to be twenty-six feet deep, thinning out towards the margin of the bed. The mineral is a loose, amorphous mass, which can be readily shovelled without the aid of a pick, and contains more or less iron pyrites disseminated in streaks and layers, though large portions of the deposits have merely a trace. This bed of bog manganese lies in a valley at the northern base of a hill, and its accumulation at this particular locality appears to be due to springs. These springs are still trickling down the hill side, and doubtless the process of producing bog manganese is still going on.

"A branch of the Albert Railway has been opened up to the mine, and kilns for drying the material were also erected. Operations had, however, ceased at the time of my visit (autumn of 1891) pending the completion of the analyses and tests of this product. Indications of other and similar deposits of bog manganese further west, about the head of Weldon Creek, have been reported.

"Another bed of amorphous bog manganese occurs near Harvey, in the same county, but it has not been opened up."

*G. S. C. Report (N.S.) vol. VII., 1894, p. 146 M.

MANGANESE.

Discovery and development.

A partial analysis of the Hillsborough ore by W. F. Best, St. John, (Report of Section of Min. Stat. and Mines, 1890) gave:

Manganese binoxide	47·0
Iron oxide	18·0
Vegetable matter	34·0
Loss	1·0
Copper	trace
Cobalt	trace
	100·0

The following analysis of this ore is taken from the Mineral Resources of the United States for 1896, p. 311.

Average of twenty samples of manganese ore from Hillsborough, N.B. (the ore being dried at 212° F.):

Manganese	45·81
Iron	9·95
Oxygen	31·01
Sulphur	·03
Phosphorus	·05
Silica	5·36
	92·21

Operations were begun in the summer of 1897, and from thirty-five to forty men have been employed clearing the land and erecting the plant.

Prof. L. W. Bailey writes concerning the deposit and the work of the company in the Summary Report of the Geological Survey for 1897, as follows:—

"The material is a fine jet-black powder, quite free from pebbles or other foreign matter, and carrying about 45 per cent of manganese, with a little iron and silica, and only a trace of phosphorus. The average value of the ore is about $13 or $14 per ton (while that of Markhamville ranged, in its higher grades, from $70 to $80 per ton), but would not even possess this value except through the operation of a special process whereby the incoherent powder is cemented and compressed into solid briquettes, capable of ready transportation and of direct addition to the iron of the Bessemer furnace. A large plant has been erected for the production of these briquettes, which are loaded directly on a short branch railway connecting with the Harvey and Salisbury Railway, by which and by the Intercolonial Railway, they are to be forwarded to Bridgeville, N.S., to be there used in connection with the plant of the Pictou Charcoal Iron Company, both plants being now under the control of the Mineral Products Company, of New Brunswick. The cost of the plant at Dawson Settlement, including the branch railway of about one mile and a half, is said to have been about $30,000."

MERCURY.

MERCURY.

Discovery and development.

Several deposits of cinnabar are known in the vicinity of Kamloops Lake, British Columbia, and some of these have been exploited although the work is as yet in the development stage.

The Gold Commissioner for the Kamloops division reports as follows :—

"The furnace belonging to the Cinnabar Mining Company was started in the latter part of March, but only ran for a short time, as it was seen that some alterations would have to be made before the ore could be treated successfully, the results not being satisfactory.

"The prospecting of the deep ground, with the diamond drill, before commencing some tunnels, cross-cuts and winzes in the 'Blue Bird' and 'Rosebush' claims, was contemplated, but for some reason this work has not been accomplished. The Cariboo Gold Fields Company has completed assessment work on a number of cinnabar claims on the north side of Kamloops Lake, but more labour will be required to determine their value."

Besides the above-described, mercury ores have been found at a number of other places in British Columbia, although as yet not proved to be workable, may at least be taken as guides to localities where prospecting might be done with probable success.

Dr. G. M. Dawson in his report on the mineral resources of the province (G. S. C. Report 1887, pp. 156-157 R, mentions those given below :—

Ebenezer Mine, two miles and a half east of Golden on the C. P. Railway. *Homathco River*. *Fraser River*, cinnabar grains obtained in gold washing near Boston Bar. *Fraser River, 12 miles above Kelly Lake Creek*, rich specimens of cinnabar with native mercury. *Vicinity of New Westminster*, float ore. *Silver Peak near Hope*, Globules of native mercury with the silver ore of that point. Besides these, specimens of ore are in the museum of the Survey from *Read*

MERCURY.

Island, north-east coast of Vancouver Island and from a point on the eastern entrance to Seshart Channel, Barclay Sound, Vancouver Island.

The following table illustrates the produuction of this metal which is altogether to be credited to British Columbia :—

Production

TABLE 1.

MERCURY.

PRODUCTION.

Calendar Year.	Flasks, (76½ lbs.)	Price per flask.	Value.
1895	71	$ 33 00	$ 2,343
1896	58	33 44	1,940
1897	9	36 00	324

Imports.

TABLE 2.

MERCURY.

IMPORTS.

Fiscal Year.	Pounds.	Value.
1882	2,443	$ 965
1883	7,410	2,991
1884	5,848	2,441
1885	14,490	4,781
1886	13,316	7,142
1887	18,409	10,618
1888	27,951	14,943
1889	22,931	11,844
1890	15,912	7,677
1891	29,775	20,223
1892	30,936	15,038
1893	50,711	22,998
1894	36,914	14,483
1895	63,732	25,703
1896	77,869	32,343
1897	76,058	33,534

Mica.

MICA.

The figures given for mica are probably much below the actual production. There are many deposits worked on a small scale by private individuals, from whom it is almost impossible to get returns.

The important deposits of mica worked at present are in the province of Quebec. Ontario only counts in the production for a very small figure.

The mica mined is almost exclusively of the quality known as "amber mica," which is used as an insulating material in the construction of electrical machinery. The greater part of the whole product is exported, chiefly to the United States. MICA.

TABLE 1.

MICA.

ANNUAL PRODUCTION.

Production.

Calendar Year.	Value.
1886	$ 29,008
1887	29,816
1888	30,207
1889	28,718
1890	68,074
1891	71,510
1892	104,745
1893	75,719
1894	45,581
1895	65,000
1896	60,000
1897	76,000

TABLE 2.

MICA.

EXPORTS.

Exports.

Calendar Year.	Value.
1887	$ 3,480
1888	23,563
1889	30,597
1890	22,468
1891	37,590
1892	86,562
1893	70,081
1894	38,971
1895	48,525
1896	47,756
1897	69,101

MICA. QUEBEC.

The more important workings of mica are all situated in Labelle and Wright counties (formerly Ottawa County.)

Occurrences. The following is a list of occurrences compiled from the reports of the Quebec Mining Bureau :—

Labelle County.

Portland West.—III., 11., 12, 13, IX., 5, 6. X., 3.
Portland East.—I. 6.
Buckingham.—XI., 26.
Villeneuve.—I., 31, 32.
Derry.—III., 4.

Wright County.

Hull Township.—IX., 14, 15, X., 6, 7, 10, 13, 14, 16, XI., 1, 5, 6, 12, 13, XII., 10, XIII., 9, XV., 15, 16,32, XVI., 11, 12, 13, 17.
Wakefield.—I., 6, 12, II. 17, 18, 23, III., 13, VII., 25, VIII., 27.
Templeton.—VIII., 15, 16, IX., 4, X., 7, 8, 9, 10, XI., 10.
Masham.—III., 10, 11.
Hincks.—II., 21, 22, 25, IV., 3, 6, 17, 18, 31, 32, 36, 37, V., 22, 23, XI., 10, 11, XIII., 48, 49.
Aumond.—B., 6 or 7.
Aylwin.—IV., 7, XI., 43.
Northfield.—A., 1, 2, 3, B. 12, 13, 19, 20, 21, II., 32, 33.
Denholm.—B., 12, V. 19, 20, 21, VI., 26, 27, VIII., 18.
Bouchette.—I., 24, 38, D., 14, 15, X., 11, 12, 24.
Low.—III., 24, 25, XII., 36.
Wright.—A., 37, D., 14, 15, V., 12, VI., 17, VII, 13.

Pontiac County.

Onslow.—VII., 17, 22.
Clarendon.—I., 14.

Besides the above, mica has been found in Bryson (on Black River), Alleyn, Cawood, and on unsurveyed lands on the Ottawa River opposite Mattawa.

Argenteuil County. MICA

Grenville.—V., 7, 10, VI., 9, 10, VII., 17.
Harrington.—IV., 8.
Wentworth.—VII., 24, VIII., 23.
Chatham.—IV., 28.

Occurrences

White mica which can be used for purposes where a high degree of transparency is required, has been observed on Lake Manouan, north of Lake St. John, also in the townships of Escoumains, Bergeronnes, Tadousac, county of Saguenay, besides occurring, in many cases, in the same areas as the darker varieties of mica.

ONTARIO.

In Ontario a few deposits are worked, but on a small scale although occurrences of economic value have been observed in many places, among which are the following:—

Lanark County, North-Burgess.—IX., 15, 16, 17.
Frontenac County, Loughborough.—VIII., 5, (near Sydenham.)
Hastings County, Hungerford.—XII., 29.
Addington County.—Effingham.
Nipissing District.—Block 24.
Parry Sound District.—Christie Township, near Edgington.

BRITISH COLUMBIA.

Several occurrences are known in British Columbia among which are those at Canoe River and Tête Jaune Cache.

MINERAL PIGMENTS.

MINERAL PIGMENTS.

Under this heading are included the minerals which, either after undergoing preparation or in the natural state, enter into the composition of certain paints.

They comprise, the ochres, umbers, siennas, certain hæmatites, limonites, barite, zinc white and the lead paints, as red lead, white lead.

To this list might be added the chrome colours, graphite, terra alba or gypsum, soapstone, etc., but these having also other uses are considered under their respective headings.

Ochres.—By far the greater part of the Canadian production of mineral pigments is represented by the ochres, the output of which has been increasing for the last three years, the figures for 1897 being the highest on record. Almost the whole production comes from the province of Quebec.

MINERAL PIGMENTS.

Production of Ochres.

TABLE 1.

MINERAL PIGMENTS.

ANNUAL PRODUCTION OF OCHRES.

Calendar Year.	Tons.	Value.
1886	350	$ 2,350
1887	485	3,733
1888	397	7,900
1889	794	15,280
1890	275	5,125
1891	900	17,750
1892	390	5,800
1893	1,070	17,710
1894	611	8,690
1895	1,339	14,600
1896	2,362	16,045
1897	3,905	23,560

Imports of Ochres.

TABLE 2.

MINERAL PIGMENTS.

IMPORTS OF OCHRES.

Fiscal Year.	Pounds.	Value.
1880	571,454	$ 6,544
1881	677,115	8,972
1882	731,526	8,202
1883	898,376	10,375
1884	533,416	6,398
1885	1,119,177	12,782
1886	1,100,243	12,267
1887	1,460,128	17,067
1888	1,725,460	17,664
1889	1,342,783	12,994
1890	1,394,811	14,066
1891	1,528,696	20,550
1892	1,708,645	22,908
1893	1,968,645	23,134
1894	1,358,326	18,951
1895	793,258	12,048
1896	1,159,494	16,954
1897 { Ochres and ochrey earths and raw siennas	644,400	$ 5,533
1897 { Oxides, dry filiers, fire-proofs, umbers and burnt siennas, N.E.S.	859,664	12,971
Total, 1897	1,504,044	$18,504

The work of exploiting the ochre deposits of Canada has been chiefly confined to the province of Quebec. Some of the chief occurrences of this province are as follows :— MINERAL PIGMENTS.

Occurrences of Ochres.

Champlain Co.

Cap de la Magdelaine, St. Malo Range.—This is an extensive deposit, having an area of over six hundred acres. It consists of layers of ochre interstratified with peat, and was opened in 1885. It has been worked ever since.

St. Marguerite Range.—Small patches of ochre a few yards in diameter, and a few inches thick, show for a distance of several miles.

St. Maurice Co.

Pointe du Lac, St. Nicholas Range.—Important ochre bed extending over an area of 400 acres, with a thickness ranging from six inches to 4 feet. The colours are different shades of red and yellow. These deposits were opened in 1851, but the enterprise was subsequently abandoned.

Montmorency.

Ste. Anne.—One mile and a half above mouth of river is a remarkable deposit of ochre, covering an area of four acres with a depth of from four to seventeen feet.

Other deposits, more or less important, have been found in :—

County.	Township.	Range and lot.
Chicoutimi	*Simard*	IV., 24, 25, 26 ; V., 26, 27, 28.
Drummond	*Durham*	IV., 4.
Montcalm	*Chertsey.*	
Wright	*Hull*	X., 15.
	Eardley.	
Pontiac	*Mansfield.*	
Saguenay	*Bersimis—Jeremie Islands, Escoumains.*	
	Iberville	III., 23, 24, 25.
	Manicouagan	I., II., III., IV., V., VI.
	Islets A, B, C.	
	De Monts—Blocks C, D.	
Vaudreuil	*Seigniory of Vaudreuil—Cote St. Charles,*	17

MINERAL PIGMENTS.

Analyses o Ochres.

ANALYSES OF OCHRES.

——	1.	2.	3.	4.
Peroxide of iron........	59·10	92·00	64·83	72·14
Protoxide of iron..	....	....	0·77	0·26
Alumina	....	3·23	*2·10	* 2·25
Silica	1·15	0·61		
Silicious matters........	3·60	....	3·70	3·05
Sulphuric acid......	....	0·10		
Water of combination ...	....	2·54	21·75	16·45
Moisture	*21·14	1·52	6·85	5·85
Organic matters........	15·01			
	100·00	100·00	100·00	100·00

(1) Ste. Anne, Montmorency—By Dr. Sterry Hunt.
(2) St. Malo, Seigniory of Cap la Magdelaine.
(3 and 4) North Shore of Little Romaine River, Iberville Tp., Saguenay County—(Mines and Minerals of Quebec by J. Obalski, Provincial Government Mining Engineer).
* By difference.

Baryta.—As will be seen by Table 3 following, the production of this mineral has been very irregular and for many years there was none to report. Most of that mined has found a market in the United States.

Production of Baryta.

TABLE 3.
MINERAL PIGMENTS.
ANNUAL PRODUCTION OF BARYTA.

Calendar Year.	Tons.	Value.
1885....	300	$ 1,500
1886.....	3,864	19,270
1887.....	400	2,400
1888...	1,100	3,850
1889......	....	....
1890....................	1,842	7,543
1891.....	....	....
1892.	315	1,260
1893.....	....	....
1894.....	1,081	2,830
1895....................	....	....
1896....................	145	715
1897.......	571	3,060

As shown by Table 4 the home consumption is small. A study of the figures there given shows a great variation in the value of the material imported. Last year it has varied between ten to twenty dollars a ton but some years the average has been from $35 to $40 per ton. These variations are probably due to the different grades of material brought in, some being crude and some ground. MINERAL PIGMENTS.

The material mined in Canada has always been shipped in the crude state which has doubtless affected the industry as the low-grade material will hardly bring a price which would allow of freighting long distances to market.

Deposits of this mineral are known to occur at a number of places in the country, but the production has chiefly come from points in Nova Scotia and Ontario. The different mines have not generally been working simultaneously, but have all been operated irregularly. Among the chief occurrences are the following. Baryta.

NOVA SCOTIA.

Colchester Co.

Near village of Five Islands. This deposit was worked several years ago by an American Syndicate, and about 3,000 tons extracted.

Cape Breton Island, Inverness Co.

A large deposit which is worked intermittently occurs on Lake Ainslie. Another deposit known as Mabou mines occurs at Mabou.

QUEBEC.

In Quebec, baryta deposits are known to occur at several points but have never been worked to any extent.

Bonaventure County.

Anse à la Vieille.—Vein about nine inches in width.

Labelle County.

Buckingham Tp.—IV., 21—Vein of baryta, six to fourteen inches in breadth.

Other deposits have also been noticed in the Saguenay valley, and other places, which, however, do not as far as known offer economic interest.

ONTARIO.

The most important deposit of baryta in Ontario, so far known is on McKellar Island—Thunder Bay district. This has been opened and worked to some extent.

MINERAL PIGMENTS.

Other occurrences, the value of which has not been ascertained have been noticed in the following places :

Frontenac Co.—Oso.
Leeds Co.—North Crosby Tp.
Leeds Co.—Lansdowne.—VII., 2.
Lanark Co.—North Burgess.—IX., 4.
Bathurst.
Lavant—I., 22.
Hastings Co.—Madoc.—VI., 15.

Imports of Baryta.

TABLE 4.

MINERAL PIGMENTS.

IMPORTS OF BARYTA.

Fiscal Year.	Cwt.	Value.
1880	2,230	$1,525
1881	3,740	1,011
1882	497	303
1883	....	185
1884	....	229
1885	7	14
1886	....	62
1887	379	676
1888	236	214
1889	1,332	987
1890	1,322	978

TABLE 5.

MINERAL PIGMENTS.

MISCELLANEOUS IMPORTS, FISCAL YEAR 1897.

—		Quantity.	Value.
Paint, ground or mixed in, or with either japan, varnish, lacquers, liquid dryers, collodion, oil finish or oil varnish	Lbs.	38,097	$3,013
Paints and colours, and rough stuff and fillers, N.E.S.	"	45,680	2,184
Paris green, dry	"	218,490	23,091
Paints and colours ground in spirits, and all spirit varnishes and lacquers	Galls.	1,041	2,920
Putty	Lbs.	190,302	3,385
Colours, metallic, viz.: Oxides of cobalt, tin and copper, N.E.S.	"	29,225	4,753
		....	39,346

MINERAL WATER.

Mineral Water.

The production and sale of mineral water in Canada has now become a fairly well established industry.

Returns for 1897 show a production of 749,691 gallons, valued at $141,477, an increase in value over the previous year of $29,741 or 26 per cent.

Producers

The following is a list of the principal contributors to the production of 1897 :—

Province.	Name of Company.	Name of Water.	Name of Manager or Secretary.	Postal Address.
New Brunswick	Havelock Mineral Springs Co.	Havelock..	C. H. Keith.....	Petitcodiac.
" ..	Sussex Mineral Springs Co.	Sussex	C. G. Armstrong.	Sussex.
" ..	....	Apohaqui..	J. R. Smith.....	St. John.
Quebec	St. Leon Mineral Springs Co.	St. Leon...	St. Leon Mineral Springs Co.	Toronto.
"	....	Richelieu..	J. A. Harte....	Montreal.
"	Radnor Water Co.	Radnor....	Radnor Water Co.	"
Ontario.......	Grand Hotel Co...	Caledonian	King Arnoldi....	Ottawa.
"	....	Borthwick.	Wm. Borthwick.	"
"	....	Georgian..	W. K. Kains....	Treadwell.
"	....	Eastman's.	J. Boyd & Son .	Eastman Spring
"	....	Ancaster..	R. A. Smith.....	Toronto.
"	Eudo Mineral Water Co.	Eudo......	L. Forrest......	Toronto.
"	....	Winchester	W. J. Anderson, M.D.	Smith's Falls.
"	....	Wensley's.	Mrs. E. Wensley.	Camperdown.
"	Diamond Park Spring.	Sanataris.	J. A. Macdonald.	Arnprior.
Brit'h Columbia	....	....	Randall H. Kemp	Kaslo.

Mineral Water.

Besides the above, numerous mineral springs are known to occur in Canada, but their being no production reported they are so far unimportant.

Production.

Table 1.

Mineral Waters.

Annual Production.

Calendar Year.	Gallons.	Value.
1888	124,850	$ 11,456
1889	424,600	37,360
1890	561,165	66,031
1891	427,485	54,268
1892	640,380	75,348
1893	725,096	108,347
1894	767,460	110,040
1895	739,382	126,048
1896	706,372	111,736
1897	749,691	141,477

Imports.

Table 2.

Mineral Waters.

Imports.

Fiscal Year.	Value.
1880	$15,721
1881	17,913
1882	27,909
1883	28,130
1884	27,879
1885	32,674
1886	22,142
1887	33,314
1888	38,046
1889	30,343
1890	40,802
1891	41,797
1892	55,763
1893	57,953
1894	49,546
1895	48,613
1896	55,864
1897 { Mineral waters, natural, not in bottles	$ 585
1897 { Mineral and aerated waters, N.E.S.	46,421
	$47,006

NATURAL GAS.

NATURAL GAS.

The commercial use of natural gas in Canada is still confined to the wells in southern Ontario, in the districts termed respectively the Essex and Welland fields. It is difficult to state the actual output in cubic feet, since with one or two exceptions the gas is not metered by the producers; the value per 1,000 cubic feet, however, remains fairly uniform. The total in 1897, viz., $325,873 shows an increase of $49,572 or 17·94 per cent over the figures given for the previous year, though considerably less than the value of the output in 1895. To this total three companies in the Essex field, giving employment to about 39 men, contributed $209,773, and six companies in the Welland field, employing about 35 men, contributed $116,100.

Table 1, below, shows the value of the production of natural gas for the past six years.

TABLE 1.

NATURAL GAS.

ANNUAL PRODUCTION.

Production.

Calendar Year.	Value.
1892	$ 150,000
1893	376,233
1894	313,754
1895	423,032
1896	276,301
1897	325,873

A large proportion of the gas from the two fields is exported to the contiguous cities of Detroit and Buffalo, the total value of these exports, according to the Mineral Resources of the United States for 1896, being as follows:

Imports of natural gas into the United States from Canada, calendar years. Exports.

1891 (latter half)	$25,500
1892	74,737
1893	90,653
1894	62,523
1895	89,419
1896	87,446

NATURAL GAS.

The quantity of gas imported into the United States is estimated by the customs officers of the two cities to be in thousands of cubic feet, as follows:

At Buffalo—

	M. cu. ft.
1892	1,295,490
1893	1,314,824
1894	1,067,850
1895	1,052,800
1896	696,928

At Detroit—

1894	10,800
1895	785,990
1896	966,800
1897 (ten months)	810,400

making a grand total of exports from Canada of

	M. cu. ft.
1892	1,295,490
1893	1,314,824
1894	1,078,650
1895	1,838,790
1896	1,663,728

These figures taken in conjunction with the values given above, indicate an average value placed upon the gas of about five and a half cents per thousand cubic feet.

In comparing the values of production (Table 1) with the values of the imports into the United States from Canada, one might be led to suppose that a much smaller proportion of our production of natural gas is exported than is actually the case. Table 1 is made up from the returns received by this department, and in most cases represents the receipts of the various companies for gas sold, the price per thousand cubic feet being variable, but ranging as high as 25 cents in some cases, and probably averaging on the whole from 10 cents to 15 cents per M. cubic feet. In the table of imports of natural gas into the United States, however, a merely nominal value of about 5 cents per M. cubic feet is placed upon the product. Over 75 per cent of the production is exported.

In 1897 the wages paid for labour (Bureau of Mines Report, Ontario) were $42,338.

The town of Leamington owns its own wells and supplies gas to its citizens and for municipal purposes. In 1894 the service pipes of the Ontario Natural Gas Co. were acquired at a valuation of $14,000, since which about $6,000 has been spent on extensions, etc. A well was drilled by a syndicate of citizens and afterwards taken over by the corporation at cost price, viz.: about $2,000; a second well has since been bored, and the two are said to have a capacity of 11,500,000 cubic feet per day. In 1897 four men were employed, viz.: a manager, a collector, a general workman and a man in charge of the regulators at the wells, the total wage cost being, $770. The revenue derived from the sale of gas in the same year was about $10,000. The rates charged are for stoves from $1.50 to $1.75 per month; for dwelling furnace $2.50 per month; for store or shop furnace $3.25 per month: factories are supplied at the rate of five cents per thousand cubic feet. NATURAL GAS.

NORTH-WEST TERRITORIES.

Whilst no natural gas was put to use except in Ontario, an important discovery was made in connection with the borings in search of petroleum carried on by the Geological Survey in northern Alberta and southern Athabasca. This work is alluded to in the article on Petroleum, but the notable feature in this connection consists in the heavy flows of gas met with in the boring at the mouth of the Pelican River on the Athabasca River. This point is of course too far away from any settlement for the present utilization of the supply. "It is of particular interest, however, when taken in connection with the considerable quantity of gas met with in the Athabasca Landing boring, and that found in borings made for water at Langevin and Cassils, on the line of the Canadian Pacific Railway. The gas is not found in these four places at exactly the same horizon in the Cretaceous rocks; but its occurrence goes far to prove that, particularly in the lower strata of the Cretaceous, natural gas in quantities of commercial value may be expected to occur over a vast area of the North-west, the distance between the extreme points at which its existence has now been determined (Langevin and Pelican) being about 350 miles." (Summary Report of the Geological Survey, 1897.)

NICKEL.

NICKEL.

The Sudbury district in Ontario is the only region in Canada where the mining of nickel ores is carried on, and the output of its mines still satisfies a large proportion of the world's requirements for this metal.

NICKEL. During 1897, the Canadian Copper Company continued active operations at the Copper Cliff and Stobie mines, and the Trill Mining and Manufacturing Company operated the Inez mine. Though the mines of the H. H. Vivian Co. were shut down during the year, a quantity of roasted ore from the stock-pile was sold to Joseph Wharton, of Philadelphia, and smelted in the furnaces of the company.

Production. The total production in 1897 amounted to 3,997,647 pounds, or 1,999 tons, which, at 35 cts. per pound, gives a final market value of $1,399,176. The increase over the previous year was 690,534 pounds, or 20·47 per cent, and in value $210,186. The value of the production according to the export returns, given in Table 2, was $723,130, or with the figures of production given above, an average value per pound of 18·1 cents. The value placed upon the nickel in the ore by the operators in the returns to the Provincial Mining Bureau, is much less than that placed upon the exports, being for the year 1897, but $359,651 (Report of Bureau of Mines, vol. VII., First Part, p. 26) or an average value per pound of 8·99 cents.

The total quantity of ore treated in 1897 was about 96,092 tons, which, with a nickel product of 1,999 tons gives an average per cent of nickel in the ore of 2·08.

Table 1 gives the production, price per pound, and the final market value of the metal for each year since the inception of the industry in 1889.

TABLE 1.

NICKEL.

ANNUAL PRODUCTION.

Calendar Year.	Pounds of nickel in matte.	Price per lb.	Value.
1889	*830,477	60c.	$ 498,286
1890	1,435,742	65c.	933,232
1891	4,626,627	60c.	2,775,976
1892	2,413,717	58c.	1,399,956
1893	3,982,982	52c.	2,071,151
1894	4,907,430	38⅛c.	1,870,958
1895	3,888,525	35c.	1,360,984
1896	3,397,113	35c.	1,188,990
1897	3,997,647	35c.	1,399,176

* Calculated from shipments made by rail.

Thus the production of nickel in Canada up to the end of 1897 was 29,480,260 pounds or 14,740 tons, or an average yearly production of 1,638 tons.

Table 2 gives the value of the exports of nickel as per the returns made to the Customs Department, and Table 3 the imports. NICKEL.

TABLE 2.
NICKEL.
EXPORTS.*

Exports.

Calendar Year.	Value.
1890	$ 89,568
1891	667,280
1892	293,149
1893	629,692
1894	559,356
1895	521,783
1896	658,213
1897	723,130

* Practically all the nickel-bearing ore and matte produced in Canada is exported, the apparent discrepancy between Tables Nos. 1 and 2 being due to the different basis of valuation adopted in the two instances. Table 1 represents the total final values of the nickel produced in Canada, for the years represented. In Table 2 the worth of the product shipped is entered at its spot value to the operators, and depends upon the particular stage to which they happen to carry the process of extraction at the time *e.g.*, whether the shipments made are raw ore, low grade matte or high grade matte, etc.

TABLE 3.
NICKEL.
IMPORTS.

Imports

Fiscal Year.	Value.
1890	$ 3,154
1891	3,889
1892	3,208
1893	2,905
1894	3,528
1895	4,267
1896	4,787
1897 { Nickel anodes	4,649
1897 { Nickel *	88
	$ 4,737

* Classified under the general heading of minerals in the Trade and Navigation Report.

Nickel refining is not carried on in Canada, the matte being shipped for the most part to the refineries at Constable Hook and Camden, N.J., U.S.A., though small amounts have been shipped to Great Britain and some to Germany.

NICKEL.

Descriptions of the mines and works and modes of occurrence of the nickel in the Sudbury region will be found in former reports of this Section and need not be repeated here.

New Caledonia.

Canada's chief rival in the production of nickel is the island of New Caledonia, a French colony, situated in the South Pacific Ocean, about 1,000 miles east of the Australian coast. Here the nickel occurs as a hydro-silicate of nickel and magnesia (garnierite) and in another ore called " chocolite " from the resemblance this mineral bears to chocolate. The two minerals are found in the same deposits and the mixed ore averages from 6 to 8 per cent nickel.

Mining is carried on by two companies, the Société de Nickel and the Société d'Exploitation des Mines de Nickel, both of Paris, the former operating at Thio and the latter at Kououa. The Si Reis mine near the Bay of Nepui is also in operation.

The latter is said to be the only mine actively worked in 1897, the two former having large stocks of ore in hand. In July, 1897, there were said to be in the stock piles at Thio 100,000 tons of ore, averaging about 6 per cent nickel, and at Kououa from 6,000 to 7,000 tons, averaging 8 per cent.

In the following table some statistics are given of the production of nickel in New Caledonia, the figures being taken mainly from the volumes of the Mineral Industry.

The ore probably averages about 7 per cent nickel.

PRODUCTION AND EXPORTS OF NICKEL ORE FROM NEW CALEDONIA.

Year.	Production.	Exports.
	*Metric tons	*Metric tons
1884-89	....	51,995
1890	22,690	22,690
1891	60,921	35,000
1892	83,114	36,000
1893	69,130	45,613
1894	61,243	40,089
1895	29,623	38,976
1896	6,417	37,467

*1,000 metric tons are equivalent to 1,102·3 short tons English measure.

It will be seen that from 1890 to 1896 the exports of the metal ranged between 1,500 and 3,000 tons per annum, while the Canadian output in the same period varied from 800 to 2,400 tons.

The total output of the New Caledonia mines from 1884 up to the end of 1896, calculating the nickel in the ore at 7 per cent, was according to the above figures 21,548 metric tons or 23,752 short tons, the amount since 1890 being 17,908 metric tons, or 19,740 short tons, with possibly from 7,000 to 8,000 tons of metal in the ore in stock. The average yearly export therefore for the seven years from 1890 to 1896 inclusive, has been 2,558 metric tons or 2,820 short tons NICKEL.

In the United States a small amount of nickel is produced as a by-product at the mine La Motte, a lead mine in Missouri. Previous to the opening of the Canadian mines, a considerable quantity was obtained from the Gap nickel mine in Lancaster county, Pennsylvania. Some work has also been done on the deposits in Oregon and Nevada.

The total quantity of nickel mined in the United States from 1887 to 1896 inclusive, was but 1,183,282 lbs., or 592 tons, less than one-third the production of the Canadian mines in 1897 alone.

Nickel is also found in Norway, Sweden and Russia, and some mining has been done, but production has been unimportant.

As stated above, the average yearly output of the New Caledonia and Canadian mines has been 2,820 tons and 1,638 tons, respectively, making a grand total for these two chief sources of supply of 4,458 tons per annum. The other producing countries, Norway and the United States, would not add more than from 100 to 150 tons yearly to the above total.

It would thus appear that the world's requirements of nickel are from 4,500 to 5,000 tons per annum, of which amount Canada supplies from 30 to 40 per cent, and that the sources of supply at present worked are more than capable of taking care of the demands made upon them.

PETROLEUM.

PETROLEUM

There is but little variation to report in the petroleum refining industry for 1897. The companies engaged in refining during the year were:

The Imperial Oil Co., Ltd. } Petrolia.
The Petrolia Crude Oil and Tanking Co. } Petrolia.
The National Oil Co., Ltd. } Petrolia.
The Empire Oil Co., London.
The Bushnell Co., Ltd.

The last named company has works at Petrolia and at Sarnia; those at Sarnia having been operated only during the months of October, November, and December.

The production of illuminating oils and other petroleum products for the year attained a total value of $1,672,429, being a decrease from

PETROLEUM. the value of the production in 1896 of $204,484 or 10·9 per cent compared with an increase in 1896 over 1895 of 4 per cent.

Production. Tables 1 and 2, show the production of illuminating oils and other products and the consumption of crude oils and chemicals respectively, the total value of the latter in 1897, being $1,147,622.

TABLE 1.

PETROLEUM.

PRODUCTION OF CANADIAN OIL REFINERIES.

Products.	Calendar Years.					
	1895.		1896.		1897.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
		$		$		$
Illuminating oils..galls.	10,711,378	1,217,426	11,207,150	1,251,122	10,493,449	1,064,130
Benzine and naphtha...... .. . "	642,484	63,026	719,453	70,733	747,163	71,978
Paraffine oils..... "	1,016,039	140,245	1,014,271	132,308	930,490	136,283
Gas and fuel oils.. "	6,095,355	218,692	6,788,353	261,618	6,723,683	249,615
Lubricating oils and tar........ "	1,698,559	75,578	1,447,455	77,109	1,148,847	62,058
Paraffine wax.... lbs.	1,840,021	82,970	1,532,670	76,249	1,805,365	81,191
Axle grease.... . "	....	8,300	318,928	7,774	227,079	7,174
Totals	....	1,806,237	....	1,876,913	....	1,672,429

TABLE 2.

PETROLEUM.

CONSUMPTION OF CRUDE OIL AND CHEMICALS.

Articles.	Calendar Years.			
	1894.	1895.	1896.	1897.
Crude petroleum ....galls.	27,884,080	24,954,855	25,881,095	25,488,230
Sulphuric acid.......... lbs.	4,974,610	4,919,271	5,146,429	5,504,411
Soda .... "	430,810	390,781	438,058	479,660
Litharge .... "	472,139	390,573	361,603	504,227
Sulphur .... "	96,144	78,597	80,612	65,349

The production of crude oil in 1897 was obtained as usual from the inspection returns of the Inland Revenue Department, by calculating from the quantity of refined oil inspected during the year, the ratio of crude to refined being taken as 100 to 42.

Table 3 shows the quantities of Canadian and imported oils inspected during the calendar year, complete details as to the number of different sized packages, etc., being given.

PETROLEUM.
Inspection of oils.

TABLE 3.

PETROLEUM.

INSPECTION OF CANADIAN AND IMPORTED OILS, CALENDAR YEAR 1897.

Number of Packages.	Inspection Fee.	Approximate Number of Gallons per Package.	Total Gallons, Canadian.	Total Gallons, Imported.
	cts.			
241,388	10	42	10,138,296	....
143,432	10	42	....	6,024,144
*82	10	42	1,722	1,722
165	5	10	....	1,650
58,972	2½	5	294,860	....
120,169	2½	5	....	600,845
Total			10,434,878	6,628,361

* Reported as mixed Canadian and Imported Oils and assumed to contain equal quantities of each.

Table 4 gives the statistics of the quantity of Canadian refined oils inspected, together with the crude equivalent calculated from the same both in gallons and in barrels, the average price per barrel (see Table 13) and the total value of the crude oil.

TABLE 4.

PETROLEUM.

CANADIAN OILS AND NAPHTHA INSPECTED AND CORRESPONDING QUANTITIES OF CRUDE OIL.

Calendar Year.	Refined Oils Inspected.	Crude Equivalent Calculated.	Ratio of Crude to Refined.	Equivalent in Barrels of 35 Gallons.	Average Price per Barrel of Crude.	Value of Crude Oil.
	Galls.	Galls.				
1881......	6,457,270	12,914,540	100 : 50	368,987	....	....
1882......	6,135,782	13,635,071	100 : 45	389,573	....	....
1883......	7,447,648	16,550,328	100 : 45	472,866	....	....
1884......	7,993,995	19,984,987	100 : 40	571,000	....	....
1885......	8,225,882	20,564,705	100 : 40	587,563	....	....
1886......	7,768,006	20,442,121	100 : 38	584,061	\$0.90	\$525,655
1887......	9,492,588	24,980,494	100 : 38	713,728	0.78	556,708
1888......	9,246,176	24,332,042	100 : 38	695,203	1.02⅔	713,695
1889......	9,472,476	24,664,144	100 : 38	704,690	0.92¾	653,600
1890......	10,174,894	26,776,037	100 : 38	795,030	1.18	902,734
1891......	10,065,463	26,435,430	100 : 38	755,298	1.33¾	1,010,211
1892......	10,370,707	27,291,334	100 : 38	779,753	1.26¼	984,438
1893......	10,618,804	27,944,221	100 : 38	798,406	1.09½	874,255
1894......	11,027,082	29,018,637	100 : 38	829,104	1.00¾	835,322
1895......	10,674,232	25,414,838	100 : 42	726,138	1.49⅔	1,036,738
1896......	10,684,284	25,438,771	100 : 42	726,822	1.59	1,155,647
1897......	10,434,878	24,844,995	100 : 42	709,857	1.42½	1,011,546

PETROLEUM

Table 6 shows the amount of oil inspected both Canadian and imported for the fiscal year and is compiled from the Reports of the Inland Revenue Department.

Inspection of oils.

Table 5 illustrates the manner in which the figures for each year in Table 6 are made up and is exactly similar to Table 3, except that it applies to the fiscal year instead of to the calendar year.

TABLE 5.

PETROLEUM.

INSPECTION OF CANADIAN AND IMPORTED OILS, FISCAL YEAR 1897.

Number of Packages.	Inspection Fee.	Approximate Number of Gallons per Package.	Total Gallons, Canadian.	Total Gallons, Imported.
	cts.			
244,616	10	42	10,273,872	....
134,842	10	42	....	5,663,364
174	10	42	3,654	3,654
184	5	10	....	1,840
45,800	2½	5	229,000	....
115,977	2½	5	....	579,885
	Total................		10,506,526	6,248,743

TABLE 6.

PETROLEUM.

TOTAL AMOUNT OF OIL INSPECTED, CANADIAN AND IMPORTED.

Fiscal Year.	Canadian.	Imported.	Total.	Per cent, Canadian.	Per cent, Imported.
	Galls.	Galls.	Galls.	%	%
1881..........	6,406,783	476,784	6,883,567	93·1	6·9
1882..........	5,910,747	1,351,412	7,262,159	81·4	18·6
1883	6,970,550	1,190,828	8,161,378	85·4	14·6
1884..........	7,656,001	1,142,575	8,798,586	87·0	13·0
1885..........	7,661,617	1,278,115	8,939,732	85·7	14·3
1886	8,149,472	1,327,616	9,477,088	86·0	14·0
1887..........	8,243,962	1,665,604	9,909,566	83·2	16·8
1888..........	9,545,895	1,821,342	11,367,237	84·0	16·0
1889..........	9,462,834	1,767,812	11,230,646	84·3	15·7
1890..........	10,121,210	2,020,742	12,141,952	83·4	16·6
1891..........	10,270,107	2,022,002	12,292,109	83·6	16·4
1892..........	10,238,426	2,429,445	12,667,871	80·8	19·2
1893	10,683,806	2,641,690	13,325,496	80·2	19·8
1894..........	10,824,270	5,633,222	16,457,492	65·8	34·2
1895...	10,936,992	5,650,994	16,587,986	65·9	34·1
1896..........	10,533,951	5,807,991	16,341,942	64·5	35·5
1897..........	10,506,526	6,248,743	16,755,269	62·7	37·3

PETROLEUM.

Inspection of oils.

This latter table illustrates very well the consumption of refined petroleum in Canada. Quite a considerable increase will be noted between 1892 and 1894, which is probably to be accounted for by the fact that in 1893, inspection fees for imported petroleum were reduced from 25c., 10c. and 5c., to 10c., 5c. and 2½c. respectively. To facilitate comparison between the quantities of Canadian and imported oils inspected, two columns not hitherto given have been added, showing the relative percentage of each in the totals. From these it will be seen that whereas from 1882 to 1893 the Canadian oil fields supplied from 80 per cent to 90 per cent of the consumption, latter years have shown a falling away in the proportion to be credited to domestic sources, the percentage from 1894 to 1897 varying from 62 to 65. It will be seen, however, that this is not due to a diminution in the home production, but is rather a result of the increased use of imported oils.

Table 6 applied to the fiscal year. Similar statistics for the calendar years being available since 1892, the figures have been given below in Table 7.

TABLE 7.

PETROLEUM.

TOTAL AMOUNT OF OIL INSPECTED, CANADIAN AND IMPORTED.

Calendar Year.	Canadian.	Imported.	Total.	Per cent, Canadian.	Per cent, Imported.
	Galls.	Galls.	Galls.	%	%
1892......	10,370,707	2,601,946	12,972,653	79·9	20·1
1893..........	10,618,804	4,520,392	15,139,196	70·1	29·9
1894..........	11,027,082	5,705,787	16,732,869	65·9	34·1
1895..........	10,674,232	5,677,381	16,351,613	65·3	34·7
1896..........	10,684,284	6,106,032	16,790,316	63·6	36·4
1897..........	10,434,878	6,628,361	17,063,239	61·2	38·8

PETROLEUM.

Statistics of the exports and imports of petroleum and its products as obtained from the Trade and Navigation Reports are given below in Tables 8, 9, 10, 11 and 12.

TABLE 8.

PETROLEUM.

Exports.

EXPORTS OF CRUDE AND REFINED PETROLEUM.

Calendar Year.	Crude Oil.		Refined Oil.		Total.	
	Gallons.	Value.	Gallons.	Value.	Gallons.	Value.
1881	....	....	....	....	501	$ 99
1882	....	....	....	....	1,119	286
1883	....	....	....	....	13,283	710
1884	....	....	....	....	1,098,090	30,168
1885	....	....	....	....	337,967	10,562
1886	....	....	....	....	241,716	9,855
1887	....	....	....	....	473,559	13,831
1888	....	....	....	....	196,602	74,542
1889	....	....	....	....	235,855	10,777
1890	....	....	....	....	420,492	18,154
1891	446,770	$ 18,471	585	$104	447,355	18,575
1892	310,387	12,945	1,146	100	311,533	13,045
1893	107,719	3,696	2,196	394	109,915	4,090
1894	53,985	2,773	5,297	513	59,282	3,286
1895	22,831	1,044	10,237	2,023	33,068	3,067
1896	601	101	7,489	999	8,090	1,100
1897	....	....	342	49	342	49

TABLE 9.

PETROLEUM.

IMPORTS OF PETROLEUM AND PRODUCTS OF.

PETROLEUM.

Imports.

Fiscal Year.	Gallons.	Value.
1880	687,641	$131,359
1881	1,437,475	262,168
1882	3,007,702	398,031
1883	3,086,316	358,546
1884	3,160,282	380,082
1885	3,767,441	415,195
1886	3,819,146	421,836
1887	4,290,003	467,003
1888	4,523,056	408,025
1889	4,650,274	484,462
1890	5,075,650	515,852
1891	5,071,386	498,330
1892	5,649,145	475,732
1893	6,002,141	446,389
1894	6,597,108	439,988
1895	7,577,674	525,372
1896	8,005,891	735,913
1897 Oils: Mineral—		
(a) Coal and kerosene, distilled, purified or refined, naphtha and petroleum, N.E.S.	7,588,028	$598,547
(b) Products of petroleum	81,367	8,105
(c) Crude petroleum, fuel and gas oils (other than naphtha, benzine or gasoline) when imported by manufacturers (other than oil refiners) for use in their own factories, for fuel purposes or for the manufacture of gas.	1,875	190
(d) Illuminating oils composed wholly or in part of the products of petroleum, coal, shale or lignite, costing more than 30 cents per gallon.	24,988	8,090
(e) Lubricating oils composed wholly or in part of petroleum costing less than 25 cents per gallon	719,044	82,237
	8,415,302	697,169

PETROLEUM

Imports

TABLE 10.*

PETROLEUM.

IMPORTS OF CRUDE AND MANUFACTURED OILS, OTHER THAN ILLUMINATING.

Fiscal Year.	Gallons.
1881	960,691
1882	1,656,290
1883	1,895,488
1884	2,017,707
1885	2,489,326
1886	2,491,530
1887	2,624,399
1888	2,701,714
1889	2,882,462
1890	3,054,908
1891	3,049,384
1892	3,047,199
1893	1,481,749
1894	1,860,829
1895	1,106,907
1896	1,079,940
1897	800,411

* This table is composed of items (*b*) and (*e*) of Table 9.

TABLE 11.

PETROLEUM.

IMPORTS OF PARAFFINE WAX.

Fiscal Year.	Pounds.	Value.
1883	43,716	$ 5,166
1884	39,010	6,079
1885	59,967	8,123
1886	62,035	7,953
1887	61,132	6,796
1888	53,862	4,930
1889	63,229	5,250
1890	239,229	15,844
1891	753,854	50,275
1892	733,873	48,776
1893	452,916	38,935
1894	208,099	15,704
1895	163,817	11,579
1896	150,287	10,042
1897	138,703	7,945

PETROLEUM.
Imports.

TABLE 12.

PETROLEUM.

IMPORTS OF PARAFFINE WAX CANDLES.

Fiscal Year.	Pounds.	Value.
1880	10,445	$2,269
1881	7,494	1,683
1882	5,818	1,428
1883	7,149	1,734
1884	8,755	2,229
1885	9,247	2,449
1886	12,242	2,587
1887	21,364	3,611
1888	22,054	2,829
1889	8,038	1,337
1890	7,233	1,186
1891	10,598	2,116
1892	9,259	1,952
1893	8,351	1,735
1894	10,818	1,685
1895	19,448	2,541
1896	25,787	4,072
1897	25,114	2,929

For the details of Table 13, showing the average closing prices for crude oil on the Petrolia Oil Exchange, we are indebted to the secretary of that Exchange.

Prices.

TABLE 13.

PETROLEUM.

AVERAGE CLOSING PRICES FOR CRUDE OIL ON PETROLIA OIL EXCHANGE.

Month.	Calendar Years.						
	1891.	1892.	1893.	1894.	1895.	1896.	1897.
	$	$	$	$	$	$	$
January	1.30	1.29¼	1.18¼	1.01¼	1.16	1.72	1.50
February	1.28½	1.29	1.18¾	1.01	1.19⅞	1.72	1.50
March	1.31¾	1.27¾	1.19	1.01	1.27	1.72	1.50
April	1.37	1.26	1.19	.99½	1.55¾	1.72	1.40
May	1.37½	1.25¾	1.07	.92	1.67¼	1.70	1.40
June	1.37	1.27½	1.07	.92¾	1.52	1.50	1.40
July	1.33½	1.26½	1.06	.94	1.54¼	1.50	1.40
August	1.34¾	1.26	1.05	.96	1.54	1.50	1.40
September	1.35	1.26¼	1.04½	.98	1.55½	1.50	1.40
October	1.35	1.26¾	1.04	1.06	1.59⅞	1.50	1.40
November	1.33¼	1.25	1.04	1.12¼	1.64½	1.50	1.40
December	1.31½	1.18½	1.02	1.13½	1.72⅜	1.50	1.40
The Year	1.33¾	1.26¼	1.09½	1.00¾	1.49⅔	1.59	1.42½

PETROLEUM.

ONTARIO.

Discovery and development.

Operations in this industry have, as in the past, been mainly located in the Petrolia and Oil Springs districts, Lambton c unty. Outside of these points, however, the work of re-opening the old Bothwell oil-field, Zone township, Kent county, begun in 1896, was continued with a fair measure of success. A number of wells were also bored on a newly discovered field in the township of Dawn, Lambton county, near the village of Florence. At the latter point it is said that eleven wells were sunk, all of which were producers. According to the report of the Ontario Bureau of Mines, the production of the Bothwell field during 1897 amounted to 1,048,862 imperial gallons, valued at $43,099, and a number of wells were bored. Some were, however, abandoned, the field in some respects not having quite come up to the expectations held with regard to it in the autumn of 1896.

All the productive operations in oil in Canada were confined, as above described, to the western portion of the Peninsula of Ontario.

QUEBEC.

In Quebec, the experimental borings in the vicinity of Gaspé Bay were continued. Of the results of this work no authentic and reliable data are available.

NORTH-WEST TERRITORIES.

Outside of these the only other point of interest is to be found in the borings carried on for the past few years by the Geological Survey with the object of proving the presence of oil in the lower portions of the Cretaceous rocks of northern Alberta. The extensive outcroppings of the "tar-sands" along the valley of the Athabasca River would seem to indicate the possibility of these same beds carrying the lighter oils if tapped in depth, and where removed from the oxidising effects to which the tarry matter of the outcropping is probably due.

With the object of testing this point, a bore hole was put down at Athabasca Landing, which it was believed should encounter the "tar-sands" at a depth of about 1,800 feet. Owing, however, to the extremely difficult character of the formation to be penetrated, this hole had to be abandoned before reaching these beds. Two new holes were started during the year at the mouth of the Pelican River ninety miles down the Athabasca River, below Athabasca Landing, and at

Victoria on the Saskatchewan. In the first, strata impregnated with maltha or heavy tarry petroleum were encountered at 750 feet, similar to those outcropping some sixty miles away on the river, but further extension of the hole was prevented by a very heavy flow of gas which was encountered. PETROLEUM.

The boring at Victoria had not yet attained a sufficient depth to give any results, but will be continued, if possible, to a depth of 2,000 feet.

Full details of the results of these borings and of the conclusions to be drawn therefrom are to be found in the Summary Reports of the Geological Survey for the years 1894 to 1897.

The above constitutes the only work done in the west in the search for oil, there having been no further exploitation of the indications described by Dr. Selwyn in the South Kootenay pass and vicinity in 1891 (Annual Report of the G.S.C., 1890-91, pp. 124 ss.)

PHOSPHATE.

PHOSPHATE.

The production of phosphate is now represented almost entirely by the mineral taken out as a by-product in the mining of mica.

As indicated by the tables, the industry was at one time of considerable extent, but the Canadian mines have been unable to compete with the more easily worked deposits in the south-eastern United States and Algeria. Production.

TABLE 1.

PHOSPHATE.

ANNUAL PRODUCTION.

Calendar Year.	Tons.	Value per ton.	Value.
1886	20,495	$14.85	$304,338
1887	23,690	13.50	319,815
1888	22,485	10.77	242,285
1889	30,988	10.21	316,662
1890	31,753	11.37	361,045
1891	23,588	10.24	241,603
1892	11,932	13.20	157,424
1893	8,198	8.65	70,942
1894	6,861	6.00	41,166
1895	1,822	5.25	9,565
1896	570	6.00	3,420
1897	908	4.39	3,984

PHOSPHATE.
Exports.

TABLE 2.

PHOSPHATE.

EXPORTS.

Calendar Year.	Ontario.		Quebec.		Totals.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
1878..........	824	$12,278	9,919	$195,831	10,743	$208,109
1879..........	1,842	20,565	6,604	101,470	8,446	122,035
1880..........	1,387	14,422	11,673	175,664	13,060	190,086
1881..........	2,471	36,117	9,497	182,339	11,968	218,456
1882..........	568	6,338	16,585	302,019	17,153	308,357
1883..........	50	500	19,666	427,168	19,716	427,668
1884..........	763	8,890	20,946	415,350	21,709	424,240
1885..........	434	5,962	28,535	490,331	28,969	496,293
1886..........	644	5,816	19,796	337,191	20,460	343,007
1887..........	705	8,277	22,447	424,940	23,152	433,217
1888..........	2,643	30,247	16,133	268,362	18,776	298,609
1889..........	3,547	38,833	26,440	355,935	29,987	394,768
1890..........	1,866	21,329	26,591	478,040	28,457	499,369
1891..........	1,551	16,646	15,720	368,015	17,271	384,661
1892..........	1,501	12,544	9,981	141,221	11,482	153,765
1893..........	1,990	11,550	5,748	56,402	7,738	67,952
1894..........	1,980	10,560	3,470	29,610	5,450	40,170
1895..........	....	....	250	2,500	250	2,500
1896..........	1	5	299	2,990	300	2,995
1897..........	70	450	165	400	235	850

PRECIOUS METALS.

PRECIOUS METALS.

The precious metals, gold and silver, are considered together, as in the past, for the reason that they occur in many districts as constituents of the same ores and are produced by the same mines.

Gold.

GOLD.

In common with a majority of the gold producing countries Canada shows a considerable increase in the production of that metal in 1897.

While in 1896 its value constituted about twelve per cent of the total mineral production of the Dominion, its proportion of the total in 1897 was not less than twenty-one per cent.

The product of 1896, $2,754,774, was exceeded by $3,272,242 an increase of 118 per cent, the output of 1897 being $6,027,016. A large part of this gratifying increase was of course due to the unusual activity displayed in the working of the placer diggings of the Yukon, consequent upon the discovery of some exceedingly rich deposits in that district. Nevertheless, the rich winnings from these northern regions must not be permitted to detract from the importance of the advance and large increase to be credited to other gold mining regions of the Dominion. PRECIOUS METALS.

In Nova Scotia, the mining of the free-milling ores of the province is an industry of long standing, and yearly increases are not large, yet the product of 1897 increased 13·9 per cent over that of 1896. Gold.

Although greater results than those achieved were expected from the Ontario ores and the total output is still small, this province, in 1897, shows the largest percentage increase, *viz.*, 64·6 per cent over the production of the previous year.

In British Columbia, the statistics show that since 1858, in but three years, viz., 1863, 1864 and 1865, was the production greater than that recorded for last year. But, whereas in those years, the entire output was due to placer mining; lode mining, is to be credited with the major part of the output of 1897. Of the $2,724,723 produced in the latter year, but $530,723 was won from the placer deposits, the remainder coming from the lode mines.

The increase per cent in the production of 1897 over 1896 was 52·4, as compared with 41·1 per cent increase of 1896 over the previous year.

The proportion contributed by the different provinces to the grand total for the Dominion was approximately:—British Columbia, 45·2 per cent; Yukon District, 41·5 per cent; Nova Scotia, 9·3 per cent; and Ontario, 3·1 per cent.

TABLE 1.

PRECIOUS METALS.

GOLD—ANNUAL PRODUCTION IN CANADA. Production.

Calendar Year.	* Ounces. Fine.	Value.
		$
1887	57,465	1,187,804
1888	53,150	1,098,610
1889	62,658	1,295,159
1890	55,625	1,149,776
1891	45,022	930,614
1892	43,909	907,601
1893	47,247	976,603
1894	54,605	1,128,688
1895	100,806	2,083,674
1896	133,274	2,754,774
1897	291,582	6,027,016

* Calculated from the values at the rate of $20.67 per ounce.

PRECIOUS METALS.
Gold.
Production by provinces.

TABLE 2.

PRECIOUS METALS.

GOLD:—PRODUCTION BY PROVINCES AND DISTRICTS, CALENDAR YEAR, 1897.

Provinces.		Ounces.*	Value.
Nova Scotia	*b.*	27,197	$ 562,165
Quebec	*a.*	43	900
Ontario	*b.*	9,158	189,294
North-west Territories—			
Yukon District	*a.*	120,948	2,500,000
Saskatchewan	*a.*	2,419	50,000
British Columbia	*c.*	131,817	2,724,657
Total		291,582	$6,027,016

* Calculated from the values at the rate of $20.67 per ounce.
a. Placer gold.
b. Gold produced in treating free milling ores.
c. As follows: Gold from placer mining .... $ 530,723
" vein " 2,193,934
$2,724,657

Nova Scotia.

NOVA SCOTIA.

The statistics of the gold production in Nova Scotia are given in Tables A, B, C, 3 and 4, Table A showing the annual gold output; Table B the tons of quartz crushed; Table C the average yield per ton. In Table 3 the total production of each district from 1862 to the end of 1897 is exhibited, as well as the average yield per ton; and Table 4 shows the amount of ore crushed and the yield per district for 1897.

With respect to the output for the latter year, it will be seen to have been derived from some twenty-five districts representing forty-seven mills. In many of these districts, however, but small quantities of ore were crushed, and seven of the twenty-five, *viz.*, Brookfield in Queens county; Caribou and Moose River, Fifteen-mile Stream, and Montague in Halifax county; Sherbrooke and Stormont in Guysborough county; and Uniacke in Hants county, account for over 84 per cent of the total gold output.

The average yield per ton of the different districts tabulated is quite variable, the lowest being 3 dwts. 11 grs. from Lawrencetown, and the highest 2 oz. 14 dwts. 3 grs. from Gold River. In two districts the average yield per ton exceeded 2 oz., and in five it varied from 1 to 2 oz., being less than 1 oz. in the remainder. Of the larger producing districts, *i.e.*, those producing over 1,000 oz., Montague and Uniacke show the highest average values, the former being 1 oz. 1 dwt. 10 grs., and the latter 1 oz. 12 grs. The average for the whole province was 7 dwts. 21 grs.

PRECIOUS METALS.

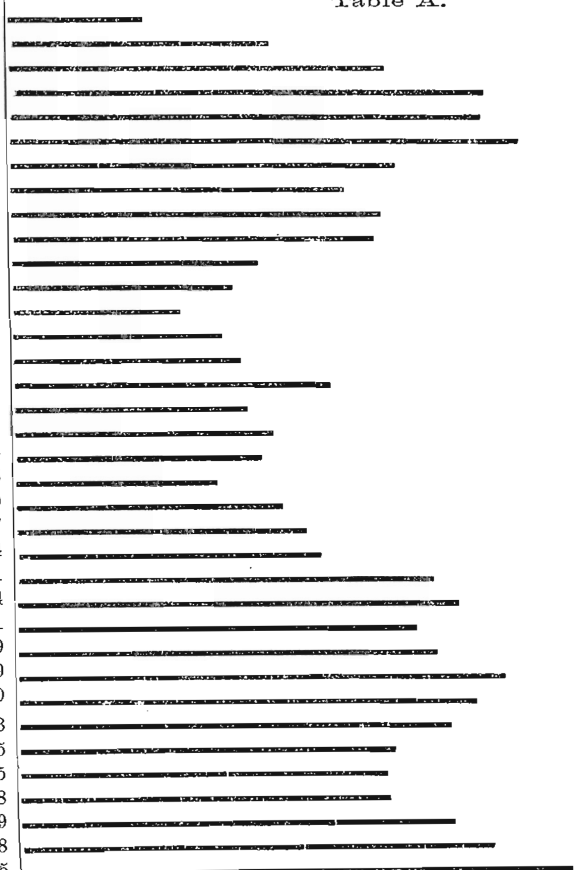
Gold.

Nova Scotia.

The statistical history of the industry, showing the yearly variations in the production of ore and of gold and the average yield per ton of ore, is clearly exhibited in graphic Tables A, B, C. The amount of quartz crushed annually will be seen to have been increased much more rapidly than the value of the gold output. This special feature is shown more prominently in Table C, giving the average yield per ton. The gradual lowering of the grade of ore treated is most probably a result of improved methods in mining and of a general lessening of mining costs, so that ores formerly incapable of profitable treatment can now be milled to advantage.

GOLD.
NOVA SCOTIA.
ANNUAL PRODUCTION.
Table A.

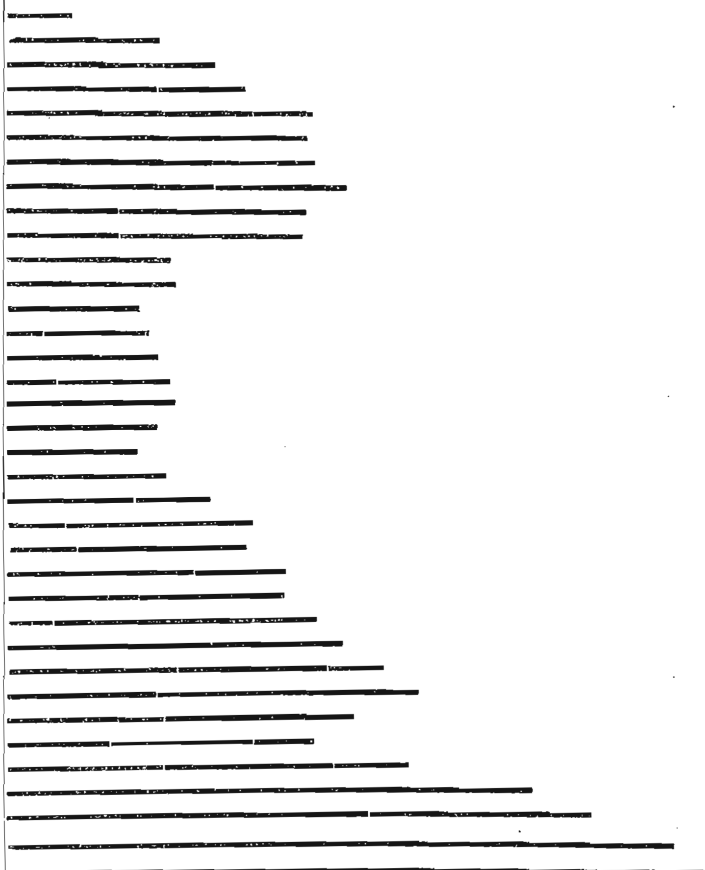
Calendar Year.	Value.
	$
1862	141,871
1863	272,448
1864	390,349
1865	496,357
1866	491,491
1867	532,563
1868	400,555
1869	348,427
1870	387,392
1871	374,972
1872	255,349
1873	231,122
1874	178,244
1875	218,629
1876	233,585
1877	329,205
1878	245,253
1879	268,328
1880	257,823
1881	209,755
1882	275,090
1883	301,207
1884	313,554
1885	432,971
1886	455,564
1887	413,631
1888	436,939
1889	510,029
1890	474,990
1891	451,503
1892	389,965
1893	381,095
1894	389,338
1895	453,119
1896	493,568
1897	562,165



PRECIOUS METALS.

GOLD.
NOVA SCOTIA.
TONS OF QUARTZ CRUSHED.
Table B.

Calendar Year.	Tons.
1862	6,473
1863	17,000
1864	21,431
1865	24,421
1866	32,157
1867	31,384
1868	32,259
1869	35,144
1870	30,824
1871	30,787
1872	17,089
1873	17,708
1874	13,844
1875	14,810
1876	15,490
1877	17,369
1878	17,989
1879	15,936
1880	13,997
1881	16,556
1882	21,081
1883	25,954
1884	25,186
1885	28,890
1886	29,010
1887	32,280
1888	36,178
1889	39,160
1890	42,749
1891	36,351
1892	32,552
1893	42,354
1894	55,357
1895	60,600
1896	69,169
1897	73,192



PRECIOUS METALS.

Gold.

Nova Scotia.

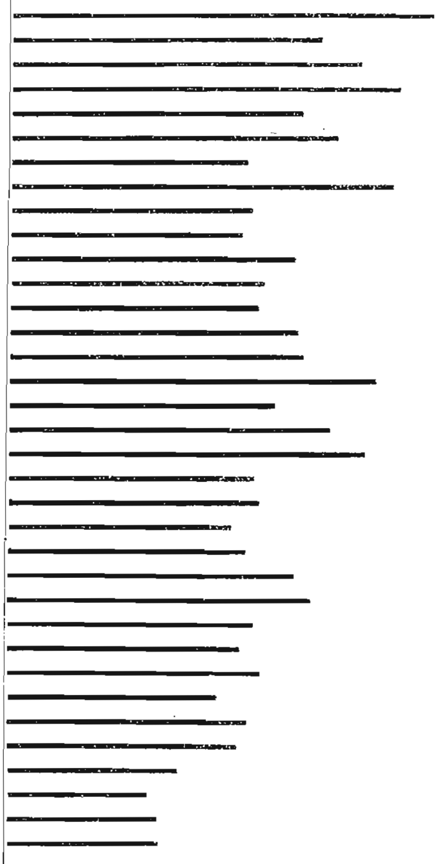
GOLD.

NOVA SCOTIA.

AVERAGE YIELD PER TON OF ORE CRUSHED.

Table C.

Calendar Year.	Value.
	$
1862	21·91
1863	16·02
1864	18·21
1865	20·32
1866	15·28
1867	16·96
1868	12·41
1869	19·91
1870	12·56
1871	12·17
1872	14·94
1873	13·05
1874	12·87
1875	14·76
1876	15·08
1877	18·95
1878	13·63
1879	16 83
1880	18·42
1881	12·66
1882	13·04
1883	11·60
1884	12·44
1885	14·98
1886	15·70
1887	12·81
1888	12·08
1889	13·02
1890	11·11
1891	12·42
1892	11·98
1893	8·99
1894	7·04
1895	7·47
1896	7 13
1897	7·68



PRECIOUS METALS.
Gold.
Nova Scotia.

TABLE 3.

PRECIOUS METALS.

GOLD—NOVA SCOTIA. PRODUCTION OF THE DIFFERENT DISTRICTS FROM 1862 TO 1897, INCLUSIVE.

Districts.	Tons of Ore Crushed.	Total Yield. Oz.	Dwt.	Grs.	Value at $19.50 per Oz.	Average Yield per Ton of 2,000 lbs.
					$	$
Beaver Dam	80	17	0	0	332	4·14
Brookfield	25,642	16,225	12	4	316,399	12·34
Caribou and Moose R.	101,736	39,478	0	23	769,822	7·57
Carlet· n	45	19	5	18	376	8·36
Cow Bay	735	701	2	0	13,671	18·60
Cranberry Head	69	46	14	0	911	13·20
Central Rawdon	13,340	10,121	11	21	197,371	14·80
Fifteen-Mile Stream	36,405	17,484	1	5	340,939	9·37
Gays River	91	14	1	0	274	3·01
Gold River	726	1,061	17	23	20,707	28·52
Kemptville	120	56	3	5	1,095	9·12
Killag	762	1,190	5	12	23,210	30·46
Lake Catcha	12,541	11,110	17	20	216,662	17·28
Lawrencetown	43	7	18	22	155	3·58
Leipsigate	295	174	9	6	3,402	11·53
Liscombe Mills	7	0	15	6	15	2·12
Malaga	23,078	15,463	4	21	301,534	13·07
Montague	21,526	37,331	10	14	727,965	33·81
Oldham	44,962	49,320	4	12	961,744	21·39
Ovens	237	83	2	14	1,621	6·84
Renfrew	48,576	34,022	1	2	663,430	13·66
Salmon River	84,028	31,966	18	19	623,355	7·42
Sherbroke	193,821	130,570	14	18	2,546,129	13·14
Stormont	116,318	50,038	0	21	975,742	8·39
Tangier & Mooseland	34,783	20,202	3	2	393,942	11·33
Uniacke	53,103	36,444	7	14	710,665	13·38
Waverly	119,372	60,561	18	3	1,180,957	9·89
Wine Harbor	43,946	29,806	2	13	581,219	13·23
Whiteburn	7,368	10,213	18	20	199,172	27·03
Unproclaimed	56,424	42,854	17	21	835,671	14·81
Totals	1,040,179	646,589	2	23	12,608,487	12·12

PRECIOUS METALS.
Gold.
Nova Scotia.

TABLE 4.

PRECIOUS METALS.

GOLD.—NOVA SCOTIA DISTRICT DETAILS—CALENDAR YEAR 1897.

Districts.	Mines.	Mills.	Tons of Ore Crushed.	Total Yield of Gold.			Average Yield of Gold Per Ton.		
				Oz.	Dwt.	Grs.	Oz.	Dwt.	Grs.
Brookfield	2	1	9,712	3,906	18	0	0	8	1
Caribou and Moose R.	4	3	9,552	2,968	19	7	0	6	5
Carleton	1	1	45	19	5	18	0	8	19
Cow Bay	1	1	409	377	3	0	0	18	11
Cranberry Head	1	1	69	46	14	0	0	13	13
Central Rawdon	1	1	532	97	15	0	0	3	16
Fifteen Mile Stream	1	1	9,429	2,850	6	0	0	6	1
Gold River	2	2	156	422	4	20	2	14	3
Kemptville	1	1	120	56	3	5	0	9	9
Killag	2	1	260	651	12	0	2	10	3
Lake Catcha	3	2	42	38	6	0	0	18	6
Lawrencetown	1	1	22	3	15	18	0	3	11
Leipsigate	2	1	284	163	19	0	0	11	1
Malaga	1	1	390	730	0	0	1	17	10
Montague	3	2	1,396	1,495	18	19	1	1	10
Oldham	2	1	474	775	15	6	1	12	18
Ovens	1	1	210	78	3	8	0	7	11
Renfrew	2	1	120	112	11	0	0	18	18
Salmon River	1	1	40	60	5	0	1	10	3
Sherbrooke	7	5	14,865	4,410	14	7	0	5	22
Stormont	9	8	20,987	6,306	19	17	0	6	0
Tangier and Mooseland	3	2	429	110	19	11	0	5	4
Uniacke	5	5	2,294	2,353	8	2	1	0	12
Waverly	2	1	777	497	12	7	0	12	19
Wine Harbour	2	2	578	293	14	3	0	10	4
Totals and averages	60	47	73,192	28,829	3	4	0	7	21

The following tabulations contain, in a condensed form, the information as to discovery and development in gold mining during 1897, given in the report of the Department of Mines for the province.

GOLD MINES OF NOVA SCOTIA.

(Compiled from the Report of the Nova Scotia Department of Mines for 1897.)

Name of Mine or Company.	Force employed.	Shafts.	Other underground Developments, Tunnels, Drifts, Winzes, &c.	Mining Plant and Additions thereto.	Milling Plant and Operations.	Remarks.
Fifteen-Mile Gold Stream (Egerton Gold Mining Company).	40	Two shafts of which the deepest is 260 feet.	Three belts of milling ore, 14, 16 and 15 ft. thick respectively, connected by tunnels driven across the strata. Probably the largest body of milling ore exposed to view in the province.	....	30 stamp mill.	Recently 3 or 4 large frame houses have been erected for tenements.
Richardson Gold Mining Company, Gold Brook.	65	Shafts 195 feet and 125 feet in depth, a third in progress.	....	Two pumps. Steam drills have been put in lately.	....	Pillars are left in for support, as, on account of the size of the belt, ordinary timber is found insufficient.
North Star Mine	....	....	....	....	....	No work being done at present.
Country Harbour Gold Mining Co., Ltd.	....	....	....	....	....	Mine idle.
Hopewell Mining Co. ..	18	Two shafts 40 ft. and 30 ft. in depth have been sunk on a lead west of the old mine.	The old shaft has been pumped out to a depth of 40 or 50 ft., and a level driven west through 7 ft. of whin to the 5-ft. belt, on which it is intended to sink and to drive west, cutting the other belts and leads. Leads west of old mine have been tunnelled 105 ft.	....	....	Work well timbered and appears in good condition.
North of Stellarton Mine, Country Harbour.	4	75 ft. in depth	Drifted 95 ft. east and west.			

Forrest Hill District—The McConnell Mining Co., The Phœnix Gold Mining Co.	20	2 shafts down 40 and 50 feet respectively.	The lead is 13 inches thick. The distance stoped east is 22 ft., and west 154 ft., connecting the two shafts underground. Some work has been done on the Ophir belt, 3 ft. thick, and on the Camp lead, 4 inches thick.	....	Preparations are being made for the erection of a mill.	An office and three dwellings have been built.
Modstock Gold Mining Co.	60	5 shafts, 35 to 85 feet on Salmon River lead. 5 shafts, 80 to 135 feet, on Ophir lead. 2 shafts, 140 feet and 60 feet, on Mill lead. 2 shafts have been sunk on a new lead, south of the Ophir lead, the depths being 100 ft. and 70 ft. respectively.	Salmon River lead stoped 600 ft. and proved 1,400 ft. Ophir lead stoped 888 ft.; not much work done on Mill lead; considerable work has been done on Barrel lead on the surface, the greatest depth being 12 ft. in the rock. 75 feet of tunnel has been driven east and west on the "New" lead.	New stamps have been put in.	The mill house has been remodelled and a new 35 H. P. engine & new force pump obtained.	
Crow's Nest Mine....	27	Sinking from present tunnel to connect with Hardman tunnel by 50-foot shaft.	Most work done in this mine was on the Stake lead, on a 7-ft. belt of milling ore.	Putting in an Ingersoll Air Compressor capable of running three drills, a Dodge Rock Breaker, two 60 H.P. boilers and a compound engine.	A new mill house with 20 stamps being erected.	Erecting a large dwelling house and intend setting up a one hundred light dynamo to light mill, boarding house, tramway & several portions of the mine. The mine is in good shape for working on a large scale.
Cochrane Hill Mining Company.	20	....	The Mitchell belt, which is 80 ft. thick, is now opened up and they are taking out 20 ft. of it.	A compressor capable of running 3 or 4 drills; good engine and boilers.	A fine new mill house with 20 stamps.	In August, mine idle on account of lack of water supply for mill and steam purposes.
Barachois Gold Mining Co., Wine Harbour..	20	Shafts down 200 feet and 215 feet on the Romkey lead.	300 ft. stoped east of the east shaft and 250 ft. west of the west shaft. The shafts are connected, making some 750 feet of workings in length.	....	....	Preparations being made to start work on the "Twin" leads. The mine is well timbered and ventilated.

GOLD MINES OF NOVA SCOTIA—*Continued.*

Name of Mine or Company.	Force employed.	Shafts.	Other underground Developments, Tunnels, Drifts, Winzes, &c.	Mining Plant and Additions thereto.	Milling Plant and Operations.	Remarks.
Napier Gold Nining Co	14	....	Working west on the slate belt which is five feet thick.	....	....	The mine has been idle for some time. The water is now only out of the west end, but they are pumping and intend to take all the water out and work east and west.
Bluenose Gold Mining Company.	60	3 shafts of 200 feet each, and one 75 ft. in depth.	The south belt, 8 ft. thick, is stoped 500 ft.; the Springfield belt 500 ft., being stoped east 200 ft. and west 300 ft., from shaft. The Coburg lead is stoped east 200 ft. and west 100 ft. Other belts and leads are opened up ready for work.	A hoisting engine of 40 H.P.; an air compressor which runs two drills; and a new trestle 1,200 ft. long for carrying the ore from the various pits to the mill house.	A new mill house with 20 stamps running with an engine of 45 H.P.	The management is preparing to put in larger air compressors and will run more drills in the near future.
The New Glasgow Gold Mining Co.	45	Down 135 feet, still sinking.				
The Sutherland Develepement Company.	15	5 shafts ranging in depth from 50 ft. to 90 ft.	A cross tunnel between two of the shafts connects several leads.	A 25-H.P. engine....	A new mill with 10 stamps in running order.	
Salmon River, Dares Hill District (Eagle Lake Mine).	...	3 shafts, 30 ft. to 50 ft. in depth.	....	Boiler, engine and pumping gear.	Battery of 5 stamps.	Vein yields from $1\frac{1}{2}$ to 3 oz. per ton.
Killag Mine	18	Shaft down 70 ft. and still sinking.	60 ft. stoped.			

Caribou District—Guffey Jennings Gold Mining Company.	12	500 feet deep..	The present working consists of a shaft 130 feet deep, then a slant down some 800 ft. at an angle of 36°, sinking a new shaft 4 ft. 6 in. by 9 ft., to go down 500 ft.; old and new shaft to be connected by a tunnel.	A new air compressor and air drills; good boilers and engines.	Well equipped with new mill houses and mill.	
Elk Mining Company.	18	100 feet deep...........	From shaft bottom there is a slant driven 300 ft. at an angle of 45°.			
The Dickson Mine ...	10	....	....	.. ..	....	Water has been permitted to rise in the mine to within 90 feet of the surface.
The Touquay Gold Mining Company.	32	4 shafts from 30 ft. to 170 ft. in depth.	About 540 ft. of stoping done.			
Little Liscombe Gold Mine.	9	Deepest shaft 60 feet.				
South Uniacke Gold Mine.	57	4 shafts from 100 feet to 225 feet in depth.	900 ft. of stoping......	2 boilers of 60 H.P. and 50 H.P., respectively; 45 H.P. hoisting engine, 2 steam drills.	10-stamp mill with 40 H.P. engine.	
Quirk and Thompson Mine.	5	....	....	Hoisting engine of 10 H.P.	5-stamp mill with 10 H.P. engine.	
Northup Gold Mining Company.	28	5 shafts of which the deepest is 405 feet.	....	There are in use at the mine one 60 H.P. boiler, one 40 H.P. engine, a steam pump for supplying water to the mill and boilers.	Two 5-stamp batteries.	The ore is taken from shaft to mill on a trestle about 520 ft. long.
Malaga Lake.........	60	7 shafts varying from 40 ft. to 100 ft. in depth.	Between 300 ft. and 400 ft. stoped.	Engine and boiler house under construction.	.. . .	Mills idle.

GOLD MINES OF NOVA SCOTIA—*Concluded.*

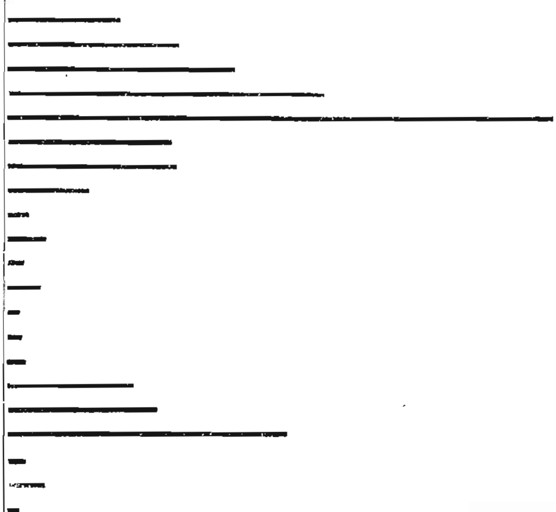
Name of Mine or Company.	Force employed.	Shafts.	Other underground Developments, Tunnels, Drifts, Winzes, &c.	Mining Plant and Additions thereto.	Milling Plant and Operations.	Remarks.
North Brookfield Mine	80	Shaft, 375 ft. deep.	Considerable underground work has been done. The shaft goes down vertically for 135 ft. and then slants at an angle of 36° for about 700 ft. Several tunnels from 60 to 85 ft. have been driven.	Engine of about 120 H.P.	20-stamp mill; milling capacity about 1,000 tons p. month and a chlorination plant capable of treating 1,000 tons p. month.	
The Philadelphia Mining Company.	30	3 shafts, 180 ft. to 200 ft. in depth.	Shafts connected underground for a distance of 300 ft.	Boilers and engines of about 100 H.P.	20-stamp mill.	
Near Stanbourn Settlement.	16	3 shafts, 18 ft. to 24 ft. deep.	....	....	5-stamp mill.	
Block House Mine....	6	Shaft, 46 ft.				
Gold River Gold Mine.	7	4 shafts, 50 ft. to 80 ft. deep.	Shafts all connected underground..	....	2-stamp mill.	
Hayward Mine, Montague.	....	Shaft, 340 ft. deep......	About 250 ft. of drifting done.....	3 rock drills in operation.		
Oland Property......	....	2 shafts, 50 and 60 ft. deep	Shafts connected by a drift 25 feet long.			

PRECIOUS METALS.

Gold.
Quebec.

GOLD.
QUEBEC.
ANNUAL PRODUCTION.
TABLE D.

Calendar Year.	Value.
	$
1877*	12,057
1878	17,937
1879	23,972
1880	33,174
1881	56,661
1882	17,093
1883	17,787
1884	8,720
1885	2,120
1886	3,981
1887	1,604
1888	3,740
1889	1,207
1890	1,350
1891	1,800
1892	12,987
1893	15,696
1894	29,196
1895	1,281
1896	3,000
1897	900



* Second half of year only.

QUEBEC.

"Gold mining operations in the Chaudière valley and in the "Eastern Townships" generally have been somewhat restricted during the past season owing to causes unnecessary to relate. In the first-mentioned district an advance has, however, been made, and new methods of operating the alluvial mines there have been inaugurated. Two new companies have been formed—one called the Gilbert-Beauce Mining Company, whose object it is to reopen and work the gold mines of the Gilbert River valley; another, known as the Central Quebec Gold Fields Company, to explore the gravels of Rivière du Loup valley. To carry on the work more advantageously in the Gilbert valley, a scheme of draining the mines by an open-cut or trench has been

PRECIOUS METALS.

Gold.

adopted, the slope of the valley being sufficient to allow this to be done by an opening of twenty to thirty feet in depth, affording an outlet to the drainage of that portion of the old pre-glacial channel above lot 15, DeLery. On 4th Nevember this open cut or trench had been carried up stream to a point where it was from sixteen to eighteen feet below the surface, and tunnelling was in progress. The bottom of the pre-glacial river-channel, it was expected, would be reached at a depth of twenty feet, when sluicing for gold would commence. If this scheme is successfnl, the whole of the Gilbert River valley above the point mentioned can be drained into this trench by gravitation."

Quebec.

"The Central Quebec Gold Fields Company, organized to work the auriferous gravels of Rivière du Loup, * * * has sunk several shafts some two or three miles above the mouth of the river to a depth of sixty feet, reaching the pre-glacial gravels. Water came in so rapidly, however, that work had to be suspended until pumps were put down."

"At Dudswell work has been in progress under the Rodrigue Mining Company during the whole season. * * * Prospecting along Kingsley Brook revealed the fact that gold exists in the gravels all along its channel nearly to the source. * * * The facts at hand render it evident now that all the streams which flow off Dudswell Mountain contain gold in small quantities, and that the source of the precious metal is probably at or near the summit."

The above quotations are from the report of Mr. R. Chalmers, contained in the Summary Report of the Geological Survey for 1897.

Ontario.

ONTARIO.

There were in Ontario in 1897, some ten mines from which returns of production of gold were received, of which one was situated in Hastings, where the gold is obtained in the mispickel ores of the district, while the remainder were free-milling properties in the northern and north-western portions of the province. According to the returns received, there were 28,084 tons of ore treated last year, giving a resultant gold product valued at $189,294, or an average of about $6.74 per ton.

A majority of the mills were operated for a few weeks only towards the end of the year while for various reasons the older and larger producers were not worked to their full capacity. The Sultana mill was idle for some time pending the erection of new stamps, and the Mikado did not commence operatious until August.

The production for the year, although an increase of 64·6 per cent over that of the previous year is sufficiently encouraging to be indicative of a brighter outlook and a probably much increased output in the immediate future. PRECIOUS METALS.

The statistics of gold production in Ontario are given below in Table 5, and show that although considerable work was accomplished in 1887, the following years were unproductive, and it was not until 1891 that a definite beginning of continuous production was made, since which time the output has steadily increased year by year. Gold.

TABLE 5.

PRECIOUS METALS.

GOLD—ONTARIO—ANNUAL PRODUCTION. Ontario.

Calendar Year.	Ounces Fine.	Value.
		$
1887	327	6,760
1888	....	....
1889	....	....
1890	....	....
1891	97	2,000
1892	344	7,118
1893	708	14,637
1894	1,917	39,624
1895	3,015	62,320
1896	5,563	115,000
1897	9,158	189,294

Besides the mines actually engaged in the production of gold, at which there were employed from 400 to 450 men, there were a large number of properties, probably forty or more, upon which prospecting and development work were being actively prosecuted; and though no statistics are available as to the amounts actually spent in development work, it must nevertheless have been considerable. There will be found below a partial list of the different properties undergoing development, showing the approximate force employed in each, the depth attained in the shafts, *etc.*

GOLD MINES OF ONTARIO.

(Compiled from the Report of the Ontario Bureau of Mines for 1897.)

Mine.	Owner.	Force employed.	Depth attained.	Width of Vein.	Extent of Underground Workings.	Remarks.
MINES OF EASTERN ONTARIO.						
Hastings District—						
Belmont Mine	Cordova Exploration Co., Limited.	......	140 "	....	....	10-stamp mill.
Bannockburn Mine	....	......	...	....	....	Operated by a Toronto company.
Deloro Mine	Canadian Gold Fields, Limited.	76	127 "	....	....	Gold extracted by the bromo-cyanide process.
Craig Mine.						
Diamond Mine.						
Sudbury District—						
Dwyer Mine	John Dwyer Gold Mining Co.	8	32 "	....	....	Five parallel veins have been uncovered.
Parry Sound District—						
McGown Mine	McGown Gold Mining Co.	6	....	....	A number of open cuttings and a tunnel.	
Beatty & Wilcox Mine						
Wahnapitae District—						
Comstock	Comstock Gold Mining and Development Co.	11	102 "	2½ feet average, 4 ft. at bottom.	Some drifting has been done.	
Crystal	The Crystal Gold Mining Co.	20	110 "	....	Several shafts have been sunk and a tunnel driven 106 feet.	A 5-stamp mill has been constructed.
Hubbell Mine.						
Last Chance Mine.						

Gold Cliff Mine		6		Vein 5 inches	Tunnel driven 182 feet.	
Charleburgh Mine	Ewen McKenzie, Toronto.					
MINES OF WESTERN ONTARIO.						
District North of Lake Superior—						
Otisse Mine	Otisse Mining Company	12	31 "			
Empress					A tunnel has been driven 417 feet.	Four veins have been prospected.
Manitou-Wabigoon District—						
Jubilee		Work ceased.	75 "		A level of 88 feet in length has been run at a depth of 48 feet.	
Upper Neepawa		"	70 "			
Lower Neepawa		"	65 "			Seven veins have been found.
Quackenbush's property.						
Northern Queen			50 "			
Lower Seine District—						
Foley	The Foley Mines Co. of Ontario.	48	309 "		Four levels have been driven in main shaft. Greatest distance tested from north to south, 278 feet. A considerable amount of stoping has been done.	32 veins, more or less, have been discovered and some eleven shafts sunk. Mill has 20 stamps. Tramways have been laid in the levels and on the surface.
Olive	Preston Gold Mining Company, Limited.	34	118 "	5 to 18 inches		2-stamp battery.
Golden Star (Randolph.	Golden Star Mining and Exploration Co.	28	135 "		At a depth of 74 feet a level has been driven north to south, 187 feet.	
A. D. 2	A. D. 2 Gold Mining Co	20				

GOLD MINES OF ONTARIO—*Continued.*

Mine.	Owner.	Force employed.	Depth attained.	Width of Vein.	Extent of Underground Workings.	Remarks.
Upper Seine District—						
Sawbill......... ..	Sawbill Lake Gold Mining Company, Limited.	50	205 feet.	.. ..	Levels have been driven at depth of 60 and 120 feet, and vein tested from north to south 372 feet on first level, and 252 feet on second level.	Tramways have been laid in the levels and on the surface, self-dumping cars being employed; two 5-stamp batteries are in operation.
Hammond Gold Reef	Hammond Gold Reef Mining Co. Folger-Hammond Gold Reef Mines Company.	30 to 70	80 "	... .	....	A considerable amount of open work has been done, and a large number of test pits sunk. A 10-stamp mill is in operation and ground has been cleared for the erection of a 50-stamp mill.
Hawk Bay Mine....	....	.. ..	122 "	....	....	A large amount of development work has been done.
W. R. 56, B. 13, 14, 15, 16.	Clearwater Gold Mining Co.	12	....	....	... .	Development work in progress.
Rat Portage District—						
Triumph	Triumph Gold Mining Co ...	10	113 feet.	. .....	No drifting will be done until shaft is completed to 200 feet.	There is on the property an old Tremaine 2-stamp mill, now idle.
Black Sturgeon Mine	Andrew Benson	6	42 "	... .	....	Only prospecting work being done.
Princess	The Princess Gold Mining Co. of Ontario, Limited.	2	65 "	... .	....	A number of test pits have been sunk at several places.
Scramble	. ...	5	85 "	....	.. ..	A considerable amount of stripping has been done, and a number of trial pits sunk.

Grey Eagle Mine ...	International Gold Mining and Development Co.	7	50 "			
Shoal Lake District—						
Yum-Yum.	Yum-Yum Gold Mining Co., Limited, of Ottawa.	14	86 feet.	... .	....	Seven veins have been explored and tested with diamond drill.
Mikado........	Mikado Gold Mining Co. . .	75	124 "	4 to 6 feet...	Two levels have been driven and vein tested for 345 ft. from north to south.	There is 830 feet of tramway on surface and 500 feet in the mine. Four 5-stamp batteries are in use and it is intended to treat product of mill by bromo-cyanide process.
Ontario Limited	Ontario Limited Gold Mining Co. of London, England.	7	....	12 inches to 6 feet.	12 veins, more or less, have been stripped and tested by trial pits and several test shipments have been made.	
Cornucopia Mine....	Cedar Island Gold Mining Co. of Ontario, Limited.	... .	75 feet.			
Cameron Island Mine	J. J. Foster, of Toronto......	6	17½ "	2½ feet average.	....	4 veins discovered and tested by stripping and open cutting. Trial shipment made.
Engledue Concession	Ontario Gold Concessions, Limited, of London, England.	....	....	....	....	A number of veins have been discovered and stripped, and several test pits sunk.
Lake of the Woods District—						
Hay Island Mine ...	Hay Island Gold Mining Co.	10	64 feet.	6 to 12 inches		
Gold Hill.... ... } Black Jack... . . . }	Dominion Gold Mining and Reduction Co.	4	115 "	12 to 18 "	....	Diamond drilling has been done on both properties, but without satisfactory results.
Golden Gate........	W. A. Laycock	6	63 "	4 to 5 ft. vein matter. 18 inches pay streak.	A level of 69 feet	Test pits have been sunk on other veins.
Stella	Ontario Prospectors' Mining and Development Co. of Rat Portage.	9	65 "	2 to 4 feet...	35 feet cross-cutting.	

GOLD MINES OF ONTARIO—*Concluded.*

Mine.	Owner.	Force employed.	Depth attained.	Width of Vein.	Extent of Underground Workings.	Remarks.
Lake of the Woods District—Con.						
Triggs Mine	Triggs Gold Mining Co. of Ontario.	8				
Ambrose Mine		5	40 feet.	4 to 12 feet.		
Bath Island Mine	Bath Island Mining Co., Limited, of Toronto.		101 "	5 to 6 "	Cross-cut driven 43 feet.	
Regina	Regina (Canada) Gold Mine, Ltd.	44	374 "	1 to 9 "	6 levels aggregate over 1,800 feet in length. Maximum length of level, 536 feet. Stoping on each of first 3 levels.	New 40-stamp mill to be erected. Cyanide plant in operation, capacity 600 tons of tailings per month.
Trojan Mine	Messrs. Stirling, Walsh & Wright.	5	67 "	18 to 24 in.		Work ceased, mine sold.
Mascotte	Colcleugh Gold Mining Co. of Rat Portage.	6	50 "	A few inches to 5 feet.	Several short drifts and tunnels.	
Sullivan's Mine	Messrs. Stirling, Walsh & Wright.	6	62 "	3½ feet wide.	15 feet of drifting along vein in both directions.	
Sultana	J. F. Caldwell	38	352 "		5 levels driven from main shaft; aggregate length 800 feet: greatest distance tested from north to south 268 feet.	A new 30 stamp mill with a capacity of 80 tons per 24 hours has been put in.
Burley Mine	The Burley Gold Mining Co. of Ottawa, Limited.	22 to 50			Location in Bald Indian Bay water, 16 to 24 feet deep. Crib 60 ft. square has been sunk, and shaft being sunk in it.	Believed to be on a continuation of Sultana vein.

PRECIOUS METALS. Gold. Ontario.

Mr. Wm. McInnes in charge of the geological work now in progress in the part of the province west of Thunder Bay, gives the facts concerning mines and mineral development as follows.*

"Prospecting was being actively carried on in the vicinity of Blueberry Lake, which lies north of Snake and Clearwater lakes on Niven's 5th meridian line. The discovery of some gold-bearing veins was claimed. Prospectors stated that they had panned gold from the lacustrine clays which cover large areas of the Wabigoon country, and to this was probably due the local name 'The new Klondyke' given to the region. It was not possible however, to personally verify this reported occurrence of gold in the clays.

"Some of the mines on the Lake of the Woods have been showing very good results, notably the Sultana, which has installed, during the summer, a new and very complete stamp-mill, with a No. 3 Gates crusher, thirty stamps and six vanners. The mining machinery has also been replaced by new and recent patterns, so that the output should be largely increased. The Regina too has been working regularly during the summer and the capacity of the mill has been increased.

"On Shoal Lake, the mine on the Mikado property has made several 'clean-ups' with results which are satisfactory in the amount of gold recovered from the battery and plates. Neighbouring properties have been carrying on the work of development, but have not yet installed mills. At Camp Bay, the work of development has been pushed forward with vigour, and a considerable amount of ore has been sacked and brought to the lake shore for shipment. At Gibi or Chipai Lake a number of properties have been located, and the owners claim good prospects. These locations are situated on the tongue of Keewatin, extending north-easterly into the gneiss east of Witch Bay. They are thus near the same contact-line in the neighbourhood of which all the properties on the eastern side of the lake lie. North of the railway line, the Scramble has been carrying on the work of sinking and general development; a good wagon-road less than six miles in length has been constructed between the mine and Rat Portage, making the property very easily accessible. More or less work has been done on innumerable other properties about the shores and on the islands of the lake.

"In the Manitou region, prospecting has been carried forward actively during the season. Many properties have been located and considerable development work has been done on some of them, notably on Anjikoming or Upper Manitou, Mosher Bay, and on one or two properties on the western side of the lake. All the properties in the

* Summary Report, Geol. Surv. Can., 1897, p. 40.

PRECIOUS METALS.
Gold.
Ontario.

Manitou region are comparatively near the contact between the gneisses and the schists, but in this case that must necessarily be so if they lie in the Keewatin at all, owing to the narrowness of the belt.

"The building of a wagon-road about seven miles in length from the head of steamboat navigation on Grassy River Lake, directly to the north end of Upper Manitou Lake, has made the transportation of supplies, machinery, etc., into this region a much easier problem. Before the building of this road, the old Manitou canoe-route was followed and the part of that route cut off by this road included five portages, a mile and a quarter in total length, and a stretch of very small and bad brook travel, near two miles in length. A dam on the outlet of Wabigoon Lake at Dryden, makes the Grassy River navigable for small steamboats, three of which were plying on the route during the summer. At the Manitou end of the road, another steamboat was built, and a dam at the lower end of the lake opens the whole of the Manitou water-stretches to its passage. With easy means of access and abundance of wood and water, this region affords good facilities for the economical development of its leads.

"Up to the present, but little work has been done in the country lying to the north of the railway in this vicinity. A few properties have been taken up and some development work done near Sandy Lake and on Minnitaki. On the latter lake the Harvey property has been partially developed by sinking, with what result I do not know.

"Taking the region as a whole, very fair progress is being made in its exploitation and development, though little close or systematic prospecting has been done, excepting that carried on by the Ontario Gold Concessions Syndicate (Limited) on their reserves, and by the Regina and perhaps a few other mining companies on their locations. The 'Engledue' Syndicate has prospected its properties pretty thoroughly during the summer without the announcement, however, of any important discoveries. Whether payable leads are discovered on these concessions or not, it must be felt that to count upon such discovery within certain defined limits in untried ground is a very severe test to apply to a district in which, as far as we know, the occurrence of the gold is conditional upon a system of fissuring."

NORTH-WEST TERRITORIES.

In former reports of this Section, the gold production from the placer deposits of the North-west Territories on the Saskatchewan River and on the Yukon and its tributaries has been given together.

The comparatively sudden and world-wide interest aroused in, and the resultant extraordinary increase in the output of the Yukon district, however, has made it expedient that the production of these two districts be now given separately and the figures of production will be found below.

PRECIOUS METALS.
Gold.
North-west Territories.

The extreme difficulty of obtaining even approximately accurate statistics of placer gold production, especially from districts so difficult of access as the Yukon, will be generally recognized, so that the figures in the table must not be taken as an absolute statement of the output, but rather as an approximation to the truth as near as the means at command allow. It should be added that the value of the gold only has been approximately ascertained, the corresponding number representing ounces of fine gold being calculated from this.

TABLE 6.

PRECIOUS METALS.

GOLD:—NORTH-WEST TERRITORIES, PRODUCTION.

Calendar Year.	Yukon District.		Saskatchewan District.	
	*Ounces (fine).	Value.	*Ounces (fine).	Value.
		$		$
1885 } 1886 }	4,838	100,000	......	......
1887	3,387	70,000	102	2,100
1888	1,935	40,000	58	1,200
1889	8,466	175,000	968	20,000
1890	8,466	175,000	194	4,000
1891	1,935	40,000	266	5,500
1892	4,233	87,500	508	10,506
1893	8,515	176,000	466	9,640
1894	6,047	125,000	725	15,000
1895	12,095	250,000	2,419	50,000
1896	14,514	300,000	2,661	55,000
1897	120,948	2,500,000	2,419	50,000
Total	195,379	4,038,500	10,786	222,946

*Calculated from the value at $20·67 per oz.

The statistics given above show the production in the North-west Territories, excepting the Yukon district, to have averaged about $50,000 a year for the past three years, the annual production previous to 1895 being much less and varying considerably from year to year.

Although the figures of production are given only as far back as 1887, mining for the precious metal in this region has been prosecuted

PRECIOUS METALS.
Gold.
North-west Territories.

for the past 30 years or more. Gold has been found upon the South Saskatchewan River, the Peace River east of the mountains, and upon the McLeod, Athabasca, Bow, Oldman and other rivers, but the North Saskatchewan, for about 60 miles above and a similar distance below Edmonton, has been the chief field of operations, and has attracted the largest number of miners. The early miners are said to have made from $20 to $30 a day, but from $1 to $1.50 is now considered a fairly good daily average. In 1897, it is estimated that there were at work upon the whole river for shorter or longer periods, from 300 to 350 men.

The bulk of the output, even during the past three years, has been taken out by the "hand miners" working with pick and shovel, and employing the rocker or grizzly.

Mining by means of dredges did not begin until about 1895, when Mr. Benoit, formerly manager of the branch of the Jacques Cartier Bank at Edmonton, undertook the management of two mining dredges and began mining on a larger scale than had hitherto been attempted.

The number of dredges has gradually increased until in 1897, there were in all 12 dredges which have been operated more or less continuously; most of these dredges are, however, quite small and as yet very imperfect and wasteful in their operations, and not capable of saving even as large a proportion of the gold as is done by the "hand miners." Some six larger dredges were working during the year. Improvements are, however, being constantly suggested, and no doubt in the near future much larger returns will be obtained with the same labour and cost of operation.

Respecting operations during 1897, Major A. H. Griesbach, Superintent North-west Mounted Police, at Fort Saskatchewan, writes as follows :*

"During the season, besides the usual 'grizzly' workers, there have been in operation upon the Saskatchewan River 12 dredges of various construction, some worked by steam, some by horse-power, others by hand. These dredges, with one or two exceptions, have made good pay, but it is impossible to give any figures as regards the quantities taken out by them, as each dredge owner claimed that he had a 'Klondike' in his machine, and they were all very reticent about giving any figures, but it is sufficient to say that they are all going to work again next spring with improved machinery, etc.

*Report of the Commissioner of the North-west Mounted Police Force, 1897.

"A mining syndicate from Nebraska was operating a 'concentrator' during the latter part of the summer, on a bar about three miles above Fort Saskatchewan. Their machinery, consisting of three concentrating tables, separators, etc., was set upon the sand and was worked by electricity, the intention being to work during the summer, and if the result of their experiments reached their expectations they intend starting again in the spring. The result evidently was satisfactory, as their managing director stated on leaving here that he would be back again in the spring, with improved machinery, and would build a boat and commence operations.

PRECIOUS METALS.
Gold.
North-west Territories.

"About $45,000 worth of gold was purchased by the banks and merchants of Edmonton during the past year, besides this amount there has no doubt been a great deal sent out of the country in other ways."

From a comparison of estimates of Mr. Ogilvie, Supt. Constantine, N. W. M. P., commanding Yukon division, and those of others conversant with the work carried on during the year, the output of the Yukon district for the season of 1897 has been estimated at about $2,500,000. The search for gold in the region has been prosecuted with greater or less success for the past eighteen or twenty years, and for the last twelve years estimates of the yearly value of the output will be found in Table 6. These figures have been arrived at mainly through information furnished by Dr. Dawson, Mr. Ogilvie, and Supt. Constantine.

In 1887, Dr. Dawson, of the Geological Survey, visited a portion of the Yukon country, and the result of his explorations will be found in his Report on an Exploration in the Yukon District, N.W.T., and Adjacent Northern Portion of British Columbia, 1887, reprinted in 1898, together with extracts relating to the Yukon district from Report on an Exploration in the Yukon and Mackenzie Basins, 1887-88, by R. G. McConnell.

In view of subsequent developments, the following extract from Dr. Dawson's report will be of interest :—

"Mining can scarcely be said to have begun in the region more than five years ago, and the extent of country over which gold has been found in greater or less quantity is already very great. Most of the prospecting has been confined to the banks and bars of the larger rivers, and it is only when these innumerable tributary streams begin to be searched, that 'gulch diggings' like those of Dease, McDame, and other streams in the Cassiar district, and possibly even on a par with Williams and Lightning creeks in Cariboo, will be found and

PRECIOUS METALS.
Gold.
North-west Territories.

worked. The general result so far has been to prove that six large and long rivers, the Lewes, Tes-lin-too, Big Salmon, Pelly, Stewart and White, yield 'fine' gold along hundreds of miles of their lower courses. * * * The developments made up to this time are sufficient to show that when means of access are improved, important bar mining will take place along all these main rivers, and there is every reason to anticipate that the result of the examination in detail of the smaller streams will be the discovery of much richer auriferous alluviums. When these have been found and worked, quartz mining will doubtless follow, and the prospects for the utilization of this great mining field in the near future appear to me to be very promising."

In the autumn of 1886 'coarse gold' was found on Forty Mile Creek, and a rush was immediately made for the new diggings. This was the first locality in which coarse gold had been found, and it continued for some time to be the chief centre of operations. Richer diggings were subsequently discovered on several of the tributaries of Sixty-mile Creek, and these for a time held the attention of the miners.

The discovery of coarse gold of unusual richness on Bonanza Creek, a tributary of the Klondike River, which has been the means of drawing so much attention to the district, was made in August, 1896. The usual stampede took place, and a large number of claims were soon staked. Other tributaries of the Klondike and of Bonanza were found to be exceedingly rich, and prospecting has developed numerous other creeks in the same vicinity of greater or less richness, among which might be mentioned Dominion, Sulphur and Quartz creeks, tributaries of Indian Creek which flows into the Yukon about twenty-five miles above the Klondike.

In spite of the immense difficulty and consequent high cost of getting in supplies and provisions to the mining camps, the output of gold has advanced to large proportions, as evidenced by the figures of production for 1897, but with the inflow of the large population of miners and prospectors now taking place, better transportation facilities will no doubt be rapidly provided, and the resulting lessening in the cost of mining and supplies will be accompanied by a largely increased production in 1898.

BRITISH COLUMBIA.

In British Columbia, a continuance of the growth of the gold mining industry evident during the past three years is still shown in 1897, and the production this year $2,724,657 has been exceeded but three times in the history of the industry, viz., in 1863, 1864 and 1865, when the extremely rich placer-mines of Cariboo were at their best.

PRECIOUS METALS.
Gold.
British Columbia.

The statistics of production are given in Table E, and require but little comment. With the exception of the past few years, the production has been almost entirely the result of placer mining and from the table will be seen to have reached a maximum in 1863, when the output was valued at $3,913,563. For the next thirty years the production steadily diminished, and in 1893 the value of the output was but $379,535. About this period, however, renewed energy was instilled into the placer industry by the inauguration of extensive hydraulic operations, and quartz mining began to be actively prosecuted, resulting in the large increases which have been recorded during the past four years.

GOLD.
British Columbia.
Annual Production.
Table E.

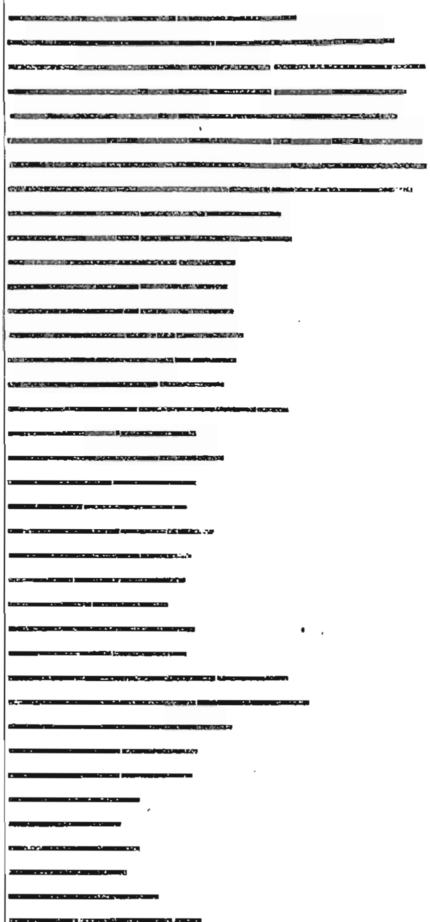
Calendar Year.	Value.
	$
1858	705,000
1859	1,615,072
1860	2,228,543
1861	2,666,118
1862	2,656,903
1863	3,913,563
1864	3,735,850
1865	3,491,205
1866	2,662,106
1867	2,480,868
1868	2,372,972
1869	1,774,978
1870	1,336,956
1871	1,799,440
1872	1,610,972
1873	1,305,749
1874	1,844,618
1875	2,474,904
1876	1,786,648
1877	1,608,182
1878	1,275,204
1879	1,290,058
1880	1,013,827
1881	1,046,737
1882	954,085
1883	794,252
1884	736,165
1885	713,738
1886	903,651
1887	693,709
1888	616,731
1889	588,923
1890	494,436
1891	429,811
1892	399,525
1893	379,535
1894	530,530
1895	1,266,954
1896	1,788,206
1897	2,724,657

Graphic Tables F and G, give further details as to the number of men employed and the average earnings per man, but are incomplete for the past two years, the data available being insufficient.

PRECIOUS METALS.
Gold.
British Columbia.

GOLD.
BRITISH COLUMBIA.
NUMBER OF MEN EMPLOYED.
Table F.

Calendar Year.	Number.
1858	3,000
1859	4,000
1860	4,400
1861	4,200
1862	4,100
1863	4,400
1864	4,400
1865	4,294
1866	2,982
1867	3,044
1868	2,390
1869	2,369
1870	2,348
1871	2,450
1872	2,400
1873	2,300
1874	2,868
1875	2,024
1876	2,282
1877	1,960
1878	1,883
1879	2,124
1880	1,955
1881	1,898
1882	1,738
1883	1,965
1884	1,858
1885	2,902
1886	3,147
1887	2,342
1888	2,007
1889	1,929
1890	1,342
1891	1,199
1892	1,340
1893	1,247
1894	1,610
1895	2,030



PRECIOUS METALS.
Gold.
British Columbia.

GOLD.
BRITISH COLUMBIA.
EARNINGS PER MAN.
Table G.

Calendar Year.	Value.
	$
1858	235
1859	403
1860	506
1861	634
1862	648
1863	889
1864	849
1865	813
1866	893
1867	814
1868	992
1869	749
1870	569
1871	734
1872	671
1873	567
1874	643
1875	1,222
1876	783
1877	820
1878	677
1879	607
1880	518
1881	551
1882	548
1883	404
1884	396
1885	246
1886	287
1887	296
1888	307
1889	330
1890	423
1891	358
1892	298
1893	304
1894	283
1895	313

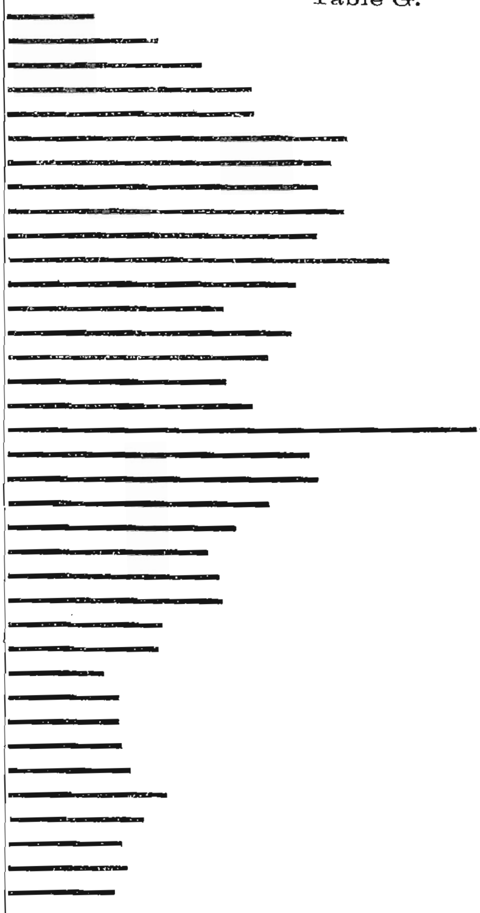


Table 7 is taken from the Annual report of the Minister of Mines for the province and shows the production by districts for 1897.

PRECIOUS METALS.
Gold.
British Columbia

Compared with a similar table given last year, the placer output will be seen to have diminished in Cariboo and Kootenay and increased in Cassiar, Lillooet and Yale. The gold production from vein mining comes almost entirely from the Trail Creek division of West Kootenay, though in 1897 the division of Nelson shows a considerable increase over the previous year. In 1897, Trail Creek supplied about 91 per cent of the lode output, Nelson about 2 per cent and Osoyoos division of Yale about 6 per cent.

TABLE 7.

PRECIOUS METALS.

GOLD—BRITISH COLUMBIA, PRODUCTION BY DISTRICTS, CALENDAR YEAR, 1897.

District.	Division.	Placer.		Quartz.	
		Ounces.	Value.	Ounces.	Value.
			$		$
Cariboo	Barkerville	3,250	65,000	....	....
	Lightning Creek. ..	1,250	25,000	....	....
	Quesnel Mouth	1,750	35,000	....	....
	Keithley Creek	10,000	200,000	....	....
Cassiar..........	....	1,853	37,060	....	....
Kootenay East...	....	600	12,000	....	....
Kootenay West..	Nelson..........	....	....	2,076	41,520
	Slocan	....	....	193	3,860
	Trail Creek	....	....	97,024	1,940,480
	Other Places	300	6,000	9	180
Lillooet	....	1,874	37,480	118	2,360
Yale	Osoyoos..........	440	8,800	6,674	133,480
	Similkameen	1,175	23,500	....	....
	Yale.......... ..	2,934	58,680	....	....
Other Districts ..	....	250	5,000	47	940
		25,676	513,520	106,141	2,122,820

PRECIOUS METALS.
Gold.
British Columbia.

Cariboo District.

In the Quesnel division of Cariboo district, hydraulic mining is being extensively prosecuted. A number of companies have commenced the exploration of this district upon an extended scale and a large amount of capital has been invested in opening up the mines, erecting dams for the formation of reservoirs, building ditches, flumes, sluices, etc.

The Cariboo Hydraulic Mining Company has a property located on the westerly side of the South Fork of the Quesnel River, three miles from Quesnel Forks, comprising about 446 acres, and extending for 9,000 feet along an ancient river-channel.

" The total depth of material in the channel at the present point of working is about 400 feet, and a section shows (*a*) at surface ten to twelve feet of surface gravel carrying a small amount of gold ; (*b*) underlying this a bed of very firm clay and rounded boulders, about 150 feet in thickness, perfectly barren ; (*c*) bands of sand and fine gravel, auriferous, ten to twenty feet thick ; (*d*) lying on bed-rock a great depth, or 150 feet to 200 feet of exceptionally rich gold-bearing gravel, coarse in kind, containing a large amount of cobble stones and a fair amount of boulders, mostly of eruptive rock, both massive and stratified." On the surface the width is about 1,000 feet.

The gold in this gravel is essentially " coarse " gold, little or no " flour " gold being found.

In the sluices, a very small amount of platinum is found, and also water-worn fragments of metallic copper, besides pyrites and iron-ores.

The company has now about 21 miles of ditch in operation. The main water-supply is brought 17 miles from two lakes, Polley and Boot-jack, where dams have been erected at their outlets to empound all the water that drains into them during the season.

The total amount of gold recovered since the beginning of operations in 1894 has been about $335,000.

The Horsefly Hydraulic Mining Company controls 19 mining leases, comprising 2,100 acres, on the west of Horsefly River, five miles south of Quesnel Lake. At first the gravel was worked very well with monitors, but after a time a band of cemented gravel was encountered and after a long struggle the method of operation with monitors had to be abandoned. Experiments were then begun to learn whether the cemented gravel would pay to mine and crush in stamp-mills. Results were found sufficiently satisfactory to justify the erection of a 10-stamp mill and mining will now probably be renewed with increased vigour.

PRECIOUS METALS. Gold. British Columbia.

The Golden River Quesnel Mining Co., Ltd., has secured the right to mine the South Fork of the Quesnel River from where it flows out of Quesnel Lake to where it joins the North Fork, or for seven miles of channel. This company, is constructing, at great cost, a dam and race-way at the foot of the lake where the river is a little over 400 feet wide.

Other companies among which might be mentioned the Consolidated Victoria Hydraulic Mining Company, the Montreal Hydraulic Mining Company, the Maude Hydraulic Mining Company, the Fishback Hydraulic Mining Company, the Horsefly Gold Mining Company, the Miocene Gravel Mining Company, (Limited), the Cariboo Gold Mining Company, (Limited), the Slough Creek Gold Mining Company, the British Columbia Development Association and the Waverley Hydraulic Mining Company have secured leases and have been exploring the gravels of the district with greater or less success.

West Kootenay District.

The chief properties contributing to the gold output from the smelting ores of the Trail Creek district are the Le Roi, War Eagle, Centre Star, Columbia and Kootenay and Iron Mask. Active development has been prosecuted on a large number of other claims, but the above are the main properties from which shipments, other than experimental, were made in 1897.

The Le Roi has been opened and worked to a depth of 700 feet, and development is being extended to the 800 foot level. Large bodies of ore have been found in the lower levels as rich as any yet taken out of the mine. This mine alone shipped over 50,000 tons of ore during 1897. The company has built a smelter of its own at Northport in the State of Washington, and all the ore is now being sent there. About 250 men are employed at the mine.

The War Eagle has been extensively developed. It has a depth of over 600 feet, and has over a mile of underground workings. A large hoisting apparatus is being constructed which will be worked by electricity and will be capable of lifting 1000 tons a day. The company employs about 220 men.

The Centre Star has also been pretty extensively developed. A tunnel has been run in giving at its inner end a depth of 300 feet from the surface, and a shaft has been sunk from 100 to 150 feet further. Altogether there is said to be about 6000 feet of workings in the mine.

PRECIOUS METALS.
Gold.
British Columbia.

The following tables which have been taken from the Report of the Minister of Mines for British Columbia, show the production of the Rossland mines and illustrate very well the average results attained during the past four years :

NET PRODUCTION, PER SMELTER RETURNS.

Year.	Tons, 2,000 lbs.	Gold, oz.	Silver, oz.	Copper, lbs.	Value.
1894	1,856	3,723	5,357	106,229	$ 75,510
1895	19,693	31,497	46,702	840,420	702,459
1896	38,075	55,275	89,285	1,580,635	1,243,360
1897	68,804	97,024	110,068	1,819,586	2,097,280
Total	128,428	187,519	251,412	4,346,870	4,118,609

AVERAGE NET SMELTER RETURNS, OR ACTUAL YIELD VALUES PER TON.

Year.	Gold.	Silver.	Copper.	Value.
	Oz.	Oz.	%	$
1894	2·00	2·89	2·85	40.69
1895	1·60	2·41	2·10	35.67
1896	1·45	2·34	2·08	32.65
1897	1 42	1·60	1·32	30.48
Average, 128,428 tons	1·46	1·96	1·73	32.05

In the Osoyoos division of Yale district, chiefly at Camp McKinney, the exploitation of the free-milling ores has been continued and the production of the division shows a slight increase over the output of 1896.

The details of the work of discovery and development in the province are fully dealt with in the report of the Provincial Mineralogist, to the Minister of Mines of the province.

SILVER.

Silver.

The production of silver in Canada in 1897 amounted to 5,558,446 ozs., valued at $3,323,395, being an increase over the production of 1896 of 2,353,103 ozs. in quantity and $1,173,892 in value, or 73·4 per cent and 54·6 per cent respectively.

The average market price for the year in 1896 was 67·06 c. per oz., and in 1897, 59·79 c. per oz., the decrease being 7·27 c. or 10·8 per cent. PRECIOUS METALS, Silver.

Annual Production.

Although there was a small production of silver in the province of Ontario and a somewhat greater production in the province of Quebec, the major portion of the output for the year, over 98 per cent, was from the province of British Columbia.

The statistics of the production of silver for the past eleven years are given in Table 8, below. It will be seen that from 1887 to 1892, Ontario and Quebec supplied the larger part of the output in about equal proportions. In 1893, however, the production of silver in British Columbia began to increase rapidly, while in Ontario its production ceased altogether in 1894, and in Quebec it fell away to half its former value.

TABLE 8.

PRECIOUS METALS.

SILVER :—ANNUAL PRODUCTION.

CALENDAR YEAR.	ONTARIO.		QUEBEC.		BRITISH COLUMBIA.		TOTAL.	
	Ounces.	Value.	Ounces.	Value.	Ounces.	Value.	Ounces.	Value.
1887..	190,495	$186,304	146,898	$143,666	17,690	$17,301	355,083	$347,271
1888..	208,064	195,580	149,388	140,425	79,780	74,993	437,232	410,998
1889..	181,609	169,986	148,517	139,012	53,192	49,787	383,318	358,785
1890..	158,715	166,016	171,545	179,436	70,427	73,666	400,687	419,118
1891..	225,633	222,926	185,584	183,357	3,306	3,266	414,523	409,549
1892..	41,581	36,425	191,910	168,113	77,160	67,592	310,651	272,130
1893..	....	8,689	....	126,439	....	195,000	....	330,128
1894..	....	....	101,318	63,830	746,379	470,219	847,697	534,049
1895 ..	....	....	81,753	53,369	1,496,522	976,930	1,578,275	1,030,299
1896..	....	....	70,000	46,942	3,135,343	2,102,561	3,205,343	2,149,503
1897..	5,000	2,990	80,475	48,116	5,472,971	3,272,289	5,558,446	3,323,395

QUEBEC. Quebec.

The production of Quebec represents the silver contained in the ores mined in the "Eastern Townships" and utilized as a source of sulphur in acid making. Besides the proportion of copper carried by these

PRECIOUS METALS.
Silver.

ores, they contain a little silver, from one to two ounces per ton. By a reference to the article on pyrites, it will be observed that the production of this ore, from which the silver is obtained, has decreased very largely during the past few years, hence the resultant lessening in the output of silver.

Ontario.

ONTARIO.

The silver mines of this province have been idle for the past four years, but in the autumn of 1897, preparations were being made to resume operations at several of the mines in the Thunder Bay district on Lake Superior. No actual mining was done during the year and the small production reported came from ore taken from the old dumps.

British Columbia.

BRITISH COLUMBIA.

British Columbia contributed over 98 per cent of the total silver output of the Dominion in 1897, and the increase in production over the previous year was 2,237,628 ounces or 74·5 per cent. A reference to the table will show that previous to 1893, the yearly production was considerably less than 100,000 ounces. Since that, however, the yearly increases have been constant and rapid.

In 1897, the Slocan division supplied 66·5 per cent and Nelson 17·5 per cent of the output. The number of ounces contributed by the various districts and sub-divisions is given below :—

District.	Ounces.
Kootenay East	116,657
Kootenay West :—	
Ainsworth division	524,578
Nelson	961,124
Slocan	3,641,287
Trail Creek	110,068
Other	116,657
Yale :—	
Osoyoos division	1,174
Other districts	1,426
	5,472,971

In the Ainsworth division, increased activity has been shown at many of the mines and the production has largely increased. The

Kootenay Air Supply Company are installing a Taylor air-compressor plant at the mouth of Krao Creek which is expected to generate about 500 h.p. The air will be transmitted in a 9-inch main, under 90 lbs. pressure, to the mines. PRECIOUS METALS.

The Nelson division has shown considerable progress during the year, and development has been prosecuted with good results on a number of claims, including Yomir, Porto Rico, Fern, Dundee, Athabasca, and others. At the Hall Mines, the Hallidie tramway which was erected to carry ore from the mines to the smelter is reported to be working well. This ropeway is the longest in British Columbia, and one of the most important of its kind on the continent. It is 23,797 feet long ($4\frac{1}{2}$ miles) and in that distance has a fall of over 4,000 feet. It is constructed in two sections: the upper one 10,300 feet long, with a fall of 1,620 feet is in the storm belt, where snow falls to a depth of 20 feet in places and the wind is very violent. The lower section is 13,500 feet long, with a fall of 2,400 feet. This is in a milder climate and relatively free from great depth of snow. Silver. British Columbia.

During the year 1897 the ropeway conveyed from the mines to the smelting works 49,540 tons of ore.

The company has decided to increase the capacity to 100,000 tons per annum, by increasing the size of the ore carriers, at a comparatively small outlay.

The most important of the silver producing divisions is the Slocan, in which there are now over 30 shipping mines, seven of which are paying dividends. The increase in the production of this division in 1897 over 1896, was 1,687,029 ounces, or 86·3 per cent.

The following tables based on the Report of the Minister of Mines for the province, give the production and the average yield per ton of the Slocan division for the past three years:

NET PRODUCTION PER SMELTER RETURNS.

Year.	Tons, 2,000 lbs.	Silver, oz.	Lead, lbs.	Gold, oz.	Values.
1895	9,514	1,122,770	9,666,324	6	$1,045,600
1896	16,560	1,954,258	18,175,074	152	1,854,011
1897	33,576	3,641,287	30,707,705	193	3,280,686
Totals	59,650	6,718,315	58,549,103	351	$6,180,297

PRECIOUS METALS.

Silver.

British Columbia.

ACTUAL YIELD VALUES PER TON.

Year.	Silver.	Lead.	Value.
1895	118·0 oz.	50.8%	$109·90
1896	118·0 "	54·9%	111·95
1897	108·5 "	45·7%	97·71
For 59,650 tons	112 6 oz.	49 1%	$103·60

The following Table, No. 9, gives the exports of silver ores as entered in the Customs Department. In comparing these figures with those of Table 8, it must be borne in mind that whilst practically all the silver-bearing products of the country are exported, the basis of valuation in the two tables is different. With the exception probably of the figures for 1896 and 1897, the valuation in the entries for exports is that of the spot value of the metal in the ore, etc., whilst in Table 8, the valuation, uniformly with that adopted for the other metallic products, is the final market value of the silver contents.

It will be noted also that the values of the exports in the two last years are higher than those given for the production, a discrepancy which there is no means of explaining.

TABLE 9.

PRECIOUS METALS.

SILVER:—EXPORTS OF ORE.

Provinces.	CALENDAR YEARS.						
	1891.	1892.	1893.	1894.	1895.	1896.	1897.
	$	$	$	$	$	$	$
Ontario	222,071	35,992	7,878	....	100	....	5,885
Quebec *	.. ....	....	....	....	....	....	....
Manitoba	....	80	820	....	....	....	....
British Columbia	3,241	20,616	204,997	359,731	994,254	2,271,959	3,570,506
Totals	225,312	56,688	213,695	359,731	994,354	2,271,959	3,576,391

* The production of silver given under the heading Quebec, in Table 8, represents the amount of that metal in the pyritous copper ores produced and exported from that province. Being but in small proportion it is ignored and does not appear under the heading Silver in the export returns.

PYRITES.

Under this heading are comprised the minerals which are mined as ores of sulphur and for the manufacture of sulphuric acid. In many cases however, the by-products, consisting of copper and silver, are extracted with great profit. The deposits worked so far, consist of chalcopyrite and iron-pyrites, or a mixture of both minerals. The most important deposits of pyrites at present worked in the Dominion are those of the "Eastern Townships" of the province of Quebec. These are situated in the township of Ascot, in the vicinity of Capelton, and occur in the pre-Cambrian rocks of that district. The ore is a mixture of the two sulphides above mentioned and carries an average of 3 to 4 per cent of copper and 42 per cent of sulphur, besides three to four ounces of silver. PYRITES. Quebec.

Descriptions of these deposits have been given in the Annual Reports of the Survey for 1887-88. S., 1888-89 K. and in the Journal of the Mining Association of the province of Quebec, volumes I and II. They are worked by the Nichols Chemical Co., and the Eustis Mining Co. The greater part of the output of the mines is shipped to the United States as raw ore, and only a small portion is treated in Canada for the manufacture of sulphuric acid.

Another important deposit of sulphur ore was opened in 1897 near Schreiber station on the Canadian Pacific Railway, north of Lake Superior. The operators are the Davies Sulphur Ore Co., of New York. The ore is iron-pyrites. The whole of the output, which in August 1897 amounted to about 500 tons on the dump, is to be shipped to the United States. (Ont. Bureau of Mines Rep., 1897.) Ontario.

TABLE 1.

PYRITES.

ANNUAL PRODUCTION. Production.

Calendar Year.	Tons. 2,000 lbs.	Value.
		$
1886	42,906	193,077
1887	38,043	171,194
1888	63,479	285,656
1889	72,225	307,292
1890	49,227	123,067
1891	67,731	203,193
1892	59,770	179,310
1893	58,542	175,626
1894	40,527	121,581
1895	34,198	102,594
1896	33,715	101,155
1897	38,910	116,730

PYRITES.

Imports of Brimstone.

TABLE 2.

PYRITES.

IMPORTS.—BRIMSTONE AND CRUDE SULPHUR.

Fiscal Year	Pounds.	Value.
1880	1,775,489	$27,401
1881	2,118,720	33,956
1882	2 375,821	40,329
1883	2,336,085	36,737
1884	2,195,735	37,463
1885	2,248,986	35,043
1886	2,922,043	43,651
1887	3,103,644	38,750
1888	2,048,812	25,318
1889	2,427,510	34,006
1890	4,440,799	44,276
1891	3,601,748	46,351
1892	4,769,759	67,095
1893	6,381,203	77,216
1894	5,845,463	61,558
1895	4,900,225	56,965
1896	6,934,190	63,973
1897*	8,672,751	87,719

* Brimstone, crude, or in roll or flour, and sulphur in roll or flour.

SALT.

SALT.

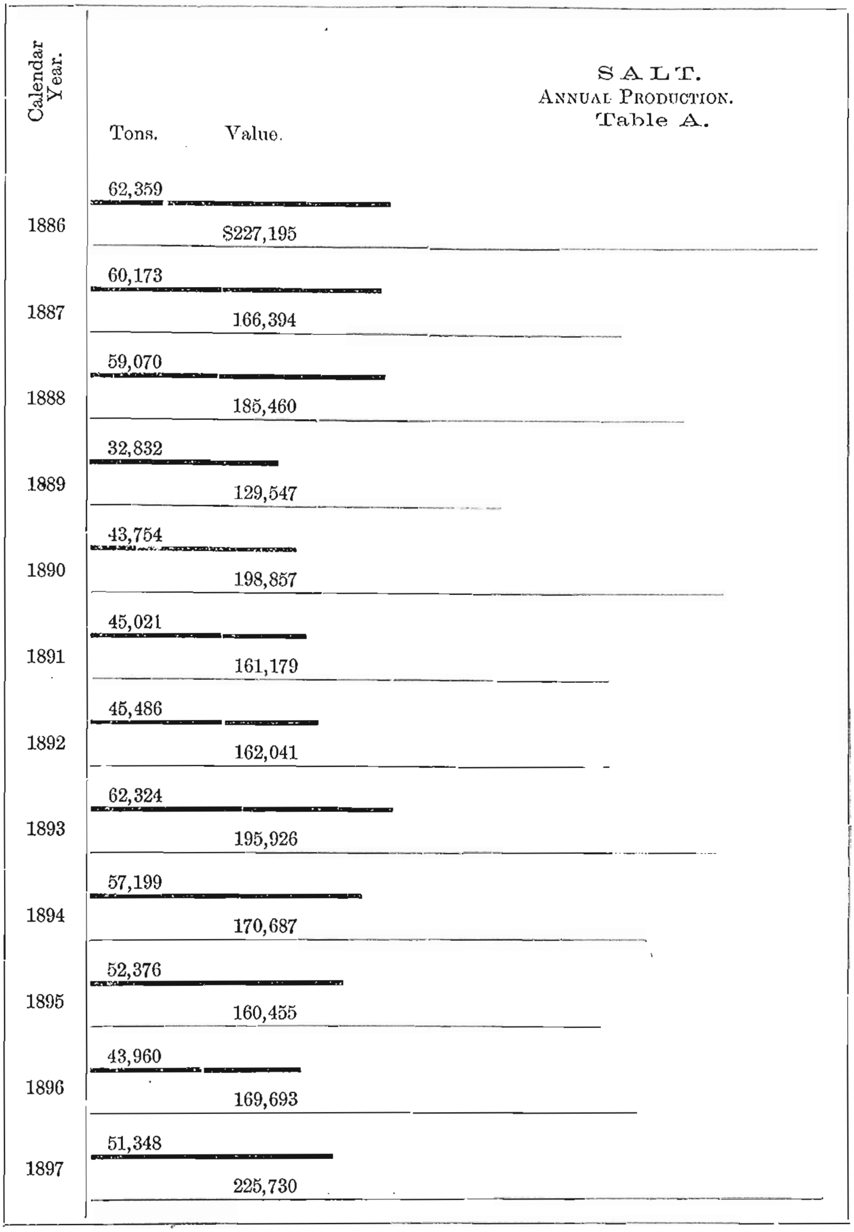
Returns of production of salt in 1897 were received from twelve operators in Ontario and one in New Brunswick, the total output amounting to 51,348 tons, valued at $225,730 or an average value per ton of $4.40. Compared with 1896, when the production was 43,960 tons, valued at $160,455, or $3.86 per ton, 1897 shows an increase of 7,388 tons or 16·8 per cent and $56,037 or 33 per cent.

Practically all the production is from the Ontario fields. The few tons produced in New Brunswick come from the Sussex Salt Works in the parish of Cardwell, Kings county, and is mostly sold locally along the Intercolonial Railway.

The statistics of production, exports and imports are given in the following tables.

The imports amount to about twice the Canadian production and the consumption in the country for the past seven years has averaged about 150,000, tons a year.

SALT.
Production.



SALT.
ANNUAL PRODUCTION.
Table A.

SALT.
Exports.

TABLE 1.

SALT.

EXPORTS.

Calendar Year.	Bushels.	Value.
1880	467,641	$46,211
1881	343,208	44,627
1882	181,758	18,350
1883	199,733	19,492
1884	167,029	15,291
1885	246,794	18,756
1886	224,943	16,886
1887	154,045	11,526
1888	15,251	3,987
1889	8,557	2,390
1890	6,605	1,667
1891	5,290	1,277
1892	2,000	504
1893	4,940	1,267
1894	4,639	1,120
1895	4,865	959
1896	3,842	899
1897	5,383	1,193

Imports.

TABLE 2.

SALT.

IMPORTS. SALT PAYING DUTY.

Fiscal Year.		Pounds.	Value.
1880		726,640	$ 3,916
1881		2,588,465	6,355
1882		3,679,415	12,318
1883		12,136,968	36,223
1884		12,770,950	38,949
1885		10,397,761	31,726
1886		12,266,021	39,181
1887		10,413,258	35,670
1888		10,509,799	32,136
1889		11,190,088	38,968
1890		15,135,109	57,549
1891		15,140,827	59,311
1892		18,648,191	65,963
1893		21,377,339	79,838
1894		15,867,825	53,336
1895		8,498,404	29,881
1896		7,665,257	24,550
1897	Salt, coarse, N.E.S.	2,779,310	4,748
	Salt, fine, in bulk	2,167,960	3,346
	Salt, N.E.S., in bags, barrels or other packages	6,964,496	25,376
	Total	11,911,766	$33,470

TABLE 3.

SALT.

IMPORTS. SALT NOT PAYING DUTY.

SALT.
Imports.

Fiscal Year.	Pounds.	Value.
1880	212,714,747	$400,167
1881	231,640,610	488,278
1882	166,183,962	311,489
1883	246,747,113	386,144
1884	225,390,121	321,243
1885	171,571,209	255,719
1886	180,205,949	255,359
1887	203,042,332	285,455
1888	184,166,986	220,975
1889	180,847,800	253,009
1890	158,490,075	252,291
1891	195,491,410	321,239
1892	201,831,217	314,995
1893	191,595,530	281,462
1894	196,668,730	328,300
1895	201,691,248	332,711
1896	205,005,100	338,888
1897*	215,844,484	312,117

* Salt, imported from the United Kingdom, or any British possession, or imported for the use of the sea or gulf fisheries.

STRUCTURAL MATERIALS.

STRUCTURAL
MATERIALS.

Under this heading are comprised building stone, granites, marbles, slates, flagstones, plasters, cements, lime, etc., as well as the manufactures of clay which include building bricks, tiles, drain-pipes, earthenware and coarse pottery.

The industries based on the structural materials are so widespread and are carried on in so many different places, on various scales and often intermittently that it is impossible to obtain anything like complete returns of quantity or value of the products. The figures of production are, therefore, to be taken only as rough approximations.

STRUCTURAL MATERIALS.
Building Stone.

TABLE 1.

STRUCTURAL MATERIALS.

PRODUCTION OF BUILDING STONE.

Calendar Year.	Value.
1886	$ 642,509
1887	552,267
1888	641,712
1889	913,691
1890	964,783
1891	708,736
1892	609,827
1893	1,100,000
1894	1,200,000
1895	1,095,000
1896	1,000,000
1897	1,000,000

TABLE 2.

STRUCTURAL MATERIALS.

EXPORTS OF STONE AND MARBLE, WROUGHT AND UNWROUGHT.

Provinces.	Wrought.		Unwrought.	
	Calendar Years.			
	1896.	1897.	1896.	1897.
Ontario	$3,367	$2,478	$16,599	$28,106
Quebec	931	5,889	...	...
Nova Scotia	636	880	8,623	9,134
New Brunswick	...	150	7,675	4,793
British Columbia	...	18	...	1
Totals	$4,934	$9,415	$32,897	$42,034

STRUCTURAL MATERIALS.

Building Stone.

TABLE 3.

STRUCTURAL MATERIALS.

IMPORTS OF BUILDING STONE.

Fiscal Year.		Value.
1880		$ 35,970
1881		58,149
1882		33,623
1883		35,061
1884		51,088
1885		30,491
1886		41,675
1887		54,368
1888		86,373
1889		100,314
1890		132,155
1891		170,890
1892		95,550
1893		56,510
1894		52,908
1895		44,282
1896		54,130
1897	Flagstones, granite and rough freestone, sandstone, and all building stone, except marble from the quarry, not hammered or chiselled	$27,442
	Granite and freestones, dressed; all other building stone dressed, except marble	11,272
		$38,714

TABLE 4.

STRUCTURAL MATERIALS.

IMPORTS OF MANUFACTURES OF STONE OR GRANITE, N.E.S.

Fiscal Year.	Value.
1880	$29,408
1881	36,877
1882	37,267
1883	45,636
1884	45,290
1885	39,867
1886	41,984
1887	41,829
1888	47,487
1889	61,341
1890	84,396
1891	61,051
1892	39,479
1893	49,323
1894	49,510
1895	51,050
1896	51,499
1897	34,026

STRUCTURAL MATERIALS.
Marble.

Marble :—Various limestones having qualities entitling them to be ranked as marble are known to occur throughout Canada. However, as evidenced by the figures given in Table 5 below, the marble quarrying and manufacturing industry has never assumed large proportions, and of late years it has decidedly languished.

TABLE 5.

STRUCTURAL MATERIALS.

ANNUAL PRODUCTION OF MARBLE.

Calendar Year.	Tons.	Value.
1886	501	$9,900
1887	242	6,224
1888	191	3,100
1889	83	980
1890	780	10,776
1891	240	1,752
1892	340	3,600
1893	590	5,100
1894	Nil.	Nil.
1895	200	2,000
1896	224	2,405
1897	Nil.	Nil.

Comparing Table No. 5 with No. 6 below it will be seen that the value of the imported stone entirely over-shadows that of the production of the home article.

STRUCTURAL MATERIALS. Marble.

TABLE 6.

STRUCTURAL MATERIALS.

IMPORTS OF MARBLE.

Fiscal Year.	Value.
1880	$ 63,015
1881	85,977
1882	109,505
1883	128,520
1884	108,771
1885	102,835
1886	117,752
1887	104,250
1888	94,681
1889	118,421
1890	99,353
1891	107,661
1892	106,268
1893	96,177
1894	94,657
1895	83,422
1896	90,065
1897 Marble and manufactures of :—	
Blocks or slabs, sawn on not more than two sides	$18,680
" " more than two sides	30,009
Finished	6,205
Manufactures, N.E.S	20,414
Rough blocks	1,842
Total marble and manufactures of	$77,150

Granite :—Under this heading would be included in trade terms, much stone such as gneiss, syenite, etc., which would not be lithologically classed under that heading.

Granite.

TABLE 7.

STRUCTURAL MATERIALS.

ANNUAL PRODUCTION OF GRANITE.

Calendar Year.	Tons.	Value.
1886	6,062	$63,309
1887	21,217	142,506
1888	21,352	147,305
1889	10,197	79,624
1890	13,307	65,985
1891	13,637	70,056
1892	24,302	89,326
1893	22,521	94,393
1894	16,392	109,936
1895	19,238	84,838
1896	18,717	106,709
1897	10,345	61,934

STRUCTURAL MATERIALS.

From the figures given in Table 7, above, will be seen that the industry has been continuously carried on for the twelve years covered. the value of the product ranging from about $62,000 to nearly $148,000,

For 1897, returns were received as follows from the different provinces :—In Nova Scotia, 5 operators contributed about 20 per cent to the total production ; New Brunswick, over 40 per cent with 6 operators ; Quebec about 28 per cent with 4 operators, the balance being contributed by British Columbia.

Slate.

Slate :—The production of this article, as shown in Table 8, below, has steadily fallen off since 1893, being in 1897 less than half what it was in the former year and about one third the value of the production in 1889, the best year in the period for which figures are given.

TABLE 8.

STRUCTURAL MATERIALS.

ANNUAL PRODUCTION OF SLATE.

Calendar Year.	Tons.	Value.
1886	5,345	$64,675
1887	7,357	89,000
1888	5,314	90,689
1889	6,935	119,160
1890	6,368	100,250
1891	5,000	65,000
1892	5,180	69,070
1893	7,112	90,825
1894	....	75,550
1895	....	58,900
1896	....	53,370
1897	....	42,800

The main work done in exploiting the slate resources of the country was at the old quarries in Richmond county, Quebec, whilst a small quantity was sold by the Westminster Slate Co., in British Columbia, from stock in hand, their quarries having been idle. Recent efforts made with some success to develop an export trade in slate from the United States to Great Britain, appear to show that something of the same kind should be possible in the case of the excellent slates of Quebec.

STRUCTURAL MATERIALS.
Slate.

TABLE 9.

STRUCTURAL MATERIALS.

EXPORTS OF SLATE.

Calendar Year.	Tons.	Value.
1884	539	$6,845
1885	346	5,274
1886	34	495
1887	27	373
1888	22	475
1889	26	3,303
1890	12	153
1891	15	195
1892	87	2,038
1893	178	3,168
1894	187	3,610
1895	36	574
1896	301	8,913
1897	Nil.	Nil.

TABLE 10.

STRUCTURAL MATERIALS.

IMPORTS OF SLATE.

Fiscal Year.		Value.
1880		$21,431
1881		22,184
1882		24,543
1883		24,968
1884		28,816
1885		28,169
1886		27,852
1887		27,845
1888		23,151
1889		41,370
1890		22,871
1891		46,104
1892		50,441
1893		51,179
1894		29,267
1895		19,471
1896		24,176
1897	Slate and manufactures of—	
	Mantels	$ 14
	Roofing slate, black or blue	3,624
	" red, green or other colour	1,408
	School writing slates	6,715
	Slate pencils	3,052
	Slate of all kinds and manufactures of, N.E.S.	6,802
	Total	$21,615

STRUCTURAL MATERIALS.
Flagstone.

Flagstone :—The figures given below in Table 11, for 1897, represent small quantities of this material produced at Bishop's Crossing, in Wolfe county, Quebec, and at Merriton, in Lincoln county, Ontario. There is nothing special to note about the industry.

TABLE 11.

STRUCTURAL MATERIALS.

PRODUCTION OF FLAGSTONE.

Calendar Year.	Quantity, Sq. ft.	Value.
1886	70,000	$ 7,875
1887	116,000	11,600
1888	64,800	6,580
1889	14,000	1,400
1890	17,865	1,643
1891	27,300	2,721
1892	13,700	1,869
1893	40,500	3,487
1894	152,700	5,298
1895	80,005	6,687
1896	....	6,710
1897	....	7,190

TABLE 12.

STRUCTURAL MATERIALS.

IMPORTS OF FLAGSTONE.

Fiscal Year.	Tons.	Value.
1881	23	$ 241
1882	90	848
1883	10	99
1884	137	1,158
1885	205	1,756
1886	1,602	9,443
1887	1,316	10,966
1888	2,642	21,077
1889	1,669	15,451
1890	5,665	48,995
1891	3,770	36,348
1892	1,571	15,048
1893	884	8,500
1894	218	2,429
1895	15	84
1896	Nil.	Nil.
1897*	13	227

* Flagstones, dressed.

Cement :—Returns were received from nine manufacturers of cement all of whom, with the exception of one in British Columbia, are located in Ontario and Quebec. Of the total value of the product Ontario contributed about 87 per cent, the balance being due to Quebec and British Columbia.

STRUCTURAL MATERIALS.
Cement.

The product is classified under the headings of Natural and Portland Cements. In the grand total the latter constituted 58 per cent of the weight and 76 per cent of the value.

TABLE 13.

STRUCTURAL MATERIALS.

ANNUAL PRODUCTION OF CEMENT.

Calendar Year.	Barrels.	Value.
1887	69,843	$ 81,909
1888	50,668	35,593
1889	90,474	69,790
1890	102,216	92,405
1891	93,473	108,561
1892	117,408	147,663
1893	158,597	194,015
1894	108,142	144,637
1895	128,294	173,675
1896	149,090	201,651
1897. Natural	85,450	65,893
1897. Portland	119,763	209,380
Totals	205,213	275,273

TABLE 14.

STRUCTURAL MATERIALS.

EXPORTS OF CEMENT.

Province.	CALENDAR YEARS.					
	1892.	1893.	1894.	1895.	1896.	1897.
Ontario	$399	$ 718	$339	$662	$484	$535
Quebec	539	386	42	30	625	109
Nova Scotia	....	68	101	245	219	....
Totals	$938	$1,172	$482	$937	$1,328	$644

STRUCTURAL MATERIALS.
Cement.

TABLE 15.

STRUCTURAL MATERIALS.

IMPORTS OF CEMENT IN BULK OR BAGS.

Fiscal Year.	Bushels.	Value.
1880	65	$ 28
1881	579	298
1882	386	86
1883	1,759	548
1884	4,626	1,236
1885	4,598	1,315
1886	6,808	1,851
1887	5,421	1,419
1888	23,919	5,787
1889	32,818	10,668
1890	21,055	5,443
1891	11,281	2,890
1892	14,351	3,394
1893	12,534	2,909
1894	9,027	2,618
1895	....	2,112
1896	....	3,672
1897	....	4,318

TABLE 16.

STRUCTURAL MATERIALS.

IMPORTS OF HYDRAULIC CEMENT.

Fiscal Year.	Barrels.	Value.
1880	10,034	$ 10,306
1881	7,812	7,821
1882	11,945	13,410
1883	11,659	13,755
1884	8,606	9,514
1885	5,613	5,396
1886	6,164	6,028
1887	6,160	8,784
1888	5,636	7,522
1889	5,835	7,467
1890	5,440	9,048
1891	3,515	6,152
1892	2,214	2,782
1893	4,896	8,060
1894	1,054	985
1895	5,333	7,001
1896	5,688	8,948
1897 Cement, hydraulic or waterlime	2,494	3,937

STRUCTURAL MATERIALS.
Cement.

TABLE 17.

STRUCTURAL MATERIALS.

IMPORTS OF PORTLAND CEMENT.

Fiscal Year.	Barrels.	Value.
1880	....	$ 55,774
1881	....	45,646
1882	....	66,579
1883	....	102,537
1884	....	102,857
1885	....	111,521
1886	....	120,398
1887	102,750	148,054
1888	122,402	177,158
1889	122,273	179,406
1890	192,322	313,572
1891	183,728	304,648
1892	187,233	281,553
1893	229,492	316,179
1894	224,150	280,841
1895	196,281	242,813
1896	204,407	242,409
1897 Portland or Roman	210,871	252,587

The articles known under the general name of roofing cement, are of varied composition, but generally consist of mica, soapstone, asbestus or some such fire-proof material mixed with tarry cementing matter. In past years small amounts have been manufactured in Canada.

TABLE 18.

STRUCTURAL MATERIALS.

PRODUCTION OF ROOFING CEMENT.

Calendar Year.	Tons.	Value.
1890	1,171	$ 6,502
1891	1,020	4,810
1892	800	12,000
1893	951	5,441
1894	815	3,978
1895	....	3,153
1896	86	430
1897	Nil.	Nil.

Structural Materials.
Lime.

Lime:—The figures of production of lime given in Table 19, below, represent the best estimates it has been possible to arrive at year by year, based on the known production of the larger firms with an estimated addition for the output of the numberless small operators from all of whom it would of course be impossible to obtain returns. Whilst there are a number of these more important firms equipped with complete and extensive plants and turning out a large quantity of lime of superior quality, every year the proportion of the whole output due to the small operators would represent a very considerable percentage.

Table 19.

Structural Materials.

Annual Production of Lime.

Calendar Year.	Value.
1886	$283,755
1887	394,859
1888	339,951
1889	362,848
1890	412,308
1891	251,215
1892	411,270
1893	900,000
1894	900,000
1895	700,000
1896	650,000
1897	650,000

Table 20.

Structural Materials.

Exports of Lime.

Province.	Calendar Years.			
	1894.	1895.	1896.	1897.
Ontario	$ 13,208	$ 25,257	$25,500	$17,730
Quebec	30,294	23,047	18,067	21,786
Nova Scotia	3,482	1,468	3,195	2,390
New Brunswick	33,830	21,891	24,058	11,021
Prince Edward Island	3	....	....	....
Manitoba	....	30	....	250
British Columbia	2,853	4	....	....
Totals	$83,670	$ 71,697	$ 70,820	$ 53,177

Structural Materials.
Lime.

TABLE 21.
STRUCTURAL MATERIALS.
IMPORTS OF LIME.

Fiscal Year.	Barrels.	Value.
1880	6,100	$ 6,013
1881	5,796	4,177
1882	5,064	5,365
1883	7,623	9,224
1884	10,804	11,200
1885	12,072	11,503
1886	11,021	9,347
1887	10,835	8,524
1888	10,142	7,537
1889	13,079	9,363
1890	8,149	5,360
1891	6,259	4,273
1892	6,132	4,241
1893	6,879	4,917
1894	6,766	4,907
1895	12,008	5,743
1896	10,239	7,331
1897	16,108	10,529

Bricks :—The remarks already made regarding the lime-burning industry apply with equal force to brick. Brick.

The number of small producers of but a few thousands yearly, to meet a local demand is legion and yet in the aggregate their output mounts up to considerable values.

Besides these there are firms working on a large scale at a great many points throughout the Dominion, and the figures given in Table 22, below, represent the best estimates it has been possible to form of the whole production.

TABLE 22.
STRUCTURAL MATERIALS.
ANNUAL PRODUCTION OF BUILDING BRICKS.

Calendar Year.	Value.
1886	$ 873,600
1887	986,689
1888	1,036,746
1889	1,273,884
1890	1,266,982
1891	1,061,536
1892	1,251,934
1893	1,800,000
1894	1,800,000
1895	1,670,000
1896	1,600,000
1897	1,600,000

STRUCTURAL MATERIALS.
Brick.

TABLE 23.

STRUCTURAL MATERIALS.

EXPORTS OF BRICKS.

Province.	Calendar Years.									
	1893.		1894.		1895.		1896.		1897.	
	M	Value	M	Value	M	Value	M	Value	M	Value
		$		$		$		$		$
Ontario..........	552	2,462	280	1,257	1,053	4,420	266	1,473	178	940
Quebec	2,189	17,969	68	917	82	1,092	41	200	316	1,114
Nova Scotia	2,561	16,449	489	3,252	199	834	600	3,276	31	285
New Brunswick...	767	7,185	258	1,979	321	2,319	76	729	48	340
P. E. Island ..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
British Columbia..	4	45	.....	.....	.....	.....	.....	.....	.....	.....
Totals.	6,073	44,110	1,095	7,405	1,655	8,665	983	5,678	573	2,679

TABLE 24.

STRUCTURAL MATERIALS.

IMPORTS OF BUILDING BRICKS.

Fiscal Year.	Value.
1880....................	$ 2,067
1881....................	4,281
1882....................	24,572
1883....................	14,234
1884....................	20,258
1885....................	14,632
1886....................	5,929
1887....................	2,440
1888....................	20,720
1889....................	24,585
1890....................	12,500
1891....................	9,744
1892....................	5,075
1893....................	14,108
1894....................	18,320
1895....................	4,705
1896....................	23,189
1897....................	10,336

Terra Cotta, etc. :—Under this heading are included the various grades and kinds of terra cotta proper, some roofing and drain tile, and a certain amount of paving and special high-grade pressed brick, some of the latter being made from ground shale. STRUCTURAL MATERIALS. Terra cotta.

Returns were received from seven firms operating in Quebec and Ontario.

TABLE 25.

STRUCTURAL MATERIALS.

PRODUCTION OF TERRA COTTA, ETC.

Calendar Year.	Value.
1888	$ 49,800
1889	Not available.
1890	90,000
1891	113,103
1892	97,239
1893	55,704
1894	65,600
1895	195,123
1896	83,855
1897	155,595

Sewer Pipes, etc. :—Returns were received from some four producers of these articles. It is propable that this does not represent all the output for Canada, but it is impossible to obtain answers from all operators. Sewer pipes.

TABLE 26.

STRUCTURAL MATERIALS.

PRODUCTION OF SEWER PIPES, ETC.

Calendar Year.	Value.
1888	$266,320
1889	Not available.
1890	348,000
1891	227,300
1892	367,660
1893	350,000
1894	250,325
1895	257,045
1896	153,875
1897	164,250

STRUCTURAL MATERIALS.
Drain tiles and sewer pipes.

TABLE 27.

STRUCTURAL MATERIALS.

IMPORTS OF DRAIN TILES AND SEWER PIPES.

Fiscal Year.	Value.
1880	$ 33,796
1881	37,368
1882	70,065
1883	70,699
1884	71,755
1885	69,589
1886	57,953
1887	71,203
1888	101,257
1889	83,215
1890	77,434
1891	87,195
1892	59,537
1893	39,001
1894	24,625
1895	21,053
1896	19,296
1897 { Drain tile, not glazed	$ 416
1897 { Drain pipes, sewer pipes, chimney linings or vents and inverted blocks, glazed or unglazed	33,870
Total	$34,286

Pottery.

Pottery :—Returns were received from twenty-three potteries, chiefly in Ontario. This is also an industry in which there are a few firms operating on a large scale and numberless small producers, and it has been found impossible either to get a complete list of all engaged in the industry or to get returns even from all those on our lists.

TABLE 28.

STRUCTURAL MATERIALS.

ANNUAL PRODUCTION OF POTTERY.

Calendar Year.	Value.
1888	$ 27,750
1889	Not available.
1890	195,242
1891	258,844
1892	265,811
1893	213,186
1894	162,144
1895	151,588
1896	163,427
1897	129,629

STRUCTURAL MATERIALS.
Earthenware.

TABLE 29.

STRUCTURAL MATERIALS.

IMPORTS OF EARTHENWARE.

Fiscal Year.		Value.
1880		$322,333
1881		439,029
1882		646,734
1883		657,886
1884		544,586
1885		511,853
1886		599,269
1887		750,691
1888		697,082
1889		697,949
1890		695,206
1891		634,907
1892		748,810
1893		709,737
1894		695,514
1895		547,935
1896		575,493
1897	Earthenware and china:—	
	Brown or coloured earthen and stoneware, and Rockingham ware	$ 14,079
	Decorated, printed or sponged, and all earthenwars, N.E.S.	192,305
	Demijohns or jugs, churns and crocks	3,458
	Earthenware or stone ink bottles not exceeding three ounces capacity	34
	Porous and hollow earthenware for fire-proofing purposes	12
	White granite or ironstone ware, C.C. or cream-coloured ware	143,390
	China and porcelain ware	192,735
	Earthenware tiles	23,124
	Manufactures of earthenware, N.E.S.	26,685
	Total	$595,822

Structural Materials.

Sand and gravel.

Sand and Gravel :—The only figures of the production of sands and gravels available are those of exports given below. It would manifestly be neither profitable nor possible to take notice of any operations other than those undertaken for more than local uses.

Table 30.

Structural Materials.

Exports of Sand and Gravel.

Calendar Year.		Tons.	Value.
			$
1893		329,116	121,795
1894		324,656	86,940
1895		277,162	118,359
1896		224,769	80,110
1897	Ontario	151,747	71,485
	Quebec	1,184	5,189
	Nova Scotia	2	15
	New Brunswick	30	40
	Manitoba	....	....
	British Columbia	....	....
	Total	152,963	76,729

Miscellaneous.

MISCELLANEOUS.

Antimony.

Antimony.—The main source of the antimony of commerce is stibnite, the sulphide. A very appreciable quantity is produced as by-product in the refining of lead, with the ores of which stibnite is often associated. The uses of antimony have not been extended during the last few years, and increased production has so affected the prices that only those mines which are under very favourable conditions can be worked with profit. As a result the Canadian mines had to shut down in 1892, and no production has been reported since.

The following are some of the known deposits of antimony ore :—

New Brunswick.—York county, Prince William.

Nova Scotia.—Hants county, Rawdon.

These two deposits have been opened and worked extensively. MISCELLANEOUS. Antimony.

Quebec.—Wolfe county, South Ham., I. 56. Some development work was done on this deposit a few years ago to ascertain its value.

Other occurrences, the economic value of which has not been investigated, have been noticed in :

Ontario.—Lake of the Woods district, Ptarmigan Bay.

British Columbia.—Near Watkinson's, on the Fraser River, 23 miles above Lytton. Queen Charlotte Islands, at Cumshewa.

TABLE 1.

MISCELLANEOUS.

ANNUAL PRODUCTION OF ANTIMONY.

Calendar Year.	Tons.	Value.
1886	665	$31,490
1887	584	10,860
1888	345	3,696
1889	55	1,100
1890	26½	625
1891	10	60

TABLE 2.

MISCELLANEOUS.

EXPORTS OF ANTIMONY ORES.

Calendar Year.	Tons.	Value.	Calendar Year.	Tons.	Value.
1880	40	$ 1,948	1886	665	$31,490
1881	34	3,308	1887	229	9,720
1882	323	11,673	1888	352½	6,894
1883	165	4,200	1889	30	695
1884	483	17,875	1890	38	1,000
1885	758	36,250	1891*	3½	60

* No exports since 1891.

Miscellaneous.
Antimony.

TABLE 3.

MISCELLANEOUS.

IMPORTS OF ANTIMONY.

Fiscal Year.	Pounds.	Value.
1880	42,247	$ 5,903
1881	....	7,060
1882	183,597	15,044
1883	105,346	10,355
1884	445,600	15,564
1885	82, 12	8,182
1886	89,787	6,951
1887	87,827	7,122
1888	120,125	12,242
1889	119,034	11,206
1890	117,066	17,439
1891	114,084	17,483
1892	180,308	17,680
1893	181,823	14,771
1894	139,571	12,249
1895	79,707	6,131
1896	163,209	9,557
*1897	134,661	8,031

* Antimony, not ground, pulverized or otherwise manufactured, and antimony salts.

Arsenic.

Arsenic.—For some years there has been no production of arsenic in Canada, so that there is nothing to report other than to give the figures relating to past years which are found in the two following tables :—

TABLE 4.

MISCELLANEOUS.

ANNUAL PRODUCTION OF ARSENIC.

Calendar Year.	Tons.	Value.
1885	440	$17,600
1886	120	5,460
1887	30	1,200
1888	30	1,200
1889	Nil.	Nil.
1890	25	1,500
1891	20	1,000
1892	Nil.	Nil.
1893	"	"
1894	7	420
1895	Nil.	Nil.
1896	"	"
1897	"	"

TABLE 5.

MISCELLANEOUS.

IMPORTS OF ARSENIC.

MISCELLANEOUS.

Arsenic.

Fiscal Year.	Pounds.	Value.
1880	18,197	$ 576
1881	31,417	1,070
1882	138,920	3,962
1883	51,953	1,812
1884	19,337	773
1885	49,080	1,566
1886	30,181	961
1887	32,436	1,116
1888	27,510	1,016
1889	69,269	2,434
1890	138,509	4,474
1891	115,248	4,027
1892	302,958	9,365
1893	447,079	12,907
1894	292,505	10,018
1895	1,115,697	31,932
1896	664,854	27,523
1897	152,275	8,378

Felspar.—The production of this material is yet small, but there appears to be a good prospect of largely increasing it. Felspar.

TABLE 6.

MISCELLANEOUS.

PRODUCTION OF FELSPAR.

Calendar Year.	Tons.	Value.
1890	700	$3,500
1891	685	3,425
1892	175	525
1893	575	4,525
1894	Nil.	Nil.
1895	....	*2,545
1896	972	*2,583
1897	1,400	3,290

* Exports.

This material is used in the manufacture of pottery. For that purpose it must be pure; its value depending on its being free from iron oxide, mica and quartz.

The sources of felspar are the veins or masses of pegmatite in which the crystals of felspar have developed to such a size as to allow of economic mining and sorting.

MISCELLANEOUS.
Felspar.

There are numerous occurrences of felspar-bearing deposits all through the Laurentian rocks of Canada, but to be of any economic importance they must be within easy distance of rail or water communication. The home consumption being slight, the question of freight charges to market becomes the dominant factor in deciding the question of profitable use of our deposits owing to the distance to outside markets in the United States, Great Britain, etc.

The following are some of the known occurrences, most of which are believed to be of workable dimensions:

QUEBEC.

Saguenay County.—Bergeronnes, "block G," McGie mine. Deposit opened up, but work suspended. *Quebec and St. John Railway*. Several veins of pegmatite carrying pink and grey orthoclase have been noticed in the cuttings along the line.

Labelle County.—Villeneuve township, lots 31, 32, range I. A large vein carrying, both microcline and albite, was worked for some years for the muscovite it carried, and a good deal of felspar produced incidentally. Now idle. *Petite Nation*—Papineauville—at the railway station and at the steamboat landing. *Buckingham township*, lot 14, range XII., and lot 20, range V., have been worked.

Wright County.—Wakefield township, Leduc's mine. *Hull township*, lot 14, range VII. Lots 7 and N. ½ 9, range X. Lots S. ½ 6, 7 and S. ½ 9, range XII. Lot 22, range XIII. An extensive deposit of quartz and microcline occasionally including small vugs of purple fluorite. Large quantities of the spar have been shipped to the United States. Distance from railway shipment about two miles. Chamberlin property near Old Chelsea, lot 6, range X. Now working, nearest shipping point about five miles. *Templeton township*, lots 27, 28, range VIII. Felspar said to exist in large quantities on both lots. About seven miles from railway shipment. Lot 14, range II. Deposit now being worked. Thus far about 2,000 tons have been shipped to the United States.

ONTARIO.

Carleton County.—March township, lot 6, concession III. A large deposit about half a mile from railway shipment. Lot 6, concession II. A deposit of quartz microcline and albite probably extensive although partly covered by arable land. Distance to South March station on the Canadian Pacific Railway one mile. *Huntley township*, near Carp, a deposit is being opened up. MISCELLANEOUS. Felspar.

Lanark County.—Burgess township, McMartin property.

Frontenac County.—Clarendon township, *Miller township*, lot 11, concession V., known as the Dawson properties.

The following analysis of felspar from the Villeneuve mine is taken from the report of Mr. Obalski, M.E., in that of the Crown Lands Department of Quebec for 1889 :—

Silica	63·96
Alumina	18·4
Potash and soda	16·88
Iron	traces.
Magnesia	"

Fire-clay.—The production of fire-clay in 1897, although small, is the largest recorded in the tables, being 2,118 tons valued at $5,759. To this total Nova Scotia and New Brunswick contributed a small amount, though by far the largest proportion was mined in British Columbia and made into bricks to be built into the coke ovens under construction by the Union Colliery Co. Fireclay.

TABLE 7.

MISCELLANEOUS.

PRODUCTION OF FIRE-CLAY.

Calendar Year.	Tons.	Value.
1889	400	$4,800
1890	Nil.	Nil.
1891	250	750
1892	1,991	4,467
1893	540	700
1894	539	2,167
1895	1,329	3,492
1896	842	1,805
1897	2,118	5,759

Moulding Sand.—This sand, which is employed by iron founders, is a fine quartzose sand containing small quantities of argillaceous and ferruginous matters. Sands having the requisite composition are known to occur in every province. Moulding sand.

The figures of the production of moulding sand do not nearly represent the total output. With the exception of a very small fraction, the figures are compiled from returns obtained from Ontario producers,

MISCELLANEOUS.

Moulding sand.

the greater part of their output being exported to the United States. Besides this there are numerous deposits which are worked for local wants.

Deposits of moulding sand are mentioned in the "Geology of Canada" to occur at St. Maurice, Batiscan in the province of Quebec; and in Ontario, at Perth, Brockville and Kingston, as well as in the neighbourhoods of Dundas, Durham and Owen Sound.

There is a large deposit worked actively in Essex county, near Union and Leamington the product of which is almost entirely exported.

TABLE 8.

MISCELLANEOUS.

PRODUCTION OF MOULDING SAND.

Calendar Year.	Tons.	Value.
1887	160	$ 800
1888	169	845
1889	170	850
1890	320	1,410
1891	230	1,000
1892	345	1,380
1893	4,370	9,086
1894	6,214	12,428
1895	6,765	13,530
1896	5,739	11,478
1897	5,485	10,931

Platinum

Platinum.—The total value of this metal mined in 1897 was $1,600. The platinum was secured from the hydraulic and placer mines in British Columbia.

TABLE 9.

MISCELLANEOUS.

ANNUAL PRODUCTION OF PLATINUM.

Calendar Year.	Value.
1887	$ 5,600
1888	6,000
1889	3,500
1890	4,500
1891	10,000
1892	3,500
1893	1,800
1894	950
1895	3,800
1896	750
1897	1,600

TABLE 10.

MISCELLANEOUS.

IMPORTS OF PLATINUM.

MISCELLANEOUS. Platinum.

Fiscal Year.	Value.
1883	$ 113
1884	576
1885	792
1886	1,154
1887	1,422
1888	13,475
1889	3,167
1890	5,215
1891	4,055
1892	1,952
1893	14,082
1894	7,151
1895	3,937
1896	6,185
*1897	9,031

* Platinum sheets and wire, and retorts, pans, condensers, tubing and pipe made of platinum, imported by manufacturers of sulphuric acid.

Quartz and Silex.—As shown by Table 11, below, quartz mining as an industry can hardly be said to exist in Canada. The mineral is known to occur in a few localities in workable quantities, being associated with the felspar in the same deposits. So far, however, no economic success can be said to have followed its extraction. Being a low priced mineral, success could hardly attend the effort to mine it except under specially favorable conditions. Quartz.

TABLE 11.

MISCELLANEOUS.

ANNUAL PRODUCTION OF QUARTZ.

Calendar Year.	Tons.	Value.
1890	200	$ 1,000
1891	....	....
1892	....	....
1893	100	500
1894	....	....
1895	....	....
1896	10	50
1897	....	....

MISCELLANEOUS.
Quartz.

TABLE 12.

MISCELLANEOUS.

IMPORTS OF "SILEX" OR CRYSTALLIZED QUARTZ.

Fiscal Year.	Cwt.	Value.
1880	5,252	$ 2,290
1881	3.251	1,659
1882	3,283	1,678
1883	3,543	2,058
1884	3,259	1,709
1885	3,527	1,443
1886	2,520	1,313
1887	14,533	5,073
1888	4,808	2,385
1889	5,130	1,211
1890	1,768	2,617
1891	3,674	1,929
1892	1,429	1,244
1893	2,447	1,301
1894	2,451	1,521
1895	2,882	1,881
1896	3,289	2,174
1897	2,564	3,415

Steatite.

Steatite (*Soapstone*).—This mineral occurs in large quantities in the province of Quebec and Eastern Ontario. It has not yet been mined to any great extent, but the numerous uses to which it can be put may before long cause a larger demand for it.

TABLE 13.

MISCELLANEOUS.

ANNUAL PRODUCTION OF SOAPSTONE.

Calendar Year.	Tons.	Value.
1886	50	$ 400
1887	100	800
1888	140	280
1889	195	1,170
1890	917	1,239
1891	Nil	Nil
1892	1,374	6,240
1893	717	1,920
1894	916	1,640
1895	475	2,138
1896	410	1,230
1897	157	350

In Canada it has, so far, been used almost exclusively for the manufacture of roofing-cements, for which purpose it is mixed with asbestus, mica refuse, tar and other matters. In the United States, the uses to

MISCELLANEOUS. Steatite.

which steatite is put are very varied, such as the manufacture of fixed tubs for laundries, slate-pencils, lubricants, fire-bricks, slabs for electric switch-boards, etc. The variety fibrous talc, is a valuable filler, or makeweight in the manufacture of medium grade papers.

With few exceptions, the deposits of steatite occur in Canada, in association with the crystalline rocks in the "Eastern Townships" of the province of Quebec.

The following occurrences, of economic value, have been mentioned at different times by officers of the Geological Survey of Canada.

Province.	County.	Township or Locality	Range or Con.	Lot.	Remarks.
Nova Scotia.	C. Breton.	Copper Mine, Eagle Head, Gabarus Bay	......	....	
Quebec.	Brome....	Potton.............	V	20........	A workable bed, 3 ft. thick.
"	" ...	"	VI	24........	
"	" ...	Bolton.............	II	6.	Band occupying a breadth of 30 yds.
"	" ...	"	IV	4.........	A breadth about 25 yds., holding bitter spar and dolomite.
"	" ...	"	IV	24........	Deposit of superior quality, consisting of two beds. 3 feet and 5 feet thick, respectively, interstratified with chlorite and dolomite.
"	" ...	"	IX	17...	
"	" ...	Sutton....	VII	12........	In micaceous slates, associated with dolomite.
"	Wolfe....	Wolfeston	II	20........	This deposit was worked a few years ago, and about 3,000 tons of the mineral were taken out.
"	"	Ham................	I	43 & 44....	Large quantities of steatite are found on these lots. The deposit has been opened to some extent, but owing to its distance from the railway, work had to be abandoned.
"	"	Hatley..............	V	19, 20 & 21.	
"	"	Broughton..........	VII	14........	The steatite of this deposit is very pure but the deposit is of limited extent.
"	"	Garthby........	I	6.........	
"	Vaudreuil	Falls of the Bras; Chaudière Valley.	......	... .	Assoc. with argillite and dolomite.

MISCELLANEOUS.
Steatite.

Occurrences of steatite—*Continued.*

Province.	County.	Township or Locality	Range or Con.	Lot.	Remarks.
Ontario	Hastings..	Elzevir....	. ..	....	This deposit consists of pure foliated talc and occurs associated with Laurentian rocks. In this province the deposits of soapstone are found associated with Archæan rocks.
"	Leeds	Rideau Lake.......	....	....	An occurrence on an island on Rideau Lake is being worked and the soapstone used in the manufacture of roofing cement.
"	"	Elizabethtown.....	....	....	
"	"	Clarendon..	II	14.......	
B. Columbia	....	At the mouth of the Salmon River, between Keefer and N. Bend Stations, C. P. Ry.	......	....	

The following is an analysis of material from a deposit in Potton Township :—

Silica................................	59·60
Magnesia......	29·05
Protoxide of Iron.......................	4·50
Alumina................................	·40
Nickel Oxide..........................	Traces
Volatile Matters.......................	4·40
	*97·95

There are numerous other deposits of steatite, which however, as far as known, are only of mineralogical interest.

* Geol. of Canada, 1863.

Tin.—No tin ores have ever been worked in Canada, nor so far, are any workable deposits known to exist.—The following table is given to illustrate the home market for tin in various forms. It will be noted however, that of the total sum of $1,274,108 representing the value of the imports, nearly 80 per cent is credited to tin plate, and sheets, tinware and other manufactures, much of whose value wou'd represent that of the sheet-iron included in that material and also the cost of manufacturing. MISCELLANEOUS. Tin.

TABLE 14.

MISCELLANEOUS.

IMPORTS OF TIN AND TINWARE.

Fiscal Year.		Value.
1880		$ 281,880
1881		413,924
1882		790,285
1883		1,274,150
1884		1,018,493
1885		1,060,883
1886		1,117,368
1887		1,187,312
1888		1,164,273
1889		1,243,794
1890		1,289,756
1891		1,206,918
1892		1,594,205
1893		1,242,994
1894		1,310,389
1895		973,397
1896		1,237,684
1897	Tin crystals	$ 1,508
	Tin in blocks, pigs and bars	249,852
	Tin plates and sheets	919,596
	Tin foil	25,966
	Tinware and all manufacture of tin, N.E.S	77,186
		$1,274,108

Tripolite.—There was a small production of tripolite in 1897 of 15 tons, valued at $150. In 1896 the first year for which figures of production were given, the output was 664 tons valued at $9,960. The production is all from Nova Scotia. Tripolite.

MISCELLANEOUS.

Whiting and chalk.

Whiting and Chalk.—These substances are not produced in Canada. The figures of imports are given below :—

TABLE 15.

MISCELLANEOUS.

IMPORTS OF WHITING.

Fiscal Year.	Cwt.	Value.
1880	84,115	$26,092
1881	47,480	16,637
1882	36,270	16,318
1883	76,012	29,334
1884	76,268	28,230
1885	67,441	23,492
1886	65,124	25,533
1887	47,246	15,191
1888	76,619	20,508
1889	84,658	22,735
1890	96,243	27,471
1891	84,679	27,504
1892	102,985	26,867
1893	88,835	25,563
1894	103,633	26,649
1895	102,751	25,441
1896	113,791	27,322
*1897	102,453	22,541

* Whiting or whitening, gilders' whiting and Paris white.

TABLE 16.

MISCELLANEOUS.

IMPORTS OF CHALK.

Fiscal Year.	Value.
1880	$2,117
1881	2,768
1882	2,882
1883	5,067
1884	2,589
1885	8,003
1886	6,583
1887	5,635
1888	5,865
1889	5,336
1890	7,221
1891	8,193
1892	9,558
1893	9,966
1894	11,308
1895	7,730
1896	6,467
*1897	7,432

*Chalk prepared.

Zinc.—But small quantities of zinc-ores have so far been produced in Canada, and the production has been incidental to that of lead. In the deposits now being exploited on Calumet Island, Pontiac county, Que., zinc-blende and galena occur together, and although no returns are made of zinc for British Columbia, blende occurs in quite considerable proportions in many of the argentiferous galena veins of the Kootenay country, and in a few cases constitutes a large proportion of the ore. MISCELLANEOUS. Zinc.

An interesting deposit of blende in the Huronian rocks was exploited some years ago near Schreiber Station on the Canadian Pacific Railway, on the North shore of Lake Superior.—It was known as the Zenith mine and lies about ten miles north of the lake shore.—It is not known for what reason the development work was not continued, but the distance from the railroad and the rugged nature of the intervening country may have had some influence in rendering further work unprofitable for the present.

TABLE 17.

MISCELLANEOUS.

IMPORTS OF ZINC IN BLOCKS, PIGS AND SHEETS.

Fiscal Year.	Cwt.	Value.
1880	13,805	$67,881
1881	20,920	94,015
1882	15,021	76,631
1883	22,765	94,799
1884	18,945	77,373
1885	20,954	70,598
1886	23,146	85,599
1887	26,142	98,557
1888	16,407	65,827
1889	19,782	83,935
1890	18,236	92,530
1891	17,984	105,023
1892	21,881	127,302
1893	26,446	124,360
1894	20,774	90,680
1895	15,061	63,373
1896	20,223	80,784
1897	11,946	57,754

MISCELLANEOUS.
Zinc.

TABLE 18.

MISCELLANEOUS.

IMPORTS OF SPELTER.

Fiscal Year.	Cwt.	Value.
1880	1,073	$ 5,310
1881	2,904	12,276
1882	1,654	7,779
1883	1,274	5,196
1884	2,239	10,417
1885	3,325	10,875
1886	5,432	18,238
1887	6,908	25,007
1888	7,772	29,762
1889	8,750	37,403
1890	14,570	71,122
1891	6,249	31,459
1892	13,909	62,550
1893	10,721	49,822
1894	8,423	35,615
1895	9,249	30,245
1896	10,897	40,548
*1897	8,342	32,826

* Spelter in blocks and pigs.

TABLE 19.

MISCELLANEOUS.

IMPORTS OF ZINC, MANUFACTURES OF.

Fiscal Year.	Value.
1880	$ 8,327
1881	20,178
1882	15,526
1883	22,599
1884	11,952
1885	9,459
1886	7,345
1887	6,561
1888	7,402
1889	7,233
1890	6,472
1891	7,178
1892	7,563
1893	7,464
1894	6,193
1895	5,581
1896	6,290
1897	5,145

Specimens of massive blende have also been obtained near Burrard Inlet, and near the head of Cascade Creek, Rocky Mountains, Alberta, which may represent deposits of economic importance.

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(NEW SERIES)

ABBREVIATIONS.

Al.	District of Alberta.	N.S.	Province of Nova Scotia.
B.C.	Province of British Columbia.	N.W.T.	North-west Territory.
M.	Province of Manitoba.	O.	Province of Ontario.
N.B.	Province of New Brunswick	Q.	Province of Quebec