GEOLOG. SURVEY

OF

CANADA

ANNUAL REPORT

NEW SERIES

VOL. IX

1896

GOVERNMENT PRINTING BUREAU

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REPORTS AND MAPS

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 IX.

REPORTS A, F, I, L, M, R, S

1896

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

To the Honourable

CLIFFORD SIFTON, M.P.,

Minister of the Interior.

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

The volume comprises 816 pages. It is accompanied by five maps and illustrated by twenty 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, July, 1898.

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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 1896

BY

THE DIRECTOR

OTTAWA

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

1897

No. 614

SUMMARY REPORT

ON THE

OPERATIONS OF THE GEOLOGICAL SURVEY

FOR THE YEAR 1896.

OTTAWA, 1st January, 1897.

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

SIR,—I have the honour to submit herewith the Summary Report on the operations of the Geological Survey for the year 1896, which Report it is directed in the Act relating to the Department shall be presented as soon as may be after the close of each calendar year. In this Report, as is customary, special prominence is given to facts ascertained in the course of the work which are of immediate economic importance, as well as to original observations or deductions and to the exploration of new ground in the field. Promptitude in publication is often particularly important in such cases, while in the detailed reports and maps which form the greater part of the annual volumes and are of more permanent value for the districts they cover, thoroughness of elaboration, both in the field and office is more essential.

Volume VII. of the new series of Annual Reports was completed in September last. Unlike previous volumes, which were issued in paper covers, this has been bound in cloth, and it is proposed, if possible, that succeeding volumes of the series shall be similarly bound. The additional expense is not great, and it is believed that a much larger proportion of the issue will thus be preserved for use and future reference. Volume VII. consists of 1239 pages and contains, or is accompanied by, eleven maps and numerous plates and illustrations. In addition to the reprint of the Summary Report of 1894, it comprises the following reports on special districts and subjects :— Annual volumes.

Report on the area of the Kamloops map-sheet, British Columbia. Contents of Vol. VII.
Report on an exploration of the Finlay and Omenica Rivers, B.C.

Report on the country in the vicinity of Red Lake and part of Berens River, Keewatin.

Report on a portion of the province of Quebec comprised in the south-west sheet of the "Eastern Townships."

Report on the Surface Geology of eastern New Brunswick north-western Nova Scotia and a portion of Prince Edward Island.

Report of the Section of Chemistry and Mineralogy.

Report of the Section of Mineral Statistics and Mines.

The edition of volume VII. in French, has also been prepared and printed, and is nearly ready for issue.

The printing of volume VIII. is now well advanced, and it is anticipated that this volume will be ready at a date much earlier than the last.

Separate reports.

It may here be explained that the reports contained in the Annual Volumes are also issued separately, and in this form are made available to the public as soon as received from the press, at a nominal charge. The volumes combining the separate issues and furnished with general indexes, serve as continuous records of the work of the Survey, and the reports are sent out in this form to scientific exchanges, libraries and institutions.

Maps in preparation.

The number of maps actually printed during the past year is considerably less than in 1895, owing to circumstances elsewhere explained by the Chief Draughtsman, and also to the fact that a number of maps printed previous to 1895 were issued together in that year. There are, however, at the present time no less than 26 map-sheets of various parts of the Dominion in process of engraving or of reproduction by different lithographic processes.

New editions required.

As a result of the important mining development in progress in the western part of Ontario, all separate copies of two of the maps relating to that country have been exhausted. These are the maps of the northern part of the Lake of the Woods and of Rainy Lake, published respectively in 1885 and 1888. Corrections and additions to the engraved stones of the first-named map are now in hand, and a new edition of it will be printed at the earliest possible moment, in order that it may be available to prospectors and miners in the spring. The Rainy Lake sheet will also eventually require to be reprinted, but as it has in large part been reproduced in a map printed by the Ontario Bureau of Mines, it is not so urgently required.

Palæontological publication.

Part 3 of volume III. of the series of publications entitled *Palæozoic Fossils*, by Mr. J. F. Whiteaves, will shortly be published. This part deals with the Cambro-Silurian fossils of the Winnipeg basin, and is based upon the study of extensive and interesting collections made in that region, by several members of the staff.

General index.

Work on the general classified index of reports of the Survey subsequent to the *Geology of Canada* (1863) has been continued by Mr. D. B. Dowling during the year, and is now completed to the beginning of the new series of reports in 1885. It includes 25,813 references. The indexing of the *Geology of Canada* (1863) is now in hand, and will add about 6000 additional references. As this volume constitutes a summary of all the Reports of Progress of still earlier years, and as the volumes subsequent to 1885 have separate indexes, the completion of the work now in progress will, with these, practically afford easy reference to the entire work of the Survey since its inception in 1843. It is intended to print the general index as a separate publication as soon as possible.

Educational collections.

The preparation and distribution to educational institutions of small collections illustrative of Canadian ores, rocks and minerals has been continued during the past year, fifty-four such collections having been sent out, aggregating over 5000 specimens in all. It is endeavoured as far as possible to confine the supply of these collections to institutions in which some elementary natural science is actually taught, but even as thus restricted, the labour and time involved in obtaining material, making up, labelling and cataloguing the collections is very considerable.

Some duplicate mineral specimens of particular interest or rarity, brought in from various parts of the Dominion, have been sent to the museums of several Canadian universities, and a few specimens of the same kind specially requested by foreign institutions have been furnished.

Contributions to Imperial Institute.

Further samples of economic minerals have been supplied from time to time, with all necessary particulars, to the Canadian section of the Imperial Institute in London, which now affords an excellent medium of making known in Great Britain products likely to find a market there. Through correspondence with Mr. Harrison Watson, the efficient curator of the Canadian section, and by means of the recently established Research Department of the Institute, producers and consumers have already in a number of instances been brought into relation with each other. The Geological Survey Department will be happy to forward to the Imperial Institute, from time to time, any approved specimens of mineral products. Such samples should in all cases be accompanied by particulars as to price, place of shipment, freight charges, etc.

Correspondence.

The correspondence of the department has greatly increased in late years and while much of this is of a routine character, a large proportion of the letters written are in reply to specific questions of various kinds, or of the nature of reports upon specimens sent in for determination or examination. Work of this character consumes a good deal of the time of several members of the staff, not otherwise accounted for, but is of direct importance, being one of the modes in which the knowledge of the mineral resources and geology of the country can most profitably be employed.

New museum building urgently required.

The number of visitors to the museum again shows a notable increase, having risen to 31,595 in 1896, and every year the necessity for a modern and safe building of greater size, becomes more urgent. A computation shows that, for the museum, such a building should have about double the floor-space of the present one, with provision in the plan for further enlargement in future years. Considerable additions to the space now employed for offices, library and for purposes of storage, etc., are also required. The situation and construction of the present building render the danger from fire excessive, a fact particularly evidenced during the past summer by the occurrence of a conflagration in lots adjacent and to the rear, which under slightly different conditions might easily have involved this building. The collections, embracing as they do more than 2000 unique "type" specimens, with the entire supply of reports and maps, and the manuscripts and notes representing over fifty years of work, would constitute an irremediable loss to the country if destroyed.

Field-work of the Director.

The session of Parliament occurring during the past summer, with difficulties arising from the want, during some part of the season, of any appropriation to cover the work in progress in the field, rendered my continued presence in Ottawa necessary and prevented me from undertaking any considerable amount of work in the field, of any kind. A few days were, however, spent in Pictou county, Nova Scotia, in company with Mr. H. Fletcher and Dr. Ami in examining some critical and interesting points connected with the geological structure of that region, of which the map-sheets by Mr. Fletcher are now in process of engraving. To Mr. H. S. Poole, who accompanied us on several occasions, acknowledgments are particularly due for information which his accurate local knowledge of the Pictou coal-field enabled him to afford.

Notable progress in mining development.

During the past year, very notable progress has been made in the development of the mineral resources of Canada, both in the way of actual work and in attracting the attention and interest of capital. British

Columbia has begun to evidence its value as a permanent producer of the precious metals, in a manner long foreseen by those who have paid attention to its geological structure and position. In Ontario, wherever the Huronian system is developed and has been examined, valuable mines—more particularly those of gold—are being discovered and opened up. In Nova Scotia, renewed interest has been shown in gold mining, and with improved machinery and methods, the output is likely soon to be greatly increased. Other mineral industries throughout the country, whether already established or in course of development, share in a general appreciation.

Resulting demand for geological information.

The fundamental work of the Geological Survey is that of providing geological maps and reports of the several parts of the country, such as to be of value to the explorer, the miner and others, and in consequence of the activity above alluded to, the demand for information of the kind has been greater than ever before. This has been largely met by the results of surveys previously planned and completed, with such foresight as a study of the geological conditions existing in different parts of the Dominion has rendered possible. Detailed surveys have been made in some districts, while in others it has so far been possible only to carry out general explorations and preliminary reconnaissances. Thus, when an increased interest is simultaneously shown concerning all parts of the vast area of Canada, it is not possible to provide, in every case, information of the kind and on the scale that may be asked for. With the available force of properly trained men and the money actually at the disposal of the Geological Survey, all that can be done is to continue the work steadily, in those which appear to be the most important fields, with a due recognition of the fact that this work must be carried out in such a manner as to have a permanent value to those actually interested in employing it upon the ground, while at the same time commanding the respect and confidence of the scientific world.

Efforts to meet this.

Want of trustworthy maps.

With the partial exception of the Topographical Surveys Branch of the Department of the Interior, by which a great portion of the North-west Territory, Manitoba and the Railway Belt of British Columbia have been or are being mapped in varying degrees of detail, the Geological Survey is the only organization under the Dominion Government occupied with anything of the character of a general mapping of the country as a whole. From the very inception of this Survey, the want of even reasonably accurate maps of any of the provinces, has constituted the principal difficulty in connection with the geological work. Wherever the operations of the Geological Survey have extended, it is universally admitted that the maps published by it are the best

The chief cause of delay in Geological Surveys.

that exist; but in producing these maps a vast amount of time and labour is involved which should not properly be thrown upon the Geological Survey. With two very limited exceptions, in the cases of Nova Scotia and British Columbia respectively, the surveys conducted by the provincial governments have been confined to the running of lines of a cadastral nature, or to the partial measurement of rivers and lakes, without any attempt at exact geodetical work or the delineation of the relief of the land.

Provincial assistance desirable in mapping.

The production of good topographical maps and the construction of roads or other means of communication in the several mining districts, are, it is believed, the most important means by which the provincial authorities may readily afford additional legitimate aid to the development of the mineral wealth of the several provinces. The work of the Mining Bureaus, or Departments of Mines, of Ontario, Quebec, Nova Scotia and British Columbia, besides its function in the inspection and regulation of the mines, is assisting materially in making known the opportunities for investment and in reporting the progress actually made, in detail. The Geological Survey is conducting its operations in complete accord with these organizations, but as the provincial revenues are those actually benefited by the sale of mining lands and royalties on output, it is surely not too much to ask for some further action on the part of the provinces in the matter of topographical surveys.

Death of Mr. Giroux.

I have to record, with great regret, the death of Mr. N. J. Giroux, who had been connected with the Geological Survey since 1883. This occurred November 30th, shortly after the completion of his field-work of the season. Mr. Giroux was a most careful and conscientious observer, and although he had not contributed any detailed reports to the volumes of the Survey, he had aided materially in the collection of facts which have found a place in these volumes. His loss is sincerely deplored by all the members of the staff.

Apart from the vacancy caused by Mr. Giroux's death, there have been no changes in the permanent staff of the Survey during the year 1896.

Parties in the field.

Fifteen field-parties have been at work during the greater part of the past season, distributed as follows:—

British Columbia	2
North-west Territories	3
Ontario	3
Ontario and Quebec	2
Quebec	1
Labrador	1
Nova Scotia	3
Total	15

Besides the above, special investigations were carried on for shorter periods by various members of the staff. Dr. H. M. Ami, spent some time in palæontological work connected with the mapping of formations in Nova Scotia. Mr. W. F. Ferrier, was instructed to endeavour to ascertain the locality in Hastings county, Ontario, from which specimens of corundum had reached him. This he successfully accomplished, with results which may prove to be of considerable economic importance. Mr. J. White, continued and extended the survey of measured lines in Central Ontario, necessary for the purpose of ascertaining the geographical position of the map-sheets already blocked out there. Mr. Willimott spent some time in collecting minerals and rocks at several localities, and Messrs. E. D. Ingall and L. L. Brophy made short excursions in Ontario and Quebec for the purpose of completing information for mineral and mining statistics.

Synopsis of field-work.

Briefly reviewing the field-work accomplished during the year, in regard to which fuller statements are made in the sequel by the several gentlemen engaged in it, the following points may be referred to :—

In British Columbia, the supplementary work necessary to complete the topographical and geological information for the Shuswap map-sheet, was completed by Mr. J. McEvoy. A small area of rugged mountainous country in the north-east corner of this sheet was left unsurveyed, as it was thought to be more important for Mr. McEvoy to join Mr. McConnell in the mapping of the West Kootanie district. In West Kootanie, Mr. R. G. McConnell geologically investigated a tract of country to the south of Slocan and Ainsworth, including the Nelson or Toad Mountain, Rossland and Trail mining centres. As already stated, the region generally is divided between highly altered stratified rocks, chiefly of volcanic origin, and granitic rocks, largely of later date than these, which have broken up through them. Fossils believed to be of Carboniferous age were found in some parts of the stratified series. The Rossland ores occur in association with an eruptive mass of gabbro, about four miles long by one in width, and the definition of this is of great importance, as the principal ore-bodies appear on or about its periphery. A close study of the conditions of occurrence of the ores here promises to be most instuctive. It is proposed to prepare, as soon as possible, a preliminary geological map of that part of the West Kootanie district which has already been covered.

To the north of Lake Winnipeg, Mr. J. B. Tyrrell's explorations were of the character of a reconnaissance, by means of which a considerable area of country hitherto unknown geologically can now be

Synopsis of field-work—*Cont.*

approximately mapped. He succeeded in defining the area of considerable bodies of the metalliferous Huronian series of rocks, and also found an unexpectedly large region characterized by good soil and presumably susceptible of ultimate agricultural occupation.

By Mr. W. McInnes, the work of mapping the mining regions of Rainy Lake district in western Ontario was continued, his time being devoted in the first place to the revision of some parts of the Seine River sheet, of which a preliminary edition had been issued, and afterwards to the Manitou country, to the north of Rainy Lake. A report on the areas covered by the Seine River and Shebandowan sheets is now approaching completion, but a considerable amount of further field-work is required for the Manitou sheet, before this can be sent to the engraver. Much general information respecting the progress of mining in the region is given in Mr. McInnes's report in the sequel, and, as in the case of the work last referred to, the knowledge being gained respecting the associates and mode of occurrence of the auriferous veins is likely to be of great practical utility.

Investigation of Archæan rocks.

Messrs. F. D. Adams and A. E. Barlow, associated in field-work on the area of the Haliburton sheet of Central Ontario, make a joint report on its progress. Besides the economic importance of this region, the examinations in progress there have a special scientific interest, being designed, if possible, to ascertain definitely the relations of the rocks of the Grenville series, the Huronian, and those long ago named the Hastings series, by Mr. Vennor. The whole question of the relations of the several members of the Archæan in North America is peculiarly a Canadian one, originating some fifty years ago in the epoch-making investigations of Sir William Logan, in consequence of which he first introduced a rational classification of the more or less completely crystalline masses underlying the Cambrian. The application of modern methods of research, however, necessarily opens for review many of the conclusions originally formed with less perfect means and knowledge, and the enormous area of these Archæan rocks in Canada renders it particularly important that the best and most natural classification should now be arrived at, for the purpose of delineating them upon our maps. Definite statements on the results so far obtained in the work here particularly referred to, are for the present purposely avoided, in order to leave the subject entirely open for the unbiassed formation of opinion in the light of all the facts. Messrs. Adams and Barlow, however, find reason to entertain the opinion that the Grenville series is the highly altered representative of the Hastings series, and with that opinion Dr. Ells, as a result of his work in the adjoining district is inclined to concur, although he thinks the equivalency of the Hastings is distinctively with the upper part of the Grenville series. The necessity for any reconsideration of the relations of the Huronian to the above-mentioned series, must remain rather a matter of conjecture than of opinion until the detailed work in progress shall have advanced further.

Synopsis of field-work—*Cont.*

Work by Dr. Ells, above alluded to, has been chiefly in connection with sheet 119 of the Ontario series, which forms a continuation of the region covered by two sheets previously surveyed. One of these sheets includes the plumbago, mica, asbestus and apatite deposits of the Gatineau, Buckingham and Grenville districts, and both will be prepared for publication, with an explanatory report, as soon as practicable.

The work in progress by Mr. Giroux, on a map-sheet to the east of Ottawa, including portions of both Ontario and Quebec, was approching completion ; but has been most unfortunately interrupted by the death of that gentleman, as elsewhere mentioned. It will be necessary to endeavour to provide next summer for the additional surveys still required and for the working up of the remaining area and of Mr. Giroux's notes and plans.

The basin of the Nottaway or Noddaway River, one of the largest rivers flowing to James Bay, has been further explored during the past season by Dr. Bell, and with results of interest both geographically and geologically. Thirteen branches of the main stream were surveyed for portions of their lengths, and a route was explored northward from Waswanipi Lake to Nemiskau Lake, an expansion of the Rupert River, by means of various streams and lakes. Mr. R. W. Brock, Dr. Bell's assistant, also carried out a track-survey to the eastward along the Waswanipi River, by which he ultimately reached Lake Mistassini. The more important geological results obtained are those relating to the distribution of the Huronian rocks in the region, which it will now be possible to lay down with some accuracy on the map.

In the "Eastern Townships" of Quebec, researches on the gold-bearing deposits and on the superficial geology generally, have been continued by Mr. R. Chalmers. With the results already obtained in 1895, it will be possible to produce a useful general report on the district, and upon this, work is now in progress in the office. Some interesting particulars relating to gold mining are given by Mr. Chalmers in his progress report, on a later page, as well as facts showing the existence of two boulder-clays and the presence and height of old shore-lines indicating remarkable differential changes in elevation.

Synopsis field-work—*Cont.*

Mr. A. P. Low's investigations were again directed to the further exploration of the great peninsula of Labrador, across the northern part of which another exploratory line was surveyed, from Richmond Gulf on Hudson Bay, to Fort Chimo on Ungava Bay. The actual distance, in a straight line, between the two points mentioned, is about 350 miles, but the total distance travelled, via Missinabie, Moose River, Hudson Bay and return round the eastern coast of Labrador, was about 4200 miles. The Cambrian rocks, with their iron ores, were again found on the northern line of traverse, but no formations of late date were met with, the greater part of the district being characterized by granitic and gneissic rocks of the Archæan. It was found that the rock-striation indicated a flow of ice, during the glacial period, from the vicinity of the present watershed, both to the westward and to the eastward, nearly in conformity with the general slopes of the surface.

In Nova Scotia, Mr. H. Fletcher, Mr. E. R. Faribault and Prof. L.W. Bailey, were engaged in geological work. Prof. Bailey devoted his time to the further examination of the south-western part of the province, with the object of obtaining data for a somewhat detailed general report, such as to fulfil requirements until the regular mapping on the scale of one mile to the inch can be extended to these counties. Attention was given to the relations of the Cambrian gold-bearing rocks and the granites, in connection with the recent renewed activity in gold mining. The Devonian rocks of Digby county were also investigated, with interesting results in respect to their distribution and the horizon which they occupy. Mr. H. Fletcher's time was again particularly directed to the surveys required for new and revised editions of the geological maps of the Sydney coal-fields. The field-work necessary for this is now complete, and the preparation of the new maps will be proceeded with as soon as possible. Some work was also done in Pictou county, and a beginning was made toward the detailed mapping of the Springhill district in Cumberland county. By Mr. Faribault, work was continued in the gold-bearing Cambrian formation of the Atlantic coast region of the province. Surveys have now extended to the westward as far as Mahone Bay, in Lunenburg county, it having been decided, for the time being, to pass over the granitic country between this and the Halifax City sheet, as of minor practical importance. The geological mapping of the structural features of the auriferous Cambrian rocks, is much appreciated by those engaged in mining, and it is hoped shortly to publish some of the large-scale plans of special mining districts which have been made by Mr. Faribault.

Boring at Athabasca Landing.

Boring operations in Northern Alberta.

Work on the experimental boring for petroleum at Athabasca Landing, in northern Alberta, was resumed early in May last by Mr. W. A. Fraser. A depth of 1731 feet had been attained before the suspension of operations in December, 1895, the Cretaceous strata penetrated had been proved to be almost exactly similar to those coming to the surface in natural outcrops further down the river, and it was believed that the top of the lowest member of the Cretaceous—the so-called "tar sands"—in which petroleum is to be looked for, would be met with within the next 100 feet. Under these circumstances it was decided that no effort should be spared to accomplish the additional amount in depth, before abandoning this first experimental hole. It was further intended to carry the boring through the "tar sands" if these should be proved to exist under Athabasca Landing, and to a depth of about 2000 feet, if possible.

Difficulties encountered.

As explained in the last Summary Report, the difficulties in executing this experimental boring have proved to be exceptionally great, in consequence of the incoherent character of the beds; while the unexpectedly great thickness of the strata, under the actual circumstances, led to the reduction in size of the original boring, in depth, to such a degree as to make further operations extremely troublesome. So long, however, as any reasonable prospect existed of carrying the boring down a few hundred feet further, it was deemed advisable to continue work on it, and Mr. Fraser was so instructed, as will appear by his report. Almost the entire working season was spent in endeavouring to enlarge the bore, by under-reaming below the smallest (or $3\frac{5}{8}$ inch) casing, so as to enable that casing to be driven down to arrest the caving in of the shales. The work has been very arduous and slow, but with all his efforts, Mr. Fraser could not succeed in advancing more than thirty-nine feet in further depth. The boring was eventually abandoned when further progress became absolutely impossible. Attention was then directed to withdrawing as much as possible of the steel casing, and a considerable proportion of this has been recovered for future use.

The bore-hole eventually abandoned.

Information gained by the work.

Although this first experiment at Athabasca Landing has thus proved inconclusive, and has not absolutely settled the question as to the existence or otherwise of the "tar sands" so far to the southwest of their natural outcrop, nor the further question of the continued presence of petroleum in them, much valuable information has been gained. As explained in the last Summary Report, the great regularity and persistency of the Cretaceous formations in the region has been established, and the depth at which the " tar sands " and base of the Cretaceous may be found, over a wide region, has been determined. We now also know the nature of the overlying strata to be penetrated, and although this is unfavourable to boring operations, it may be stated with confidence that, with this knowledge, a second boring at the Landing could now be begun and carried down to any required depth without much chance of failure or loss of time.

Proposed further operations.

Sooner or later in the course of testing the great oil-bearing territory believed to exist in Athabasca and Alberta, it will probably be necessary to arrange for such a second boring at the Landing, but in the meantime, it is proposed, in the light of the facts now known, to make, in the first instance, a second experimental boring about eighty miles further down the Athabasca Valley, near the mouth of the Pelican River. At this place the summit of the " tar sands " should be reached at a depth of about 700 feet, and the base of the same formation (probably resting on the Devonian limestones from which the petroleum is originally derived,) at 800 or 900 feet. It is hoped that a boring to such a depth may be made with facility, in adopting the necessary precautions, during next summer.

Two boring plants might be employed.

As explained in the last report, it would greatly accelerate the proving of the field if money sufficient to enable two borings to be carried on concurrently in different localities could be obtained. This would, in fact, practically enable the experimental work now possible in two years to be executed in one, because of the restricted length of the favourable season for operations of the kind. It may be supposed that this work could be prosecuted throughout the year, and this may no doubt eventually be the case, should petroleum be discovered; but at the present time, the difficulty of communication, the distance from the base of supplies and the great expense and almost impossibility of having every appliance on hand in duplicate or triplicate, renders this practically impossible.

Conditions as to probable occurrence of petroleum unaltered.

It is proper to add that the work so far accomplished, although without positive results in the matter of petroleum, has not in the least degree tended to render the existence of petroleum, even at Athabasca Landing, more doubtful than before. It means only that the stratum in which the petroleum is likely to occur has not been reached in this instance, because of its unforeseen depth and other difficulties encountered. The importance of the inquiry, and its probable eventual success remain unchanged, and all that has been said on this subject in the Summary Reports for the years 1894 and 1895, might here be repeated.

Had petroleum been found in the boring at Athabasca Landing, it would probably have been decided to at once move the boring plant to some place in the valley of the North Saskatchewan, for the purpose of tracing the productive beds further south, where their economic development might be of greater importance, because of the adjacent settlements and proximity to railway communication. With this possibility in view, it was thought proper to instruct Mr. R. G. McConnell, before returning to his work in West Kootanie, to spend a few days in making a special investigation of part of the North Saskatchewan valley below Edmonton, of such a character as to supplement that already carried out by Mr. J. B. Tyrrell, by whom this part of Alberta had been geologically mapped. The result of this investigation is thus summarized by Mr. McConnell:— Examination of North Saskatchewan.

"It was found that the central anticline of the plains, which has been traced northwards from the International boundary to beyond Battle River, dies away or becomes inappreciable before the Saskatchewan is reached. The beds, so far as can be judged by the eye, are practically horizontal along the valley, from Edmonton eastward as far as the examination extended, or to Saddle Lake Crossing, some thirty-five miles below Victoria. The choice of a site for a bore-hole, in the absence of any evident arching up of the strata, becomes a difficult one, and will necessarily be largely speculative. If a test is decided on, I would advise the selection of a site in the vicinity of Victoria. The upper beds disappear gradually going eastward, and a hole of less depth would therefore be required here than further west; also, if the anticline referred to above continues north in a reduced form, it must cross the Saskatchewan in this vicinity." Site recommended for boring there.

As already stated, the results at the Landing were not such as to enable any further boring elsewhere to be attempted during the season. Mr. McConnell's observations will, however, serve as a guide for future explorations.

The greatest credit is due to Mr. W. A. Fraser for his indefatigable and skilful conduct of the work at Athabasca Landing, under circumstances often very discouraging, and for most of the time without any prospect, under the arrangements made, of obtaining any adequate remuneration for his time and labour. His report is as follows:— Report on boring operations.

"During the season of 1895, the boring had been carried to a depth of 1731 feet, and had reached into the Clearwater shales which overlie the 'tar sands.' Further progress at that depth had become impossible owing to caving in of the sides of the bore. The casing had been carried down to a depth of 1473 feet. Reaming had then been

Report on boring operations—*Cont.*

resumed with the 'under-reamer,' and the casing had been carried down to 1624 feet. This was the condition of the bore when work ceased, owing to the severe weather, on the 5th of December, 1895.

"The under-reaming had ceased in an extremely hard stratum of sandstone; presumably one of the concretionary nodules, similar to those found in this formation below Grand Rapids. The reaming had been carried into this for six feet, and the constant wearing away of the reamer by the emery-like rock, had reduced the shoulder the reamer was carrying down, until the bore was not larger than the casing. It became evident that an entirely different reamer was required.

"Great difficulty was experienced in making a reamer strong enough to stand this hard rock, owing to the small size of the bore. Before going up in the spring of the present year, I had one made in Toronto from patterns of one used successfully in Australia, and resumed work on the 4th of May.

"The new under-reamer worked fairly well for a time, but finally the steel legs broke. An extra pair of legs had been provided, but these also were used up before the hard stratum was reamed through. Two of the legs broke off in the bore, but were fished out successfully. Another pair of legs was got from Calgary, and reaming was resumed. Most of the summer was taken up in reaming through this hard stratum, for it proved to be about 18 feet thick.

"It was thought to be of great importance to get the casing through this hard streak, for we were probably not over a hundred feet from the 'tar sands,' the reaching of which might make the test a successful one and determine whether the sands carried oil at this place or not. The bore had cost so much, that it was thought wise to spend a little more time and money in an endeavour to get down the short remaining distance.

"Finally, on the 27th of July, the reamer passed through the hard streak. But it took several days more to enlarge the hole to 4⅝ in. diameter to allow the casing to pass through. On the 4th of August the casing was tried for the first time, and it just managed to scrape through.

"From this depth (1635 feet) to 1720 feet, the reaming and casing went very well, but on another very hard streak which was encountered at 1670 feet, the reamer broke again, and much time was lost trying to fish it out.

"When the casing was down to 1720 feet, the bore caved very badly, the shale being often forced up into the casing 100 feet, and requiring to be drilled out. From 1720 to 1731 feet the caving was again very bad. Report on boring operations—*Cont.*

"Drilling was now resumed, and five feet drilled, when the casing was put down a few feet again. At 1735 feet, the casing was only a foot off the bottom, and the sand-pump could not be got to the bottom, even then, because of the caving. As no progress could be made, I was forced to put the casing on the very bottom. If the formation below had been soft, the casing might have been carried on, but it turned out that about a foot below this (1736 feet) a very hard streak of about six feet occurred, and further reaming was impossible, because at least three feet of space was required between the casing and the shoulder to work the reamer.

"For the last few feet, the casing had been put down a few inches at a time, trying to shut off the caving sufficiently to work without getting it on the bottom, if possible. But it was found impossible to even get to the bottom before the casing was actually on the very bottom. This was owing to two causes.—The gas travelling down outside the smaller casing and forcing the caving shale up on the inside, and the great pressure of 1736 feet of overlying strata acting on the shale in much the same manner.

"Under these circumstances drilling was again resumed, and if the formation had continued hard, no further casing would have been required, but unfortunately, it soon again changed to a very soft shale and the caving became so bad that all progress was finally stopped at 1770 feet.

"My instructions had been to carry on the bore while there was any prospect of getting down to the 'tar sands,' and not to abandon it until further progress had become impossible. Recognizing the wisdom of this, I had used every endeavour to get down to a depth which would make it a test and had laboured against obstacles seemingly unsurmountable.

"Acting in compliance with instructions received by wire, I now made preparations to pull out and recover as much of the casing as was possible, as soon as I had found that further progress was stopped. I succeeded in cutting off the 4 inch casing at a depth of 1100 feet, and pulled that much out of the bore. Of the 4⅝ inch casing I cut off and saved 700 feet. In pulling it, it parted three times, owing to a defective joint. The 5⅝ inch casing was parted at 200 feet from the top, and this was all I was enabled to save of it.

"After this the derrick was pulled down, the casing all piled up in good order, and the material left in good shape for an early move down

Report on boring operations—*Cont.*

the river. Logs for a large raft have been taken out and landed just at the rig, and a large boat has been built and made ready for moving next spring. A contract has also been let for chopping 60 cords of wood at the Pelican River.

"From the work that has been accomplished much valuable information has been obtained. The bore has demonstrated that all the strata which overlie the 'tar sands' at their outcrop lower down the river, extend as far as Athabasca Landing. The 'tar sands' appear to be at a greater depth than estimated, but the discovery of the overlying strata in very regular order, would seem to indicate that the 'tar sands' also will be encountered within the next few hundred feet.

"The want of success in reaching the depth necessary to decide by actual boring whether the 'tar sands' are beneath the Landing or not is to be deplored, but every endeavour was used to get the bore as deep as possible.

"The strata actually penetrated before the abandonment of the hole, and beneath those reported on last year, are as follows :—

"1731—36, very soft shale, dark, caving badly.

"1736—47, very hard sand-rock.

"1747—52, shale.

"1752—59, shale and sand sandstone, shale caving badly.

"1759—63, shale, caving badly.

"1763—67, hard, supposed sandstone.

"1767—1770, soft shale, caving badly."

It will be understood that the above strata may now be added to the thickness of the Clearwater shales, as given in the Summary Report of 1895 (p. 12 A.) The thickness of the entire Cretaceous section known at the Landing, now amounts to 1950 feet.

In accordance with the practice previously followed, the succeeding reports of work accomplished, are arranged by order of provinces and districts, from west to east.

British Columbia.

British Columbia.

The winter months of 1896, were spent by Mr. R. G. McConnell in working up the geological and topographical surveys of the previous season in West Kootanie, and in other investigations related to the preparation of a detailed report on that very important mining district

Mr. McConnell left Ottawa for the west on May 13th, and was instructed in the first place to devote a short time to an examination of part of the North Saskatchewan River, below Edmonton, with the object of determining the most favourable place for an experimental boring, should it prove to be desirable to move the plant then employed at Athabasca Landing to the Saskatchewan. Mr. McConnell's observations on this point are given elsewhere, in connection with the report on boring operations (p. 15A).

British Columbia—*Cont.*

Respecting the work accomplished during the summer in West Kootanie, Mr. McConnell reports as follows :—

Work by Mr. McConnell, West Kootanie.

" From Edmonton, I went to Nelson, B. C., arriving there on June 1st. Owing to the late season, snow still covered the higher peaks and ridges in this region and I was unable to commence regular mountain work for some weeks. The time, however, was fully occupied in an examination of the Kootanie and tributary valleys. In the latter part of June a traverse was made up Sproule Creek, a stream flowing into the Kootanie from the north, four miles below Nelson. From the head of Sproule Creek, a summit about 4500 feet in height was crossed to Cedar Creek, and the latter stream was followed down to Slocan River, which it joins about thirteen miles below Slocan Lake. A traverse was also carried up Slocan River to Lemon Creek, connecting there with the work of the previous year. We returned by the Slocan River, down which a track-survey was carried. In July, the work was extended south of the Kootanie to Toad Mountain and neighbourhood, and to the North Fork of the Salmon. In August we moved to the Columbia River, and the remainder of the season was spent on Trail, Murphy, Champion and other creeks flowing into that river below Robson. Work was discontinued on the 20th of October.

Districts examined.

" Mr. H. Y. Russel, my assistant during two previous years in this region, having resigned, Mr. W. W. Leach, B.Ap.Sc., was engaged as field assistant for the season. I was also joined on the 1st of August by Mr. J. McEvoy of the Geological Survey staff, who assumed charge of the topographical work.

" The region examined forms part of the southern continuation of the Selkirk Range, and is everywhere of a rugged and mountainous character. It is traversed by several large and deep valleys running in different directions, the principal ones being those of the Columbia, the Kootanie, the Slocan, the Beaver and the Salmon. Draining into these are numberless small streams, usually of no great length, which take their rise among the higher peaks and summits and descend through deep wooded valleys to the main rivers. The present rough condition

Character of country.

British Columbia—*Cont.*

of the country is mainly due to the slow but persistent wearing action of these streams, or their predecessors, on rocks of differing hardness, the process having continued long enough to entirely obliterate all traces of the earlier configuration.

"The most prominent range south of the Kootanie, is the group called on some of the maps the Beaver Mountains, situated in the granite belt west of the North Fork of the Salmon. The higher peaks of this range approach an altitude of 8000 feet. A number of peaks of scarcely inferior height also occur south of the head of Hall Creek. South of the Beaver Mountains the country declines 1000 feet or more in general elevation and the contours of the hills and ridges become more uniform and rounded. Portions of the interior of this district bear a strong resemblance to a boldly rolling plateau. West of the Columbia River, an apparently endless succession of deep branching valleys and lofty ridges crowned at intervals with sharp peaks and crests, are everywhere met with.

Forest.

"The whole country is, or rather has been, covered with heavy forests, for, since mining operations began, destructive fires have raged every summer over large areas. The forest is principally coniferous, but is relieved by a few broad-leaved trees, among which are the aspen (*Populus tremuloides*), the cottonwood (probably *Populus trichocarpa*, a birch (*Betula occidentalis*), and a small maple (*Acer glabrum.*) Among the coniferous trees the pines are represented by the red pine (*Pinus ponderosa,*) the black or bull pine (*P. Murrayana*), the white pine *P. monticola*), and the high mountain species (*P. albicaulis*). The firs by the Douglas fir (*Pseudotsuga Douglasii*), two mountain species (*Abies subalpina* and probably *A. amabilis*), and by a species usually of fair size, growing on the lower flats, which is possibly *bies nobilis*. The spruces include Englemann's spruce (*Picea Englemanni*), and a couple of other varieties not determined. Other trees well represented are the larch (*Larix occidentalis*), the cedar (*Thuya gigantea*), the hemlock (*Tsuga Mertensiana*). Of occasional occurrence are the juniper (*Juniperus Virginiana*), and the yew (*Taxus brevifolia*). The above list of forest trees has been revised by Professor Macoun.

Prevalence of igneous rocks.

"The most notable feature in the geology of the district examined, is the marked predominance of rocks of igneous origin. Two great series are represented, of which the older consists mostly of porphyrites, diabases, gabbros, tuffs and agglomerates, and the younger of granites.

Granites.

"The granites belong to the same mass so largely developed in the country north of Kootanie Arm and outlined in my summary of last year. The normal type is a medium-grained grayish rock, consisting mostly of biotite, hornblende, quartz, orthoclase and plagioclase; but great variations in both texture and composition are frequent. In places and over considerable areas the development of large felspar crystals give it a distinct, porphyritic appearance. When crushed, this form results in a typical augen-gneiss. With variations in the proportion of its constituents the granite passes into hornblende-granite, granodiorite and mica-syenite. The latter, cut by dykes from the more acidic varieties, occurs largely along the Kootanie River west of Nelson.

British Columbia—*Cont.*

Distribution of granites.

"The granites, except for some small inliers of schists, are found in their various phases all along the Kootanie River and down the Columbia to near the mouth of Bear Creek. The south-eastern edge of the area crosses the Columbia River, below the mouth of Bear Creek and continues south for some distance along Lookout Mountain ridge. West of the Columbia River from Lookout Mountain north to China Creek, the granites occur in a band from one to two miles in width, following the river and sending out occasional spurs to the west, one of which partly encircles the Kootanie-Columbia and Monte-Cristo mountains; but north of China Creek it spreads westward beyond the edge of the district treated of. East of the Columbia River, the granites extend, in an irregular-shaped mass from three to ten miles in width, northeastward to Hall Creek. Besides the main granite area, numerous bosses and reefs of granite, evidently of the same age, break through the older rocks throughout the district. The largest of these crosses the Nelson and Fort Shepherd Railway near Salmon siding, and extends eastward into the still unknown country between the Salmon and Kootanie rivers.

"The rocks on the Columbia River, for some miles above and below the mouth of Champion Creek, have some resemblance to parts of the Shuswap series. They consist of mica-schists and gneisses, evidently derived from granites interbanded with pegmatites, and the ordinary gray granites of the district in a more or less schistose condition. Somewhat similar rocks were also found on the Slocan River, near the 15-mile House, but the presence there of some bands of lustrous mica-schists, typical of the Shuswap, led me to refer them to that series.

Porphyrites and associated rocks.

"The older system of predominantly porphyritic rocks, through which the gray granite breaks, occurs under so many forms and in such different degrees of preservation that it is highly probable rocks of different ages are represented in it. The prevalent rock of the series is a greenish augite-porphyrite often passing into a porphyrite. The groundmass of this rock is usually diabasic, and in many places the augite phenocrysts of the porphyrite disappear and it passes into a fine-grained diabase. The

British Columbia—*Cont.*

porphyrites, while often massive and uniform in texture and appearance, usually show a more or less brecciated structure on weathered surfaces. The embedded fragments and the groundmass, except for slight differences in coloration, appear macroscopically almost identical. Besides the augite-porphyrites and diabases, massive eruptive rocks are also represented by gabbros, small areas of which occur at Rossland and on the North Fork of the Salmon, and by the grayish porphyrites with plagioclase phenocrysts of Toad Mountain and Spokane Mountain. Fragmental volcanic rocks, consisting of tuffs and agglomerates, occur on Granite, Spokane and Sophia mountains, and also on the ridges south of Lake and Bald mountains and in other places in the district. The agglomerates are calcareous in places and are interbedded occasionally with bands of fossiliferous limestones. The fossils collected are imperfectly preserved, but are probably Carboniferous in age.

Slates

"The eruptive series of rocks inclose bands and patches of dark fissile slates, which appear in most cases to be residual portions of the formations amid which the igneous rocks were erupted, as none of the bands, even where a thousand feet or more in thickness, can be traced for any distance along the strike. Slates holding small limestone bands occur on Hall Creek, on the North Fork of the Salmon, on Trail Creek and in other places.

Dykes.

"The granites and other rocks of the district are cut by numerous dykes and bosses mostly belonging to about the same period, but showing extreme variations in texture and composition, specimens showing a range from a light-coloured acidic rock to a dark basic one, and from a microcrystalline to a coarse granitic condition.

"The distribution of the various members of the eruptive series is extremely irregular, and owing to the large proportion of the surface concealed by drift and forests, and the limited time at our disposal, it was found impossible in many cases to trace out junctions except in an approximate manner. A brief statement of the distribution and character of this group so far as known, will, however, be given here; being of great economic interest, inasmuch as it contains the gold-bearing pyrrhotite ores which have made the district famous. The principal rocks of the series are now being examined microscopically by Mr. Ferrier and some of the names given here may be altered when his investigation is completed.

Distribution of gabbros.

"At Rossland, the central member of the group is a fine- to coarse-grained gabbro, apparently passing in a couple of places into a uralitic granite. The gabbros occupy an irregular-shaped area with a length of about four miles and an average width of one mile. They extend from Deer Park Mountain eastward to the western base of Lookout Mountain. The line of junction between the gabbros and the bordering porphyrites, commencing at the north-west corner of the area, runs south through the Cliff, War Eagle and Le Roi claims; then turning to the west, circles round a spur from the main area which covers part of Deer Park Mountain and continues eastward in a sinuous line, passing about a quarter of a mile north of the Crown Point mine to the foot of the west slope of Lookout Mountain. The northern edge of the area runs from the Cliff mine eastward to Monte Cristo Mountain, then bends more to the south, and skirting the southern base of the Kootanie-Columbia Mountain, continues in a south-easterly direction towards Lookout Mountain. The eastern edge of the area has not been precisely defined owing to the absence of sufficient exposures. The gabbros are fringed with a varying width of augite- and uralite-porphyrites, and fine-grained green diabases. The passage from the porphyrites to the gabbros is nowhere sharply defined and the two rocks have apparently originated from the same magma, but have cooled under different conditions. The gabbros and bordering porphyrites are important from an economic standpoint, as most of the ore-bodies at present being worked are situated either on or close to their line of junction.

British Columbia—*Cont.*

Relation of gabbro to ore bodies.

"In passing outward from the gabbro area, a section taken at almost any point, shows a bordering zone of brecciated porphyrites and diabases of varying width, but seldom exceeding a mile, beyond which comes an alternating series of porphyrites, tuffs and slates, and still farther away agglomerates, associated in places with fossiliferous limestone, make their appearance. Slates and tuffs occur with the porphyrites on Red Mountain, on Kootanie-Columbia Mountain and south of the gabbro area on Lake and Bald mountains, and the ridges running south from them. Agglomerates make up the main mass of Sophia Mountain and occur with slates, tuffs and porphyrites on Granite, Spokane, Grouse and Lookout mountains, and on the ridge immediately east of Sheep Creek.

Massive and fragmental igneous rocks surrounding gabbros.

"The roughly concentric arrangement of the Trail Creek rocks, and the gradual passage outward from a holocrystalline central area through semi-crystalline rocks to bedded volcanic fragmentals, suggest an ancient (although now deeply eroded) volcanic centre, situated near the site of the present town of Rossland, from which lavas and ashes deluged the surrounding district. The presence of small bands of coral-bearing limestones with the agglomerates and tuffs, also makes it probable that a shallow sea existed at the time of the outburst, and that the eruptions were intermittent and continued during a lengthened period.

Volcanic origin of rocks.

British Columbia—*Cont.*

Serpentines.

"The porphyrites on Spokane and O. K. Mountain and on Lake Mountain are much fresher looking than those on Red Mountain, and may belong to a more recent period. An area of partly, and wholly serpentinized rocks occurs on Sheep Creek between the western base of Deer Park Mountain and O. K. Mountain.

"From Rossland, porphyrites and associated rocks, often crushed into a schistose condition and accompanied by bands of argillites, were traced northward across Rock and Murphy creeks to China Creek, where they are cut off by the gray granites.

Distribution of porphyrites and associated rocks.

"West of the Columbia River, porphyrites and other igneous rocks similar to those at Rossland have a wide distribution. They are found along the Columbia River from the boundary north to near the mouth of Bear Creek, where they are replaced by granites, and thence were followed in a north-easterly direction along the line of the Nelson and Fort Shepherd Railway to within a couple of miles of the Kootanie River. The width of the band was not ascertained, as the country east of the N. and F. S. Railway was not examined except at a couple of points. From the railway west to the granite area, a variable distance, dependant on the sinuosities of the latter, the country is altogether occupied by these rocks. They were found at the head of Bear Creek and Champion Creek and along the lower part of the North Fork of the Salmon. Near the mouth of the latter stream is a small area of gabbro indistinguishable in appearance from that at Rossland, while farther up augite-porphyrites of the ordinary type, accompanied by diabases and slates, make their appearance. The series here, as over most of the district, is traversed in all directions by porphyrites and other dykes of a later age.

Schistose eruptives.

"The eruptive series bends round the end of a spur of the granite area near the head of Hall Creek, and extends eastward across Toad Mountain as a broad band penetrating the granite, to Rover Creek, and then continues in a more southerly direction to near Waterloo on the Columbia River. In parts of this area, as on Toad Mountain, the porphyrites and other igneous rocks have been crushed and altered into finely foliated diabasic, chloritic and hydro-mica schists. The strike of the schists usually corresponds very closely with the edge of the bordering granite. The derivation of the schistose rocks from the massive eruptives, as already noted by Dr. Dawson (Annual Report, N.S., vol. IV., p. 56 B) admits of little doubt, as gradations from one to the other are frequent, and in many places the crushed and flattened phenocrysts of the original porphyrite are still apparent. On Rover Creek and southward towards Waterloo, where they disappear, the narrowing bands of porphyrites and associated volcanic and argillaceous rocks are broken up by numerous granitic intrusions, and assume a more or less schistose character, although the alteration is nowhere so complete as on Toad Mountain.

British Columbia—*Cont.*

"No systematic examination of the mines in the district treated of was made during the past season, as Mr. Carlyle, recently appointed Provincial Mineralogist of British Columbia, was devoting his time to this particular work, and it was thought best, in consequence, to give all possible attention to the geological structure of the country. A bulletin descriptive of the Trail Creek mines has already been published by Mr. Carlyle, and another, which will embrace those of the Slocan, Toad Mountain and other parts of the district, is in course of preparation. A large number of mines and prospects in different parts of the district were, however, examined in connection with the geological work, and with a view to the elucidation of their character and the classes to which they may be referred. A brief statement of the results of these examinations is given below.

Examination of mines.

"The auriferous iron and copper sulphide-ores of Trail Creek, occur almost exclusively in the massive members of the eruptive series, and most of the important ore-bodies which have so far proved productive, are situated either on or close to the line of contact between the gabbros and surrounding porphyrites and diabases. The Le Roi, War Eagle, Cliff and a number of other leads west of Centre Star Gulch, cut through the line of junction almost at right angles, while the Josie is situated a short distance to the left of it, in the porphyrites, and the Centre Star workings almost immediately east of it in the gabbros. The Monte Cristo and Deer Park claims occur close to the same line, the Kootanie-Columbia, a few hundred feet to the north of it in a band of porphyrites, and the Crown Point, Homestake, Gopher and other leads of the south belt, a short distance to the south of it, in diabases and porphyrites. The ore-bodies are, however, not altogether confined to the neighbourhood of the central gabbro area, but are also found in the bands of massive porphyrites which alternate with the surrounding volcanic fragmental rocks and argillites. The Jumbo is situated on one of these belts, as is also the Coxy, the Giant and a number of other claims. The tuffs, agglomerates and associated slates, with few exceptions, and those of little promise, do not carry the typical iron and copper sulphide-ores characteristic of the Trail Creek region, but are traversed by occasional quartz veins which appear to belong to a later date.

Distribution of ore-bodies.

Quartz veins.

"The ores of the massive eruptive rocks, as stated above, consist principally of sulphides of various metals. Of these pyrrhotite or mag-

Trail Creek ore.

British Columbia—*Cont.*
Pyrrhotite.

netic iron-pyrites is by far the most abundant. This mineral constitutes the common Rossland ore and also occurs in quantity, among other places, on Bear Creek, Champion Creek, the North Fork of the Salmon, and at Waterloo. It is found as a rule in a massive condition, ranging in texture from a fine to medium grain, but it is also disseminated through the country-rock. The massive variety usually holds blebs of quartz, and grains and irregular patches of other sulphides. The pyrrhotite contains gold and silver in varying quantities, a small percentage of nickel and traces of cobalt. A specimen from the Iron Colt, analysed in the laboratory of the Survey gave 0·234 per cent of nickel, and one from the Monte Cristo 0·13 per cent. The gold contents are exceedingly irregular, ranging from traces up to several ounces to the ton, and the silver from traces to four or five ounces to the ton.

Chalcopyrite.

"The pyrrhotite is usually accompanied by a certain amount of chalcopyrite or copper-pyrites, intimately commingled with it. The copper-pyrites is extremely irregular in its distribution, in some places constituting a considerable proportion of the ore-body and in others occurring only as isolated and occasional grains and patches. It was nowhere seen pure in large masses. It is auriferous and holds apparently about the same percentage of gold as the inclosing pyrrhotite.

Mispickel.

"Mispickel or sulph-arsenide of iron, is found associated with the pyrrhotite in a number of the mines, and in places occurs in considerable quantities. It is auriferous, and at the Evening Star mine and possibly at other places, a portion of the iron is replaced by cobalt and it passes into cobaltiferous mispickel or danaite. Dr. Hoffmann furnishes the following note on this mineral.—The specimen consists of a fine to coarse crystalline calcite carrying a cobaltiferous mispickel—most probably the variety known as danaite. It is coated in parts with ferric hydrate and peach-blossom red, hydrous cobalt arsenate (earthy cobalt bloom a variety of erythrite) resulting from the decomposition of the mispickel. The mispickel may not improbably contain sufficient cobalt to be of economic importance, a point which will shortly be determined; the analysis of the mineral having been entered upon.

Cobaltiferous mispickel.

Molybdenite.

"Molybdenite or sulphide of molybdenum, occurs at some of the mines, notably at the Coxy and Deer Park. At the latter mine it is stated to be highly auriferous.

Other minerals.

"Besides the above minerals, galena and blende occur at the Lilly May and other locations in the south belt and also at the Union and other mines to the north of the main mineral area, but are not found, so far as I am aware, in the principal Red Mountain mines. Ordinary iron-pyrites is met with in greater or less quantities nearly everywhere. British Columbia—*Cont.*

"The ores are usually oxidized on the surface, but the alteration seldom extends downwards for more than a few feet, and in some cases a single shot brings the unchanged sulphides into view.

Ores in schistose eruptive rocks.

"The ores in the schistose eruptive rocks differ markedly from those in the massive eruptives. In the well known Silver King mine, on Toad Mountain, the ore consists mostly of argentiferous bornite with some copper- and iron-pyrites, tetrahedrite, argentite, blende, galena and stromeyerite. A specimen of the latter interesting mineral, which has only recently been detected, was handed to me for determination before leaving Nelson, and was submitted to Dr. Hoffmann who reports as follows.—It consists of stromeyerite, a sulphide of silver and copper with a little galena and pyrite in a gangue composed of a grayish felspathic rock. An approximate determination of the silver in this particular specimen of the mineral after separation of all gangue etc., gave 51·9 per cent, of silver. The analysis of this mineral will shortly be taken in hand.

Stromeyerite.

In the Dandy, a claim adjoining the Silver King, argentiferous galena is the principal mineral, and associated with it in more or less abundance in different places are tetrahedrite, blende, bornite and copper- and iron-pyrites.

Classification of ore-bodies.

"The classification of the Trail Creek ore-bodies, and the sulphide deposits generally of the igneous rocks of the district, is a difficult problem and one which has given rise to considerable differences of opinion. They may be original segregations from a cooling magma, like the Sudbury pyrrhotite ores, secondary segregations from the basic rocks which inclose them, replacement veins along lines of fissuring, or, as the majority of the miners are inclined to believe, true fissure veins. Isolated examples might be cited in support of any of these views, but taking the deposits as a whole, the theory which fits in best with the prevailing conditions is undoubtedly the third. The blunt irregular outlines of some of the ore-bodies, and their fissure-like regularity in others, the presence in most cases of a single wall which is often meaningless as a confining line, and the occasional lack of any wall, the gradual blending of the ore with the country-rock, and the presence of the latter as the principal gangue, are all characters consistent with the deposition of the ore from ascending heated waters, which have eaten away portions of the country-rock along lines of fracturing, and replaced it by the minerals held in solution. The definite and approximately parallel direction and dip of the majority of the Rossland

British Columbia—*Cont.*

leads, the siliceous character of many of the ores and the presence of calcspar in seams and irregular pockets, tell against the theory of original segregation, which has of late years been applied to somewhat similar deposits in different parts of the world, while the ordinary ear-marks of fissure veins, as usually understood, are seldom observable.

Permanency of ore-bodies.

"The miners of the district are generally prejudiced in favour of fissure veins, under the belief that they are the only ones which are apt to be continuous in depth. There is no reason, however, why replacement veins following lines of fissuring, and filled with material derived from below, though subject to greater variation in volume, should not be equally permanent.

Auriferous quartz veins.

"Besides the pyrrhotite and associated sulphide-ores characteristic of the basic volcanics, an important system of siliceous ore-bearing fissure veins has a wide distribution in the district. The quartz leads are not confined to one formation, but occur indiscriminately in all. The O. K. occurs in an altered and partly serpentinized basic volcanic rock, the Fern in massive porphyrite, the Poorman, Maud S. and Clearwater in granite, the Exchequer in schistose eruptives, the Elise in slates, and the Gold Hill and Helen in eruptive rocks later than the granite. The quartz leads vary greatly in size, but seldom exceed six to eight feet in width, and usually average less. They contain free gold, auriferous pyrites, chalcopyrite and galena. Stamp-mills have been erected at the Poorman, O. K. and Fern, and a number of the other leads are being prospected.

Mineralized belts.

"A third class of gold leads includes the Starlight, Golden King and others in the vicinity of Toad Mountain, and consist of pyritized belts, often a hundred feet and more in width, traversing the schistose eruptives. These leads are simply more or less mineralized portions of the schistose country-rock, carrying occasional ribs and stringers of quartz. They are low grade, the Starlight, which has been prospected during the past summer by Mr. Francis for an English company, averaging about $3 in gold per ton, but owing to the practically unlimited amount of material available, they may possibly in some instances be profitably worked.

"Mining has made satisfactory advances on all sides in West Kootanie during the past season. Prospectors, the pioneers of the industry, swarmed over the country making numberless locations everywhere. A fair percentage of the prospects of previous years on which development work has been done, promise to become mines, and the older mines show no signs of deterioration as developed. Several new camps, notably Waterloo, Champion Creek, the North

Fork of the Salmon, and the Springer Creek district, have come into prominence, while the older ones have developed into recognized mining centres. The output of ore has largely increased and the capacity of the smelters has been more than doubled in order to meet the demand. Favourable reports from competent men have been received in regard to a number of outlying districts which have not yet been examined, and it is altogether probable that, with the advent of easy communication, the successes of Trail Creek and the Slocan will be repeated in East Kootanie, Boundary Creek, the Lardo, the Big Bend and other places. Capital has flowed freely into the district during the season, but it is to be feared that an undue proportion of it has found its way into the pockets of speculators rather than into legitimate mining.

British Columbia—*Cont.*

"In Rossland and vicinity, although there has been a good deal of scarcely warranted speculation, much conscientious development and prospecting work is being carried on, the result of which, in large part, will not be known for some time yet, as the hard eruptive rocks of the district necessarily make mining a slow and expensive operation. Compressor plants have, however, been erected at a dozen or more of the principal mines, and machine drills with their quicker results are rapidly supplanting hand labour. The Le Roi and War Eagle are still the principal producing mines in the camp, but considerable shipments at irregular intervals have also been made from the Josie, Iron Mask, Cliff, Evening Star, Crown Point and others, and it is highly probable that, with the extensive development work now in progress, the output from these will be largely increased in the near future.

Development in Rossland.

"The Rossland ores, as a rule, are not of high grade, and a large proportion of those in sight cannot be profitably worked under present conditions. The cost of freight and treatment is given by Mr. Carlyle at $10 to $14 per ton.* If the cost of mining, a variable factor, is added to this, it will be evident that ores carrying less value than $15 per ton can only be worked at present at a slender profit, if at all. In order to utilize this material, reductions in both freight and smelting charges are imperative, and will doubtless be made as the treatment of the ore becomes better understood and competing lines of communication are opened up. Should the railway now projected through the Crow Nest Pass be built, and the mines connected with the extensive coal-fields known to exist in the Rocky Mountain Range, fuel, the principal item in the expense of smelting, could be obtained at a much lower figure than at present, and the smelting charges reduced in pro-

General character of the ores.

Importance of reducing smelting charges.

* Bulletin No. 2. The Provincial Bureau of Mines, Victoria, B.C. Aug., 1896.

British Columbia—*Cont*

portion. A large percentage of the ores are of too low grade to be worked under any circumstances, but it is believed that with smelters built on the spot, cheap fuel and improved processes, those with a valuation of $8 and upwards will eventually be profitably treated.

"The Slocan and Ainsworth camps, accounts of which were given in last year's Summary Report, were not visited by me during the past season."

Work by Mr. McEvoy.

In the early part of the year, Mr. J. McEvoy was chiefly engaged in compiling the information obtained during the previous summer for the completion of the Shuswap map-sheet, with a view to ascertaining if any further geological investigation would be desirable. Some time was also spent in the final revision of the Kamloops map-sheet for publication.

Mr. McEvoy left for the field on the 10th of June and returned on the 1st of November. The first part of the season was occupied in filling in certain portions of the Shuswap sheet which had proved to be wanting in detail. Upon this work Mr. McEvoy reports as follows:—

Completion of surveys for Shuswap sheet.

"Arriving at Kamloops on the 15th of June, and having secured the necessary equipment, I started with pack-horses up the North Thompson River. Some days were spent in examining the country in the vicinity of the Barrière River, where the outline of the rocks of the Adams Lake series was uncertain.

"A short trip was next made to the north-east side of Mount Tod to define the boundaries between the Shuswap and Nisconlith series there.

"Attention was then turned to the geology of the south-west corner of the sheet, where little was known of the arrangement of the rocks. Here the discovery of a small area of rocks of the Shuswap series (gneisses and mica-schists) on Sucker Creek, to the east of Chaperon Lake, gave a definite point to work from. From this an ascending series of rocks was traced up to the Triassic, similar to that found elsewhere on the area of the sheet as well as upon the adjacent Kamloops sheet. A couple of weeks spent in this vicinity resulted in obtaining satisfactory outlines for the formations.

Surveys undertaken near Rossland.

"After this a few days were spent on Shuswap Lake, and then, leaving the horses at Kamloops, I proceeded to Rossland to commence a survey of the country in that vicinity.

"The methods of surveying employed were triangulation with the transit, extended from points fixed by Mr. J. H. McGregor of the Provincial Survey, with topographical sketches supplemented by odometer and paced surveys. Barometers were used for heights going from and returning to definite points.

British Columbia—*Cont.*

"Much trouble was experienced on account of the dense smoke which prevailed during the greater part of the season and prevented any distant views. This difficulty was partly overcome by taking more small and partial sketches than would otherwise have been necessary.

Area covered.

"The area surveyed extends from the International boundary-line northward to Robson, and from the head of Murphy Creek on the west to the mouth of Salmon River on the Pend D'Oreille River.

"I was assisted in carrying out this work by Mr. W. W. Leach."

NORTH-WEST TERRITORIES AND KEEWATIN.

Work by Mr. Tyrrell.

Subsequent to the date of the last Summary Report, Mr. J. B. Tyrrell was employed chiefly in completing a report on the country between Athabasca Lake and Churchill River, and in working up the results of his expedition of 1893, through the Barren Lands.

Country north of Lake Winnipeg.

On June 13th, Mr. Tyrrell left Ottawa for the west, having been instructed to undertake a preliminary geological examination of a tract of country to the north of Lake Winnipeg and lying between the upper part of the Nelson River and the longitude of Cumberland House. The existence of rocks referable to the Huronian system in this region had been conjectured, from information already gained by Mr. Tyrrell in adjoining areas, and as it is comparatively easy of access from Lake Winnipeg, it appeared to be of particular importance to define the area occupied by these rocks and to ascertain their character. Mr. Tyrrell reports as follows on the work done, and it will be observed that he believes the region to be one of considerable promise and worthy of the attention of the prospector.

"On the 29th of June I left Selkirk, Manitoba, accompanied by two canoemen who had been with me through two previous seasons, and the following day reached Selkirk Island, near the mouth of the Saskatchewan River. On the morning of the 1st of July we were taken by a small fishing tug northward to Limestone Bay, and thence we proceeded by canoe along the north shore of Lake Winnipeg and through Playgreen Lake to Norway House.

Enumeration of routes surveyed.

"Here two Indians and an extra canoe were hired, and we turned westward into the country lying to the west of Nelson River, explor-

North-west Territories—*Cont.*

ing Goose-gut, Pine and Wolf rivers ; returning from the latter stream to Norway House, where the two Indians were paid off.

"We then descended Nelson River to Cross Lake, where two other Indians were hired, and the descent of the Nelson River was continued to the north end of Sepaywisk Lake, whence we crossed several portages and small lakes until we reached Burntwood River, which was ascended to Nelson House, where the Cross Lake Indians were paid off and allowed to return home. With one canoe, and the two men from Selkirk, I returned to Paint Lake, and then ascended Grass River, through Setting, Herb and Reed lakes to its source in Cranberry Lake. From the south end of Cranberry Lake, we crossed the Cranberry Portage to Athapapuskow Lake, and thence descended Goose River, through Goose Lake, to Sturgeon River, which was descended to Cumberland on the Saskatchewan River.

"From Cumberland we ascended the Saskatchewan River to Fort à la Corne, where the canoe was stored for the winter, and we drove to Prince Albert, arriving there on the evening of the 9th of October, three months and eleven days after leaving Selkirk, having travelled in all about 1100 miles, largely over routes previously unexplored.

Northern edge of Palæozoic limestone

"From Lake Winnipeg and the Saskatchewan River, the horizontal Palæozoic limestone was found to extend northward to the south end of Hills Lake, on Pine River, and Herb Lake, on Grass River. Thence, the northern limit of the limestone extends westward, keeping to the south side of Grass River, and generally forming an escarpment from fifty to one hundred feet high. Goose and Athapapuskow lakes lie in a deep bay in the face of this escarpment. West of the latter lake the northern edge of the limestone is known to extend along the south-west side of Beaver Lake, and thence onward towards Lac la Ronge, south of Churchill River.

Laurentian and Huronian rocks.

"North of the limestone escarpment, the country is underlain by Archæan rocks, which have usually a gently undulating surface contour. From the Nelson River westward as far as longitude 99° 30′ they consist chiefly of gray and reddish-gray Laurentian gneisses and granites. Along the Nelson River these are cut by numerous dykes of dark-green, highly basic traps, and in the vicinity of Pipestone and Cross lakes they are associated with an area of micaceous, hornblendic and sericitic schists, stretched schistose conglomerates and fine-grained slates of Huronian age.

"On the south side of this area, and near the edge of the gneiss, is an eruptive mass of light greenish-gray anorthosite, and a gabbro containing a large quantity of mispickel, associated with some copper-pyrites.

North-west Territories—*Cont.*

"On the south side of the Indian Reserve Island in Cross Lake, the hornblende-schists are cut by wide veins of coarse, white, pegmatitic granite, containing large crystals of black and white mica, some of the latter being nine inches in diameter, and very possibly indicating deposits of commercial value. On account of the evenly rounded nature of the surface, and the want of blasting materials, none of the larger crystals could be taken out, but some of the smaller fragments obtained were clear and unbroken.

"Thinly foliated green schists, probably of Huronian age, were again found on another Pipestone Lake, on the way from Cross Portage to Burntwood River.

Largest Huronian area.

"But the most extensive and interesting area of Huronian rocks was discovered on the upper part of Grass River. Beginning a short distance east of Herb Lake it extends almost continuously westward through Reed, Elbow and Cranberry lakes, and crossing to the drainage basin of the Saskatchewan River, underlies parts of Athapapuskow and Goose lakes.

"Seven miles east of the north end of Herb Lake, the Huronian rocks are first encountered, in a hill of massive or slightly foliated diabase largely altered to chlorite, and a short distance further west is a ridge of dark-gray micaceous schist studded with rather large crystals of staurolite. On the east side of Herb Lake is a ridge of thinly foliated light-gray micaceous gneiss, containing a good deal of white mica, and cut by many veins of white quartz.

"On the west side of the same lake, and extending south to Wekusko Point, is an eruptive mass of coarse gabbro, approaching a diabase in texture. South of this is a considerable area of dark-green, slaty schists. On the south-west side of the lake these are cut by another large eruptive mass of a finer grained and more typical gabbro. The schists are also disturbed and altered by a large mass of red granite.

Numerous quartz veins.

"Almost everywhere the schists are cut by larger and smaller veins of white quartz. The river above Herb Lake runs for a considerable distance along the line of contact of red granite on the west, and Huronian schists and conglomerates on the east, above which it crosses an area of coarse, dark-gray gabbro, returning, near the entrance into Reed Lake, to the red granite. Near the contact are many quartz veins, associated with a good deal of iron-pyrites.

North-west Territories—*Cont.*

" On Reed Lake, the Huronian rocks consist chiefly of fine-grained, green, slaty schists, holding much pyrites, and cut by many stringers of quartz.

Rocks of Reed and Cranberry lakes.

" Above Reed Lake the country becomes more rugged and the hills more precipitous. The river circles round an area of basic igneous rocks, as far as Cranberry Lake, often occupying a valley along the line of contact of these rocks with the surrounding granite or gneiss. Near the contact, the rocks have been much disturbed and are cut by many veins of quartz, often containing a large quantity of pyrite.

" On Cranberry Lake the Huronian rocks are often altered to a silvery sericitic schist. The same schists extend across the watershed to Athapapuskow Lake, and thence continue westward, perhaps beneath the undisturbed Palæozoic limestones.

Promising field for prospectors.

"This area of Huronian rocks, extending about seventy-five miles from east to west, and an unknown distance towards the north, presents a good field of exploration for the prospector for gold and other precious metals, on account of the number and variety of eruptive masses that break through it, surrounded by zones of highly disturbed and fissured rocks.

Superficial deposits.

"From Nelson River westward to longitude 100° 30′, and from the north end of Lake Winnipeg northward to beyond latitude 56°, the country is generally covered with a coating of stratified clay, varying in thickness from a few feet up to fifty, sixty or even one hundred feet. This clay is of much the same character as that of the Red River valley, having been, like it, deposited in the bed of the old post-glacial lake that once occupied the basin of Lake Winnipeg. The rivers have, as a rule, cut down through this clay to the underlying rock, but away from the water-stretches, rock-exposures are not of very frequent occurrence. The soil is rich and fertile, and since summer frosts do not seem to be very prevalent, the country will doubtless produce in abundance all the hardier roots and cereals grown in the province of Manitoba, and cattle, sheep and horses could be successfully raised. If the country were made accessible by a railway passing through it to Hudson Bay, it would certainly support a considerable agricultural population."

Soil and climate.

Mr. Tyrrell returned to Ottawa on October 16th.

ONTARIO.

(With adjacent parts of Quebec.)

Work by Mr. McInnes.

The greater part of the winter of 1895-96 was spent by Mr. W. McInnes in plotting surveys of the previous summer, in preparing for the engraver the Shebandowan Lake sheet, correcting the Seine River sheet, and in compiling a report on these two sheets, shortly to be issued. On the field-work accomplished in 1896, Mr. McInnes reports as follows:—

Ontario—*Cont.*

Surveys by Mr. Lawson.

"I left Ottawa on the 5th of June, and arrived at Port Arthur on the 8th. Mr. William Lawson, B.A., of Toronto, who had been engaged as assistant for the summer, joined the party here. During the early part of the summer Mr. Lawson was employed in making independent surveys in the region immediately east of Lake of the Woods. He first made a survey by boat-log of the canoe-route leading from the head of Long Bay, Lake of the Woods, to Eagle Lake. A series of lakes lying to the north of this route, between it and the line of the Canadian Pacific Railway, was also surveyed. This included Hilly, Whitefish, Narrow, Windy, Porcupine, Buzzard and Pine lakes, with connecting streams and portages. A survey was then made of the long westerly arm of Eagle Lake known as Vermilion Bay, and of the greater part of the main body of Eagle Lake, with its easterly extension, Osborne Bay. Geological notes were taken by Mr. Lawson throughout, and a set of typical rock specimens was collected.

Re-examination of Seine River country.

"While Mr. Lawson was so engaged, I made a trip from English River station on the Canadian Pacific Railway, southwards to the Seine River, for the purpose of supplementing the information on that region contained in the notes of the late Mr. W. H. Smith.

"The route led through Upper and Lower Scotch lakes, Irish Lake, Welsh Lake, Norway Lake and a number of small lakes and streams to Upper Seine Lake and the Seine River.

Route from English River station.

"About midway on this route, the belt of Keewatin which forks from the Seine River band at Steep Rock Lake, was crossed. It has here, at its narrowest, a width of about two and a-half miles, and is made up of diorites and kindred eruptives of the Keewatin, with considerable areas of greywacke and crushed quartz-porphyry, and of felsitic and quartzose schists, all more or less pyritous. Belts of the schist, in a number of places, show pyrites in thin sheets along the planes of cleavage, as well as scattered irregularly through the mass of the rock.

"Large angular blocks of quartz with iron- and copper-pyrites, which evidently had not travelled far, were noted about the shores of two of the small lakes near the height-of-land.

"Along the southern edge of this belt, a band of hornblende-gneiss or crushed hornblende-granite occurs, and forms a rim along the

Ontario—*Cont.*

northern edge of the large biotite-gneiss area of Caribou Lake. This hornblende-gneiss band, where crossed on this route, has a width of a little over a mile, and is without doubt continuous with the area of the same rock about Sawbill and Moose lakes. The area just described with its extension towards the head of Sawbill Lake seems to offer a promising field for the prospector.

Sawbill Lake.

"Sawbill mine (location 313X.) was visited and the rocks about Sawbill Lake examined. They were found to consist in the main of hornblende-gneisses and hornblendic granites and syenites often much crushed and sheared, in places becoming schists in structure.

"In one of these much crushed and sheared bands the vein occurs on which the Sawbill shaft has been sunk. The shaft, which follows the vein, was down about 40 feet at the time of my visit, and work was continued actively during the summer. The vein at the surface has a width of about 4 feet. It strikes N. 9°E. astronomical (or N. 15° E. mag.) * and can be followed in a southerly direction for 300 feet, where it bends to a direction S. 24° W. for another 300 feet, gradually failing in width until it becomes very small. In a northerly direction it has been traced about 900 feet, beyond which point the surface falls away into a swamp. It was stated by those in charge at the time, that the vein could be picked up again beyond the swamp. The hade of the vein is easterly at an angle of a little over 10 degrees from the vertical. Though running 'with the formation' there seems to be no doubt about the true fissure character of the vein. The walls are well defined, the hanging-wall particularly so, often showing slickensided surfaces and a parting of crushed chloritic material between the wall and the vein-matter. On the foot-wall, there is a certain amount of mingling of the vein-matter with the inclosing rock and a number of stringers and small parallel veins, so that the vein contents do not come away so freely from this wall as from the hanging-wall. The dump showed quartz carrying iron- and copper-pyrites and a considerable amount of free gold, and the vein at the bottom of the shaft was well defined and solid.

Sawbill mine.

Harold Lake.

"After a few days spent in an examination of some points about Steep Rock and Moose lakes, where the geology is somewhat complicated, Harold Lake was visited. A number of veins have been exploited here, and half a mile of tramway has been built, connecting the different openings with a five-stamp mill at the lake shore. The outlet of the lake has been deepened to allow sinking on a vein known

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

as the shore vein, which outcrops at the base of a low cliff near the south-west corner of the lake. This vein strikes N. 29° W., with a hade to the north-east of a few degrees from the vertical; it is rich in free gold, but small and somewhat irregular. On No. 1 and No. 2 veins, which vary in width from one to two feet, were drifts about 200 and 140 feet respectively with a shallow winze on each. The mill was not working at the time of my visit. Work was continued during the summer, and Mr. Wiley informs me that a more promising vein, near the tramway, was being opened up. The veins occur near the contact of a highly crushed and altered granite with Keewatin schists and diorites.

Ontario—*Cont.*

Exploration of Pipestone River.

"At Nonwatin or Calm Lake, the Seine River route was left for the purpose of exploring the Pipestone River. Pine Lake, at the head of Pipestone River, is reached from Calm Lake by two portages with a small intervening lake. On the first of these portages the ascent from Calm Lake is about 130 feet, and on the next there is a descent of a few feet to Pine Lake. As Calm Lake has probably an elevation of nearly 100 feet above Rainy Lake, the descent by the Pipestone River must be a little over 200 feet. The river proved very rough, with many falls and rapids, and along its upper stretches was barely large enough for canoeing. Evenly foliated, fine biotite-gneisses of the Coutchiching, occur all along its course, striking about east-and-west, with minor local deviations from this direction. These gneisses are an extension easterly on their strike of those described by Dr. A. C. Lawson as occurring about the most easterly extension of Rainy Lake, into which this river empties.

Bad Vermilion Lake.

"A week was next spent in the region about Bad Vermilion Lake, in an examination of some of the gold locations. In this vicinity, on the north shore of Shoal Lake, at Foley's (locations 174E. and 175E.), the veins occur in the so-called protogine granite area. This granite is first seen on the road leading northwards from the shore of the lake, at a point about 200 yards from the shore, and extends continuously northwards nearly to the southern shore of Bad Vermilion Lake. Two shafts have been sunk on a vein on this property to depths of a little over 200 and 100 feet respectively, with drifts aggregating over 300 feet. The vein is a true fissure, and has a width, as exposed on the surface, of from 18 inches to 3 feet. At the bottom of the deeper shaft it is stated that the vein has widened to 5 feet or more. The dump shows very rich looking quartz with iron- and copper-pyrites, galena, and a good proportion of visible free gold.

Foley's

"Other good looking veins occur on the same property. One of these about 100 feet to the south-west of the first-named vein promises very

Ontario—*Cont.*

well. It has a surface width of about $2\frac{1}{2}$ feet, and shows free gold in good quantity. Since my visit the company have continued active work on the property, and a mill is in course of construction.

Mine Centre, Shoal Lake.

" Further to the east, on the road running northward from Mine Centre towards Hillier's and Ferguson's, the first rock exposures after leaving the Keewatin rocks, which are seen on the immediate shore, are met with about half a mile south of Hillier's, or about three miles north-west of Mine Centre, on Shoal Lake. They are greenish, highly altered granites with prominent blebs of opalescent quartz. The same granite is continuous to and beyond Ferguson's (A.L. 110). To the north, between the granite and the south shore of Bad Vermilion Lake, occurs a belt of alternating bands of gabbro and Keewatin diorite and schist. A great part of the area crossed by the road is covered with a thick coating of fine white sand, with large boulders of granite, which conceals the underlying rock, except where occasional bosses protrude.

Ferguson's.

" At Ferguson's (A.L. 110 and adjoining locations) in addition to a considerable amount of surface stripping, cross trenching, etc., two shafts have been sunk to depths of about 50 feet each. On one of these the vein is divided into two small veins of a few inches each, separated by an intervening mass of granite about 18 inches in thickness, which continues to the bottom of the present shaft though narrowing down to a few inches.

" In the other shaft on the same vein, further west, the vein is better defined though still narrow. Among the other veins on the property is one, on which only stripping has been done, which can be traced for over 1000 feet, varying in width from 6 inches to between one and two feet. These veins carry free gold in quantity sufficient, it is claimed, to well repay working. Work was continued during the summer on this property, preparatory to the building of a mill.

Lucky Coon.

" At Hillier's (the Lucky Coon, 655 P.) the mill was idle and nothing was being done. The shafts, which were filled with water at the time of my visit, have been sunk on two parallel veins about 80 yards apart, one vein showing a surface width of from 3 to 6 feet and the other varying from a little over a foot to a broad, irregular vein showing about one foot of crushed country-rock, a foot and a-half to three feet of quartz, and 2 to 3 feet of mixed stringers of quartz and country-rock. These are fissure veins cutting the granite mass. This whole area of granite lying between Bad Vermilion and Shoal lakes has been very much crushed and is fissured in all directions, so that the number of veins is very great, some of them promising well. On locations A.L. 103-4-5-6, are many good veins, the principal among them striking from N. 20° W. to N. W. They vary in size up to a width of from 3 to 7 feet and generally show good walls. Many show visible free gold and others are strong in sulphides. At K. 244, on the north shore of Bad Vermilion Lake, a band of greenish-gray, quartzose, massive rock, fairly mineralized with iron- and copper-pyrites and from 50 to 100 feet in width, is inclosed in green hornblendic schists of Keewatin age with a trend parallel to the strike of the schists. This band appears to be an arm from the granitic area; it is cut in all directions by stringers and small veins of quartz from 9 inches in thickness to mere threads, running generally across the trend of the band but following also every possible direction. These stringers, where weathered on the surface, it is stated, pan well.

Ontario—*Cont.*

Other gold properties.

"On K. 231, are a number of veins, some of good size but irregular and difficult to trace on account of a swamp on one side and a sand-hill on the other. What their gold content is was not ascertained. Many other properties from which good assays are stated to have been obtained, have been taken up in the neighbourhood, some in the granite, and others both in the interbanded gabbro and diorite and in the Keewatin bands.

"There does not seem to be any good reason why gold-bearing lodes in these last-mentioned rocks should be less permanent or persistent than in the granite.

Relations of gabbros and granite.

"Prospectors in the district informed me they have observed that the gabbro in places sends arms or apophyses into the granite mass. This I was not able to verify. My own observation has been to the contrary, and where the two were seen in contact on the south shore of Bad Vermilion Lake, the granite cuts the gabbro in an unmistakable manner. The gabbro at this point has an indistinct schistose or foliated structure from crushing, and this foliation is cut across abruptly by the granite.

Surveys in the Manitou district.

"Fort Frances was next reached by steamboat, and after refitting there, a log-survey was carried from Lawrence Lake through Rowan, Denmark and Sturgeon lakes to Caribou or Deer Lake. The western shore of this lake and its northern and north-eastern arms were surveyed, together with a route by a number of small lakes to one of the southerly bays of Eagle Lake.

Lake Rowan

"Lake Rowan was found to be entirely within the Keewatin area of Crow and Whitefish lakes. The exposures along its northern shore consist of diorites and felspathic greywacke-like rocks of the agglomerate type, with bands of green and gray schist. The western

Ontario—*Cont.*

end of Denmark Lake shows the same rocks, and its eastern end extends into the band of hornblende-syenites and gneisses which form a rim between the Keewatin and the extensive biotite-gneiss area lying to the north-east.

Caribou Lake.

"Caribou Lake lies within the biotite-gneiss area. The eastern edge of the arm of Keewatin, which extends north-easterly to Eagle Lake, after crossing Caribou Lake at its extreme south-western end, keeps about two miles to the west of that lake, with the same narrow rim of hornblende-gneiss intervening between the Keewatin and the biotite-gneiss area.

Keewatin belt

"This Keewatin belt gradually narrows down as it is followed northward from a width of about six miles between Dryberry and Caribou lakes, to little more than a mile where it crosses the narrows between Eagle Lake and Vermilion Bay. It, however, widens out again almost immediately and bends around to the east to join the Keewatin area of Wabigoon and Manitou lakes.

Eagle and Wabigoon lakes.

"Surveys by micrometer telescope were next made of parts of Eagle and Wabigoon lakes and of the routes between them, both north and south of the Canadian Pacific Railway. Two other routes to Caribou Lake were traversed, one leaving Eagle Lake at the narrows between the lake and Vermilion Bay, and the other starting from the western side of Osborne Bay. Each leads through a series of small lakes which were surveyed by boat-log. The easterly one lies wholly in the biotite-gneisses; the western cuts across the Keewatin band, referred to above as connecting the Crow and Whitefish Lake areas, and gives a good cross-section of that band.

Routes to Caribou Lake.

Areas which invite attention.

"The regions lying immediately to the south of Eagle and Wabigoon lakes offer a field which promises well for the prospector. In both these districts are bands of Keewatin of very irregular outline, with intrusive areas of hornblende-granites and saussurite-gabbros. These two districts and that to the south of Lower Scotch Lake, have been particularly mentioned only because they are all easily accessible and do not seem to have attracted the notice of prospectors to any great extent, though the character of their rocks is such as to warrant their examination.

Caribou Lake to Whitefish Bay.

"The micrometer survey was continued through Caribou, Sturgeon and Whitefish lakes to Whitefish Bay on Lake of the Woods, and the long easterly bay known as Lobstick Bay was also surveyed. From the foot of Caribou Lake this route lay for the whole distance in Keewatin rocks, excepting where the granite area on which the Regina mine is situated, extends easterly about the mouth of Lobstick Bay.

"While on Lake of the Woods, the Regina and Sultana mines were visited. The vein in the case of the former of these, traverses both an intrusive area of altered hornblende-granite and a Keewatin diabase, the line of contact between the two cutting the drifts in the mine and showing an overlap of the diabase by the granite. Ontario—*Cont.* Lake of the Woods. Regina.

"At the Sultana, the vein occurs in a very much crushed and sheared hornblende-granite which occurs here, as it does generally, as an intrusive mass not far from the contact between the biotite-gneiss area and an area of Keewatin rocks. The Scramble mine, which lies to the north of the railway, within six miles of Rat Portage, occurs in a band of Keewatin hornblendic schists or crushed diorites, and close to the edge of the Rossland granitic area. Some surface stripping has been done here, and a shallow shaft has been sunk on a band 25 to 35 feet in width, made up largely of quartz and heavily charged with iron-pyrites, occurring both in thin sheets along the planes of cleavage, and irregularly distributed through its mass. Parts of the band were found to pan well, and an average value of over twenty dollars to the ton is claimed for the whole band. Sultana. Scramble

"Considerable activity has been shown in developing and exploiting gold properties about Lake of the Woods generally, and attention is being again devoted to various properties which have lain undeveloped for years. New discoveries of gold-bearing veins have been made in various places in the district, notably about Shoal Lake, where the Mikado and other properties have been attracting attention. Shoal Lake.

"Here, as in the Seine River country, the gold has been found, in every case of which we have any record, at no great distance from the contact between the Keewatin and intrusive granitoid rocks, which occur most frequently as narrow rims along the edge of the more extensive areas of biotite-gneiss, but which also invade the Keewatin rocks as isolated intrusive masses. I know of no case where gold-bearing veins have been found to occur in the main body of the biotite-gneiss areas which we have classed as Laurentian. On a preliminary edition of the Seine River sheet, the rocks in which the Sawbill vein occurs were so classed, but this was owing to a misinterpretation of the notes of the late Mr. W. H. Smith, and it has been corrected on the regular edition of the map. The gold-bearing rocks.

"As surveys of Manitou Lake were already available from the work of previous seasons, it was not thought necessary to visit this lake during the summer. A number of claims have been located along the shores of the lake as well as about Little Manitou Lake. These claims lie in the Keewatin belt, which extends all along the lake in the form Manitou Lake.

Ontario—*Cont.*

of a narrow band, between the large Laurentian areas to the east and west, and connecting the Keewatin area of Pipestone Lake with that of lakes Wabigoon and Minnietakie. It was known from last seasons' work that the Laurentian areas approach the shores of the main Manitou closely, and a trip eastward from the foot of Osborne Bay, made by Mr. Lawson last summer, proved that the gneiss area of Eagle Lake extends eastward at least to beyond Niven's 22-mile post on the Base Line of 1893-94. The marginal area of hornblende-gneiss which so commonly surrounds the biotite-gneiss areas, was found to intervene here also between the main gneiss area and the Keewatin.

Minnietakie Lake.

" Prospecting was extended northward during the summer into the region lying to the north of the Canadian Pacific Railway along the Minnietakie Lake Keewatin belt, which is a continuation north-easterly of the Wabigoon Lake area. Promising veins are reported in this district, and assays of specimens from there made in the laboratory of the Survey gave small quantities of gold, enough at least to confirm the occurrence of gold in the region.

Lake Superior. Empress mine.

" Work for the season was closed on the 6th of October, but on the way back to Ottawa, the Empress mine, situated on the north shore of Lake Superior, was visited. This is a low-grade proposition, largely free milling. It lies to the north of the Canadian Pacific Railway, near Jackfish station. At the lake-shore, the rock exposed in the cuttings on the line of railway is a medium-grained, red, hornblende-granite, and along the road leading to the mine the same rocks are seen to within a half-mile or less of the mill. The veins on which work is being done occur in green, somewhat hornblendic schists striking N. 67° E. and dipping eastwards at an angle of 64°. Where work was being carried on, there is a series of closely parallel veins, striking and dipping with the cleavage of the schists. The largest of these was about six feet in width where stripped. The belt has been uncovered by cross-trenching for upwards of a mile along the strike, varying, of course, very considerably in quartz contents in that distance. The outcrop occurs on the slope of a southerly-facing hillside at a height of two hundred feet or more above the valley bottom. The ten-stamp mill now on the property, has been placed near the bottom of the hill, so that a tunnel may readily be driven which will catch the veins at a depth of about 140 feet below their outcrop, and will prove the property pretty thoroughly and permit also the economical stoping of a large amount of vein-matter. At the time of my visit no mining work of a permanent character was being done, the ore for the mill was being taken by shallow shaft and drift from wherever it could be got at most conveniently. It was the intention of the management, however, to proceed with the driving of the tunnel during the winter. The owners claim only a low grade ore, but they claim also that the unusual facilities for working economically will ensure them a reasonable margin of profit.

Ontario—*Cont.*

" Other discoveries of gold-bearing veins were reported during the summer from different points along the north shore, but none of these were seen. Ottawa was reached on the 11th of October."

Work by Mr. Barlow.

Before the commencement of field operations in 1896, Mr. A. E. Barlow was engaged in the collection and compilation of the material necessary for the completion of the report and maps in connection with the exploration and surveys made in the Temiscaming region (Sheets Nos. 131 and 138 of the Ontario series of geological maps). These two maps, as will be seen by a reference to the Chief Draughtsman's statement, are now in the hands of the engraver, and it is hoped that both report and maps will be ready for issue shortly. The plotting of the various surveys made during the previous season and the labelling of the large number of rock specimens then collected, consumed a considerable proportion of the time. In addition to this, detailed petrographical studies were made, in conjunction with Mr. W. F. Ferrier, of a large number of thin sections of the various gneissic rocks which cover much of the area examined, and a subdivision based upon their lithological and mineralogical characters will be incorporated in the forthcoming report.

Field-work in Central Ontario by Messrs. Barlow and Adams.

The work on the Nipissing and Temiscaming sheets having thus been practically completed, it was deemed advisable to associate Mr. Barlow with Dr. Adams in the continuation of the work already begun by the latter on the Haliburton sheet in Central Ontario (Sheet No. 118, Ontario). Mr. Barlow had already spent the month of September in 1895, on work in connection with this sheet, and its geographical position is described in his preliminary report of that year.*

The construction of the Ottawa, Arnprior and Parry Sound Railway renders accessible the northern part of this area, as a portion of this line, from a short distance east of Barry's Bay to a point a few miles beyond Whitney, lies within the confines of the area. The extension of the Irondale, Bancroft and Ottawa Railway to Baptiste Lake in the Township of Herschell, affords an easier entrance to the southern portion, while the Central Ontario Railway with its present terminus at Coe Hill, opens up the south-eastern portion.

*See Summary Report 1895, p. 63A.

Ontario—*Cont.*

Surveys of roads, &c.

Mr. A. A. Cole, B.A.Sc., as in previous years acted as assistant, his attention being mainly directed to the prosecution of some of the various topographical surveys necessarily undertaken. The surveys of the roads were made with Rochon micrometer and compass, although occasionally, in the measurements, the chain or steel tape was substituted for the former. Leaving Ottawa on May 31st, Mr. Barlow accompanied by Mr. Cole reached Peterborough the following day. A couple of days were spent in Peterborough and Lindsay, engaging men, procuring supplies, and making other preparations for the season's work. Gelert station on the Victoria Branch of the Grand Trunk Railway was made the starting point, and all the roads in this vicinity were surveyed, while a detailed geological examination was made of the adjoining townships of Snowdon and Glamorgan. This occupied the time till the 10th of June, when a few days were spent at Minden, completing surveys in the townships of Minden, Lutterworth and Anson, when a move was made to Haliburton. The latter part of June was occupied in making similar road-surveys, with Haliburton as a centre, in the townships of Dysart, Guilford, Dudley, Harburn and Monmouth. The northern shore of Twelve-mile Lake was the next stopping place, from which surveys and geological examinations were made northward through the townships of Stanhope and Sherborne as far as the village of Dorset on the shores of Trading Lake.

Districts geologically examined.

Dr. Adams joined the party on July 1st, at Haliburton, and spent the first month in a detailed geological examination of the shores of most of the lakes situated in the western and north-western parts of the sheet, and also of the portion of the Muskoka River running through the townships of Peck, Finlayson and McClintock. During this time also he made paced and compass surveys of the roads around Dorset, as well as of the colonization and lumber road from Dorset north-eastward to Tea Lake, in the township of Peck.

The month of August was spent in geological and topographical surveys in the central and southern parts of the sheet, chiefly in the townships of Cavendish, Monmouth, Dudley, Harcourt, Cardiff, Anstruther, Chandos, Herschell, Faraday, Wollaston, Limerick, Dungannon and Monteagle. At the same time, Dr. Adams was engaged in making examinations of the country bordering the lakes in these townships, as well as some paced surveys of roads in the same neighbourhood.

A few days (September 7th to 10th) were spent by Dr. Adams and Mr. Barlow in the examination of the various rock-cuts along the line of the Ottawa, Arnprior and Parry Sound Railway between

Killaloe and Whitney stations, for which facilities were kindly given by the Chief Engineer of the road. Dr. Adams returned to Montreal on September 10th to resume his duties at McGill University, while Mr. Barlow went northward to complete certain surveys in the Temiscaming district, returning to Ottawa on October 2nd.

Ontario—*Cont.*

Surveys made in September by Mr. James White, in this region, for the purpose of fixing the necessary geographical positions, are referred to on a later page.

Geological importance of the work.

The surveys and examinations which Messrs. Barlow and Adams are carrying out in the area of the Haliburton map-sheet and its vicinity, have a special importance because of their bearing upon some of the most intricate questions of Archæan geology, including the relations of the Grenville and Hastings series, the Fundamental gneisses, and also those of rocks probably equivalent to the Huronian system. Upon the results so far arrived at, the gentlemen above named make the following joint report :—

Rocks present in Haliburton sheet.

" The rocks exposed within the boundaries of the present sheet belong to several subdivisions of the Archæan. 1. Lower Laurentian. 2. Grenville series. 3. Hastings series. The Lower Laurentian covers by far the largest portion of the area examined, as rocks belonging to this formation occupy the whole northern and north-western half of the district, while a smaller area occurs at the south-western corner of the map in the townships of Lutterworth, Snowdon and Glamorgan. In the southern and south-eastern parts of the sheet, there are other occurrences of similar rocks which, however, present a more normal granitic character.

Lower Laurentian or Fundamental gneiss.

" 1. The Lower Laurentian of Logan is also frequently referred to under the names of the Basement Complex or the Fundamental gneiss, as it seemed to be composed of an assemblage of crystalline foliated rocks, of which the macroscopical appearance, causes them to be constantly spoken of and described under the general term of 'gneiss.' Petrographical studies have of late amply demonstrated the inapplicability of this latter name, save as a 'field' term or for the purpose of rough correlation and description, or as an affix to describe the structural features of the rock-type examined. In petrographical character the Fundamental gneiss is more or less monotonous, consisting as it does of several varieties of plutonic rocks, belonging chiefly to the granitic and dioritic families, with which are intimately associated dark basic masses of amphibolite and pyroxene-granulite. These have the appearance of igneous masses in which a more or less distinct foliation is usually present, the persistence of such a structure over large areas having

Origin of foliation.

Ontario—*Cont.*

suggested the term 'gneiss', as all were supposed to be of the same origin and composition. Although it seems quite certain that the foliation so common in these rocks is, in many cases, a structure developed during the solidification of the magma from which they have crystallized out as a result of differentiation, it is in other cases probably the result of movement or flowing in the mass itself, or again it may be owing to subsequent pressure exerted at a time when the rock had acquired much of its present rigidity. This has in many instances rendered foliation originally present, more pronounced, by the breaking down of the large felspar individuals and the drawing of these out into lenses or pod-shaped areas, in the direction of motion. Thus it usually happens that the most beautifully and evenly foliated rocks are those in which the constituents have undergone excessive granulation as a result of such pressure. It would therefore seem evident that this foliation, which may generally be seen in the hand specimen, is in the first place but an illustration in miniature of the effects of magmatic differentiation, by which probably the immense bodies of the more basic constituents have become segregated out, forming the dioritic or amphibolitic bands which are so commonly found associated with rocks of the granitic type.

Complicated intrusions.

" The different varieties of gneissic rocks, alternate with or succeed each other across the strike, and sometimes cut one another off, suggesting a complicated intrusion of one mass through the other, but there is usually a general strike, to which in any particular district the foliation of all the varieties conform. The associated basic masses are very dark or black in colour. They are usually rather distinctly foliated, but are sometimes quite massive, occurring in pieces and fragments of all sizes and shapes scattered through the more acidic portions, and in the great majority of cases so intimately mixed with the latter, that it is impossible to separate the two in mapping. The smaller of these masses can be distinctly seen to have been separated from the larger ones, which are often of enormous size, and this process may be observed in all its stages. The different varieties of granite-gneiss, which are perhaps the most prevalent of these gneissic rocks, invade the great basic masses, partially absorbing and sending wedge-like arms into them which tear them apart and anastomose through them in the most complicated manner. The smaller masses may then be seen to be separated into still smaller fragments, which either from the fact that they split more readily in the direction of their foliation, or owing to subsequent movements when the rock was in a more or less plastic condition, often assume long ribbon-like forms. That great movements have taken place in the whole series at a later date, is shown by the complicated folding and curving of these darker bands and masses into all sorts of curious forms, as well as in the frequent rolling out of great masses of the amphibolite when penetrated in all directions by little pegmatite veins, giving rise to masses of a dark, basic, gneissoid rock, filled with strings, bunches or separated fragments or grains of quartz and felspar, giving a pseudo-conglomeratic appearance.

Ontario—*Cont.*

"2. The Grenville series differs in a marked manner from the Fundamental gneiss. In the region under examination, it comprises a great development of limestones, with which are associated certain gneissic rocks whose minute structure and appearance mark them as highly altered sediments. In the Archæan area to the north of the St. Lawrence and Ottawa rivers, where these rocks have been studied in much detail by Dr. Adams both in the field and under the microscope, these are seen to be very different from the prevailing types of granitic and dioritic gneisses.

The Grenville series.

"The various analyses made, indicate in most instances a composition almost identical with that of ordinary shale or slate, while more quartzose specimens resemble the siliceous bands frequently met with in many slate quarries. These gneissic rocks frequently contain garnet, sillimanite, graphite, rutile and pyrite, the last-named mineral when present, as it usually is, causing the rock to weather in a very rusty manner, which suggested the name 'rusty gneiss' so commonly applied to this member of the series. Under the microscope, they are seen to have undergone such complete recrystallization as to entirely mask their original character, although the appearance and arrangement of the component minerals is often suggestive of the contact-zones bordering granites. Their almost invariable association with the limestones was also an additional argument in favour of their original clastic character. In the Haliburton sheet, similar gneissic rocks are found associated with the crystalline limestones.

Composition of gneisses.

"The gneiss, on a fresh fracture, is generally light-gray in colour, sometimes nearly white, the rusty weathering of the rock being caused by the abundant dissemination of pyrite and pyrrhotite. Frequently the pyritous matter is so abundant that the exposure is capped by a veritable 'gossan' of the decomposed mineral, and their resemblance to the Sudbury nickeliferous deposits appeared to be so close as to warrant a detailed examination of some of the occurrences. Their total dissimilarity in origin to the Sudbury deposits as well as their analogy to pyritous deposits so abundant in the Laurentian was, however, clearly shown by Dr. Adams's work in this region in 1893.

"These rocks constitute an irregular belt, between the great area of Fundamental gneiss in the north-west portion of the sheet and the

Relation to Fundamental gneisses.

Ontario—*Cont.*

Hastings series exposed in the south-east. The strike of the foliation of the Grenville series follows, in a general way, the boundaries of the Fundamental gneiss, and is seen in an especially distinct manner to wrap itself around the long and narrow area in the south-western corner of the map. Isolated masses of the limestone and gneissic rocks characteristic of the Grenville series are also found in the form of outlying patches in the Fundamental gneiss about its margin, as for instance, in the townships of Lutterworth and Stanhope.

"The limestones and associated gneisses which characterize this series, form but a very small proportion of the rocky complex of the areas in which they occur, and which, owing to their presence, has usually been referred to as the Grenville series. They are associated with and usually inclosed by much greater volumes of gneissic and amphibolitic rocks identical in character with those of the Fundamental gneiss. The limestones are also almost invariably penetrated by great masses of coarse pegmatite, and in some cases large occurrences of the limestone are embedded in the Fundamental gneiss.

"The whole thus presents the character of a series of sedimentary rocks, chiefly limestones, invaded by great masses of the Fundamental gneiss, and in which possibly some varieties of the gneissic rocks present may owe their origin to the partial commingling of the sedimentary material with the igneous rocks by actual fusion. There is, however, no reason to believe from the evidence at present available that any considerable part of the series has originated in this last-mentioned manner.

Separation from Fundamental gneiss difficult.

"It will be readily seen that the exact delimitation of areas of the Grenville series is thus often a matter of great difficulty, as there is no sharp boundary between this series and the Fundamental gneiss, and it has hitherto been difficult, in the case of the Grenville series, to account for the existence of such a comparatively small proportion of sedimentary strata intimately associated with such great volumes of igneous gneissic rocks.

Bearing of recent observations.

"The relations of the two series in Central Ontario, as they appear by the investigations of the last two seasons, throw new light on the subject and indicate its probable explanation. These are such as to suggest that in the Grenville series we have a truly sedimentary group of strata, which has sunk slowly down into, and has been invaded by great intrusions of the igneous rocks of the Fundamental gneiss, when these were in a molten or plastic condition. The limestones however do not show any distinct evidence of absorption or solution in the invading rocks, unless some of the highly garnetiferous gneisses often associated with the limestone are really formed by an intimate admixture of the two rocks. The limestones are always highly metamorphosed, presenting the characters of coarsely crystalline, although often more or less impure, white and pink marbles. Masses of this highly crystalline limestone or marble in some cases lie quite isolated, imbedded in the gneissic rocks as if they had been separated from the parent mass and pressed outwards or downwards into the gneissic magma. The contact of the Fundamental gneiss and the Grenville series would therefore appear to be a contact of intrusion.

Ontario—*Cont.*

" 3. The south-eastern portion of the sheet is chiefly underlain by rocks of the so-called Hastings series, consisting in the main of thinly bedded limestones, dolomites, &c., cut through by great intrusions of gabbro-diorite and granite. These limestones and dolomites are usually fine-grained and bluish or grayish in colour, with thin interstratified layers holding sheaf-like bundles of hornblende crystals, and as compared with the limestones of the Grenville series, are usually much less altered. They constitute beyond all doubt a true sedimentary series, and in the region to the south of the present map are associated with conglomerates or breccias and slates of undoubtedly clastic origin.

Hastings series.

" Although repeated traverses have been made from the Grenville to the Hastings series, no sharp line of division has as yet been found. Toward the south-eastern part of the area, the limestones of the Grenville series in many places, while still highly crystalline, seem to be less altered, and finally, as the Hastings series is approached, they present in places the bluish colour of the limestones of the latter series, so that it is often impossible to determine to which series they should be referred. The limestones of both series have the very numerous interstratified impure or gneissic bands so frequently referred to in descriptions of the limestones of the Grenville series, making the resemblance still more complete. In fact, although the true relations of the two series are obscured by the presence of numerous great intrusions of granitic and basic pyroxenic rocks, and can only be determined with absolute certainty by the completion of the mapping, the investigations so far indicate that, in the region in question, the Hastings series probably represents the rocks more nearly in their original form, and that the same rocks, when invaded, disintegrated, fretted away and intensely altered by and mixed up with the underlying gneissic magma into which they had sagged down, became identified as the Grenville series. If this should prove to be a correct diagnosis of the relations of the two series, we have in the Grenville series an extremely metamorphosed portion of the Hastings series.

Its relation to Grenville series.

Ontario—*Cont.*
Huronian.

"Concerning the age of the Hastings series but little is known as yet, but the character and composition of some of its members, chiefly the breccias and conglomerates, as well as the nature of its contact with the associated igneous gneissic rocks, seem to offer some presumptive evidence in favour of its ultimate correlation with the Huronian.

Nepheline-syenite.

"The occurrence of nepheline-syenite within the boundaries of the present sheet has been previously noticed.* A small additional mass not previously noted, was found by Mr. Barlow on lot 30, con. IV, of the township of Glamorgan. In the townships of Dungannon and Faraday three distinct masses of these rocks were roughly outlined. One of these covers portions of concessions XIII. and XIV., extending from lots 25 to 29 in the former and 23 to 26 in the latter. With this are associated large masses of a deep blue sodalite, much of which might be utilized for jewellery and ornamental purposes. Another much smaller mass occurs on the Mississippi road, to the east of the bridge crossing the York River in the township of Dungannon, near the line between lots 12 and 13 in concession XI. The sodalite found at this locality is in small quantity, but the nepheline occurs associated with the albite in very large individuals, forming pegmatite-like masses and segregations. The rock is usually of a pale gray colour, and, especially when foliated, presents a strong resemblance to the gray or dioritic gneisses so common in the Laurentian. Although the rock is sometimes massive, it has usually a very distinct foliation, this foliation corresponding in direction with that of the ordinary gneissic rocks exposed in the vicinity.

Blue sodalite.

Hastingsite and Cancrinite.

"The syenite weathers with a curious pitted surface, the depressions being occupied by the nepheline, which is usually very abundant, leaving the irregular-shaped felspar and bisilicate individuals standing in relief. At the York River mass, the bisilicate present seems to be mainly hastingsite (so called by Dr. Harrington who made an analysis of the material) the most basic hornblende yet described. Cancrinite was found intimately associated with the nepheline on lot 25, concession XIII. of Dungannon.

"A small area of nepheline-syenite occurs to the north-west of the village of Bancroft, sending a spur crossing the Hastings road about half a mile north of the village.

Iron ores of the district.

Deposits of iron ore are somewhat frequently associated with the dark basic amphibolites of the Fundamental gneiss in the southern

*Annual Report, Geol. Surv. Can., Vol. VI. (N.S.), part J., p. 5. Am. Journ. Sci., July 18, 1894.

part of the district, but although frequently of very large extent they usually contain a great deal of intermixed pyritous matter, while frequently the ore itself is rendered more or less impure by the presence of black ferruginous silicates such as hornblende, pyroxene and garnet. The ore is in general a magnetite, in places containing a small though varying proportion of ilmenite, but many deposits are entirely free from this objectionable mineral. The quantity of sulphur in many of the deposits, owing to the presence of sulphides, would lessen the value of the ore considerably, while in many cases its abundance would render the ore unsuitable for smelting purposes. Further search may however reveal workable deposits of iron sufficiently free from these sulphides to justify their development. *Ontario—Cont.*

Iron ores from the following places have been examined in the laboratory of the Geological Survey Department:— List of those examined.

a. Minden, Haliburton County, lot 11, Range I., Report 1894, page 19 R, No. 14.
b. Lutterworth (Paxton mine), Haliburton County, lot 5, Ranges V. and VI., Report 1894, page 19 R, No. 16.
c. Lutterworth (Paxton mine), Haliburton County, lot 5, Ranges V. and VI., Report 1892–93, page 8 J.
d. Lutterworth, Haliburton County, lot 16, Range VII., Report 1878–79, page 16 H.
e. do do do 5, do VI., do 1878–79, page 15 H.
f. Snowdon, Haliburton County, lot 20, Range I., Report 1873-74, page 211, No. 8.
g. do do do 20, do I., do 1894, page 19 R, No. 18.
h. Wollaston, Hastings County, lot 16, do II., do 1887–88, page 24 T, No. 4.
i. do do do 15, do II., do 1887–88, page 24 T, No. 5.
j. do do do 9-10, Range XV., Report 1887–88, page 24 T, No 6.
k. Carlow, do do 6-7, do XVI., do 1887–88, page 24 T, No 9.

Analyses of the above ores. Analyses.

Specimen.	Ore.	Met. Iron.	Ox. of Manganese.	Alumnia.	Lime.	Magnesia.	Sulphur.	Phosphorus.	Titanium.	Insoluble.
a.	Magnetite	30·29	......	......	......	......	......	......	Traces.	......
b.	do	......	......	......	......	......	......	......	None..	......
c.	do	48·64	......	6·24	3·81	3·38	·03	None.	0·15	19·30
d.	do	46·50	......	......	......	......	......	......	None..	20·16
e.	do	49·26	......	......	......	......	......	......	......	26·55
f.	do	60·19	·13	·42	1·43	2·56	·04	·07	·73	11·17
g.	do	......	......	......	......	......	......	......	None..	......
h.	do	26·94	......	......	......	......	......	......	None..	......
i.	do	56·50	......	......	......	......	......	......	None..	......
j.	do	28·42	......	......	......	......	......	......	Trace..	......
k.	do	46·66	......	......	......	......	......	......	Trace..	......

" Ores from the following localities have been examined and reported on by various chemists (see Report Royal Commission on the Mines of Ontario, pages 130-132.) Other occurrences of iron ores.

Ontario—*Cont.*

"The Howland mine (sometimes also called the Snowdon or Pusey mine) is situated on lots 26 and 27, concession IV. of Snowdon. The shaft is on lot 26 and the analysis of the ore gave metallic iron 59·50, phosphorus ·005, sulphur ·06.

"The Imperial mine on lot 33, concession III. of Snowdon is in a brown hæmatite. The analysis shows the ore to contain 45·82 per cent of metallic iron. The phosphorus is very low; no sulphur or titanium, a little lime and a large amount of silica.

"The Pine Lake mine on lot 35, concession IV. of Glamorgan, is in a magnetite running from 52 to 55 per cent of metallic iron. It is low in phosphorus but contains considerable lime and titanium.

"The National mine is on lots 30 and 31 in concession XIII. of the township of Glamorgan. This is likewise a magnetite.

"The New York mine is on lot 27 in concession XV. of the township of Glamorgan, and contains over 70 per cent of metallic iron, traces of phosphorus, and no sulphur or titanium.

"The Coe Hill mine is situated on lot 16, concession VIII. of Wollaston, and seems to occur as a consequence of the local enrichment of a dark basic amphibolite coming in contact with a granite. The ore is a magnetite but contains a considerable admixture of pyritous matter, and some of the lumps piled on the ore-heap are falling to pieces owing to the abundance of the sulphides undergoing decomposition.

"In the township of Wollaston, magnetite occurs on lots 14 and 15, concession II., and on lots 17, 18, and 19 in concession VIII., being an extension westwards of the Coe Hill deposit. Magnetite also occurs in considerable quantity associated with the masses of nepheline-syenite, but in no place where seen are the deposits of economic importance.

Apatite

"Apatite, as might be expected, is found at various points throughout the region, but hitherto the inaccessibility of the district together with low prices have forbidden the shipping of the material, although considerable development work has been done in the township of Monmouth to the north-west of Tory Hill station on the I. B. & O. Railway

The mineral has however been found at the following places:

Township of Dudley, lot 4, concession III.
" Dysart, lot 11, concession V.
" Harcourt, lot 21, concession XI.
" Monmouth, lots 14, 15 and 17, concession XI.
" Cardiff, lot 22, concession XIV.
" Faraday, 5 miles south-west of Bancroft.
" Monteagle, lot 26, concession VI.

"Mica, both phlogopite and muscovite, occurs in considerable quantity at a number of places. A promising deposit was being developed close to the I. B. & O. Railway about two miles west of Wilberforce. In the townships of Herschell and Dungannon, the mineral was noticed at several localities. Ontario—*Cont.* ica.

"The discovery of a large deposit of corundum on lot 14, concession XIV. of the township of Carlow, by Mr. W. F. Ferrier of the Geological Survey Department is elsewere described (p. 116A). Corundum.

"The various crystalline limestones are often sufficiently pure to yield the very finest quality of lime, while some of the beds would doubtless furnish material for use as marble. Marble.

"Graphite, has been found associated with rocks of the Grenville series in the townships of Dysart and Glamorgan. It is probably widely distributed throughout the region, but no deposits of economic importance have yet been discovered." Graphite.

About four months of the first part of the year, were devoted by Dr. R. W. Ells to the plotting and compilation of notes of survey made during the preceding season, chiefly connected with map-sheet 122 of the Ontario series. This sheet covers the Ottawa valley from the vicinity of the city of Ottawa to Petewawa, and with sheet 121, lying to the east of it, now only requires final compilation and adjustment previous to publication. Early in May, Dr. Ells began his work in the field, attention being chiefly directed to the area of sheet 119, which adjoins No. 122 on the south. Work by Dr. Ells.

On the work accomplished during the summer, Dr. Ells reports as follows:—

"The surveys of the present season extended over portions of the counties of Renfrew, Addington, Frontenac, Lanark and Carleton, included in map-sheet No. 119. The first part of the season was devoted to the examination of the country along the Rideau River and Lakes; including several large lakes connected with this system, or in the vicinity, among which were Bobs Lake, Sharbot Lake, and others easily accessible by short portages. The Mississippi River and its chain of lakes, as well as the country adjacent on both sides, was carefully examined from Carleton Place to the head-waters, as also were the lakes on the upper part of the south branch of the Madawaska, including Weslemkoon Lake and others of that chain. Area covered by surveys in Ontario.

"The latter part of July and the first part of August were spent in examining the Black and Coulonge rivers, on the north side of the Black and Coulonge rivers.

Ontario—*Cont.*

Ottawa. The first-named was ascended for about seventy miles, to Forans Creek, whence a route extends through a series of lakes and streams, to Bryson Lake, which is about one mile west of the Coulonge, into which it empties by Bryson Creek about seventy-two miles above the mouth of the Coulonge. This portion of the map of Quebec is practically a blank on the Crown Lands plan, though a number of large lakes occur in the area, some of them ten or twelve miles in length.

In Quebec.

Road surveys along the Madawaska and Mississippi.

" The last two months of the season were spent in the survey, with wagon-odometer, of the roads in the country between the Madawaska and Mississippi rivers, and in the country to the north of the latter stream. Much of this country is very rough and hilly, and in certain portions, the surface is largely bare rock, the timber and soil being almost entirely burned off. While the great mass of the rocks observed belong to the crystalline formations, certain, often large, areas of the newer sedimentary formations from the Potsdam to the Black River, both inclusive, were met with. The largest developments of these belonged to the latter formation, the characteristic fossils being tolerably abundant. These frequently rest upon the crystalline rocks without the intervention of the lower formations of the Cambro-Silurian.

Rocks of Black and Coulonge rivers.

" The area traversed by the Black and Coulonge rivers, is largely occupied by reddish granite and gneiss. The latter is, however, sometimes grayish and hornblendic, and occasionally garnetiferous. Bands of crystalline limestone are well exposed along the lower forty miles of the Black River, and similar bands occur along the Coulonge as far as the 70-mile post from its mouth. The general strike of the gneiss and limestone in this area is N. 30° W., but this is frequently deflected, apparently by masses of granite. The upper part of these streams flow through a comparatively level country, largely covered with sandy drift which is, in places, underlain by clay. Isolated masses of reddish granite rise here and there, but this area is much less rugged than that nearer to the Ottawa.

Course of Black River.

" The Black River has a very tortuous course, flowing for a great part of the way through banks of sand, with a steady current of two to three miles an hour, when the water in the stream is low. The ascent of the stream is therefore somewhat arduous. Rapids occur at frequent intervals, necessitating a number of portages, some of which are very heavy. The worst of these is past the Long Rapids, sixty miles from the mouth, where a carry of three miles is necessary, over the spur of a mountain. The heavy rapids along the lower part of the stream, from the twentieth to the fortieth mile, are passed by taking the Green Lake route, through a chain of lakes with six portages, returning to the river just below the Manitou Rapid. The longest carry on this route is about half a mile. A band of crystalline limestone extends along the route, and is associated with rusty and garnetiferous gneiss. Ontario—*Cont.*

Bryson Lake.

"The country between the Black and Coulonge rivers, south of Forans Creek and its chain of lakes, is generally rough and hilly. No limestone was observed on any of these lakes or streams, or along the portages. The character of the country to the north is similar to that seen on the upper portions of the Gatineau and Rouge rivers, further to the east. About Bryson Lake, which is not laid down on the map of Quebec, and which is from twelve to fourteen miles in length with a breadth of from one to two miles, great cliffs of grayish quartzose gneiss occur along the east side, with a dip of 10° to 50° eastward. These, in places, appear almost as flaggy as the Potsdam sandstone, and they dip beneath the limestone of the upper Coulonge. The limestones show on that stream at and above the mouth of the Crow River, which enters the main stream from the east at about the 70-mile post, and by which a route for canoes extends to the Désert and thence to the Gatineau.

General trend of Archæan rocks.

"The strike of the rocks along the Black and Coulonge, as contrasted with that seen on the Gatineau and the streams further east, is worthy of note. This is still more marked when contrasted with the trend of the rocks as noted on the Bonnechère and the Madawaska to the south, where the general strike of the different bands is 40° to 60° east of north. On the Kingston and Pembroke Railway, south of Calabogie Lake, the course of similar rocks is north or a few degrees west of north. The formations therefore appear to follow a broad sigmoid curve over a very considerable area. The details have not yet been laid down on the map, but sufficient data have now been obtained to do so with a fair degree of accuracy. At the same time, it must be recognized that the presence of large areas of intrusive rocks, such as diorites, syenites and granites, has influenced, to a very considerable extent, the disposition of the rocks as shown by the strikes at many points.

Crystalline limestones.

"A marked feature in the formations in the vicinity of the Madawaska, in the area to the south of that river, is the great development of crystalline limestones. In character these differ somewhat from the limestone found in the Grenville district. They are often characterized by the presence of bluish and bluish-gray shades, and by a well-defined banding, which imparts a peculiàr striped aspect to the rock over large

Ontario—*Cont.*

areas. The limestone is also often highly dolomitic, and in places weathers to a peculiar ochreous brown. Instead of the usual association of grayish and reddish-gray gneiss found north of the Ottawa, the associated rocks are mostly schists, either hornblendic, micaceous or chloritic. The characteristic mica-schists are beautifully exposed on the line of the Kingston and Pembroke Railway, between Lavant and Flower stations, as well as along certain portions of the Mississippi River on the north side of Mud Lake, about a mile below Ardoch. They are also well seen on the south side of Marble Lake, in the township of Barrie. The hornblende-rocks, however, have a much greater development, being often massive and without any schistose structure.

Associated schists.

Argentiferous galena.

"North of the Long Lake, an expansion of the Mississippi, the lime stone is mostly blue in colour and often slaty. This character is well seen along the road from Ardoch to the head of Long Lake; but in the vicinity of the intrusive masses the bluish colour disappears and the rock changes to a highly crystalline cream-coloured mass in places affording a white marble, often of great beauty. Serpentine, though sometimes seen, is rare. In this area the presence of argentiferous galena in the limestone, in close proximity to the hornblende-rock, is worthy of remark, the percentage of silver in some of the veins being sufficient to render them economically valuable. In the hornblende-rocks and other schists of this area, quartz veins also occur which carry gold in small quantities, but these veins, so far as known, are generally pockety in their distribution. As these rocks are apparently the eastward extension of those which carry gold in Marmora and Madoc, it is quite possible that true gold-bearing veins may some day be found.

Gold.

"In this connection, it may be noted that an assay of a sample of quartz from the 28th lot of range VIII. of Clarendon, in Frontenac county, made in the laboratory of the Survey, showed gold at the rate of 2·098 oz. to the ton. This locality is about two and a-half miles northwest of Ardoch, on the Mississippi River, the rocks being those of the Hastings series. Another specimen from the west half of lot 10, concession VI. of Lavant, in the county of Lanark, yielded gold at the rate of 0·195 oz. to the ton. These assays clearly indicate the existence of the gold-bearing belt of the Madoc and Marmora region, in this area. Gold has also been reported from several points in the western part of the township of Denbigh, and several mines have been opened in this area, but nothing definite as to the true value of the quartz has yet been ascertained.

Iron ores.

"The principal mineral of economic importance yet found in the hornblende-rocks and associated limestones are the ores of iron.

These are of two kinds, magnetite and red hæmatite. An examination of these deposits was made in 1895 by Mr. Ingall, of this Survey, whose report is now in course of preparation. A preliminary report on the subject by Mr. Ingall has already appeared in the Summary Report for 1895. A number of these deposits occurring in the area of the present season's work, were carefully examined with reference to their geological relations. It was found that the hæmatites, of which only three were recognized, viz., that at the Dalhousie mine and two on the south side of White Lake, in the township of Darling, occurred in the crystalline limestone formation, in connection with which no eruptive rocks were visible. The magnetites, on the other hand, were invariably associated with eruptive masses, mostly dioritic, hornblende largely predominating. Some of the largest and apparently most important deposits are associated with the limestones, in which case, however, masses of greenstone or hornblende-rock were present, as at the Caldwell and Yuill mines. In no case was any distinctly bedded deposit observed. In many of the ores small quantities of pyrites were observable, but in some cases this was almost entirely absent and the ore was of excellent quality.

Ontario—*Cont.*

"An outcropping of magnetic iron ore was observed near the road from Dacre to Mount St. Patrick, about a fourth of a mile south of the former village, but no attempt has been made to develop the deposit and the quantity is yet unknown.

Mount St. Patrick iron ore.

"The iron ores of the district, in the vicinity of the Kingston and Pembroke Railway, occur in what has been styled the Hastings formation. Small deposits of apatite and mica were observed at several places in the area surveyed, but the associated rocks differ largely from those which occur throughout the lower Ottawa mineral belt, or to the south of the Rideau Lakes, and the observed quantity of these minerals was not such as to warrant the expenditure of much capital in their investigation.

"North of the Madawaska, in the townships of Griffith, Brougham and Bagot, while the surface of the country is often exceedingly rough and broken, great areas of crystalline limestone, often dolomitic, are seen. These calcareous masses occur, not only in the valleys but constituting large hills. In places the rock is highly charged with tremolite, and this character is also well seen in the limestones to the north of Calabogie Lake, as well as at certain places in the township of Darling, and in South Elmsley. Great areas of these limestones, often well exposed, occur in McNab, Darling, Lanark and Ramsay.

Crystalline limestones north of the Madawaska.

Ontario—*Cont.*

Graphite mine of Whitefish Lake.

"In the 18th lot of range III. of Brougham, at the south end of Whitefish Lake, an important deposit of graphite occurs. The containing rocks are crystalline limestone, but dykes of granite also appear in the vicinity. At the shore of the lake, the deposit has been uncovered to a distance of one hundred and fifty feet or more, showing a bed of graphite eight to ten feet in thickness. The mineral appears to be, for the most part at least, amorphous, but a flakey structure is seen in certain portions. This mine is about twelve miles distant from the railway at Calabogie, and a new road has been constructed for the purpose of shipment. A small deposit of similar graphite occurs in the township of Darling, near Tatlock.

Mazinaw Lake.

"The country from about the middle of Mazinaw Lake, northward into Denbigh, and thence westward for some miles, including the greater part of the townships of Ashby, Effingham and Abinger, is occupied for the most part, by grayish and reddish-gray gneiss and granite, generally having a well defined foliation. This may probably represent the Fundamental gneiss of the Laurentian. The area is very rough and settlements are few. To the south of Mazinaw Lake, the rocks are mostly hornblendic, often with a well marked green shade, passing in places into well-defined chloritic schists. These often become micaceous, and are associated with slaty bands which sometimes contain an abundance of quartz pebbles, thus constituting true conglomerates, in which the pebbles are ususually elongated along the lines of schistosity. They are well seen in the township of Kaladar, near the gold mine, not far from Flinton.

Boundaries of the Hastings series.

"The northern limit of the Hastings series proper on the Ottawa River, as at present recognized, is a short distance west of the mouth of the Bonnechère; whence the line of division between this and the underlying portion of the Laurentian, passes a short distance west of the town of Renfrew. Continuing south-west, it crosses the Madawaska in the township of Griffith, near the Denbigh road, and extends thence to Mazinaw Lake as already indicated. Its southern limit has not yet been continuously traced. On the Kingston and Pembroke Railway, the hornblendic rocks with bands of limestone extend for at least four miles to the south of Sharbot Lake, and they apparently occupy the greater part of the township of Lanark, north of the Mississippi River. Certain areas in South Elmsley also contain masses of tremolitic limestone, and in this respect, as also in the character of the associated rocks, resemble the Hastings series.

Mica mine.

"Mining operations in the area examined during the past season, are at present almost entirely suspended. On the south side of Rideau

Lake, about four miles from the Narrows at Oliver's Ferry, a very considerable deposit of mica was, however, being worked at the time of our visit. Ontario—*Cont.*

"The graphite deposit near Oliver's Ferry is not now being worked, though the mineral appears to be abundant and of good quality. **Graphite of Oliver's Ferry.**

"Great masses of white binary granite, in which the felspar largely predominates, were seen at a number of places, and certain of these, where not too far distant from a point of shipment, should be commercially important for the manufacture of porcelain. Very large masses of these whitish rocks occur a short distance west of the Kingston and Pembroke Railway between Lavant and Snow Road stations. A large deposit of this rock also occurs at Black Lake in North Burgess, not far from the Rideau Lake, and in North Crosby, near the upper lake. **Binary granites.**

"A possibly important deposit of good looking iron-ochre was noted, on a rough road a short distance west of the Kingston and Pembroke Railway, in Blythfield township. It is situated on ranges II. and III., between lots 5 and 10. **Iron-ochre.**

"A number of lakes containing marl beds were observed at various points, in some of which the deposits seemed to be extensive. These lakes can easily be recognized by their peculiar light bluish-green colour. **Marl.**

"The season's work extended from May 10th to October 3rd."

After the close of field-work in the autumn of 1895, Mr. N. J. Giroux began the plotting of his surveys made during the summer, but early in 1896, he was forced to suspend this work on account of severe illness. Upon his recovery, some further progress was made in collecting the material for the geological maps upon which he had been engaged, and on June 1st he returned to the field to continue and if possible to complete the mapping of sheet No. 120, which covers portions of Ontario and Quebec between the Ottawa and St. Lawrence rivers, including the city of Ottawa and Cornwall. As elsewhere stated, Mr. Giroux's labours were unexpectedly ended by death, shortly after his return from the field. The following preliminary report, which had in part been prepared by him, has since been edited by Dr. Ells:— **Work of Mr Giroux.**

"The first few days of field-work, for the season of 1896, were spent with Dr. Ells in the survey of the area along the junction of map-sheets 120 and 119, on which he is engaged; and on the 1st of June, **Surveys near Ottawa.**

Ontario—*Cont.*

I left for my own field of work, nearer the St. Lawrence. The surveys were resumed in the county of Glengarry, in continuation of those of the previous year, in order to complete, as far as possible, the mapping from east to west.

" A small amount of work yet remains to be done in Soulanges county, as well as in Huntingdon, on the east side of the St. Lawrence, in order to complete the map-sheet No. 120, for publication.

Area traversed.

" Surveys of roads were made, principally to the south of the Canada Atlantic Railway, and extending as far south as the town of Prescott, on the St. Lawrence, which is near the southern limit of the map-sheet. Connections were made with the city of Ottawa and with the work on the sheet to the west, No. 119. The greater part of the area between the Ottawa and the St. Lawrence was traversed, so that the surveys in the area of this sheet are now nearly completed.

Rocks seen.

" The rocks found are entirely confined to the lower Palæozoic formations, extending from the Potsdam to the Lorraine, both inclusive. Large areas are occupied by Calciferous and Trenton beds, and an outcrop of red shales was noted, similar to those classed as Medina to the east of the St. Lawrence, near Three Rivers. The surveys were all made with the wagon-odometer, and the number of miles measured amounted to nearly 1150.

Calciferous formation.

" The rock formations throughout the area surveyed have generally a nearly horizontal attitude. A line of disturbance was observed, running almost north-and-south, for a distance of about four miles, in the township of Mountain, Dundas county, extending from Lockville to Van Camp's mill. The Calciferous rocks which outcrop on each side of the line and not very far distant, do not show the least sign of alteration and lie in the usual horizontal attitude. But at a short distance north of Lockville, ledges of fine-grained gray conglomerate, light in colour, with greenish bands, and of Potsdam age, occur. At the northern end of this line, on a small brook, near Van Camp's mill, there are ledges of whitish-gray grit, of Potsdam age, holding small rounded pebbles of white quartz, along with banded micaceous, somewhat twisted, sandy slates or slaty sandstones, probably of Chazy age. These outcrops are, however, so limited in extent, that it will be impossible to show them on the four-mile scale map. So far as I know this is the most easterly disturbance recognized on the area of map-sheet 120.

" The Calciferous limestones have a very considerable development on this sheet, and the soil overlying them is generally poor and thin or sandy, unless covered with heavy beds of clay, as in Soulanges county, the eastern part of Glengarry and some parts of Huntingdon.

"The principal places at which the Calciferous formation has been observed are as follows. At Manotick, on the Rideau River, the beds resembling those seen at Glen Nevis. They are also well exposed at Manotick station and to the south of this place. Similar rocks also occur on lot 20, range VI., Osgoode township, Carleton county, the dip of which is S. 88° E. $<$ 6°. They are also well exposed along the road between ranges VI. and VII., Osgoode, from Vernon Corner, north for about three miles, as also on lot 23, range XII., Mountain, Dundas county, and near Van Camp's mill, and they again appear about three and a-half miles west of Winchester, with a dip of S. 45° E. $<$ 4° to 6°. Areas in Dundas Co.

"About two miles, in a north-easterly direction from Van Camp's mill, Calciferous limestone occurs in thin beds and much disturbed, with characteristic vugs of pink and white calcite. This place has been opened as a quarry.

"The formation is also well exposed in the neighbourhood of South Mountain, and all along westward of this place towards Kemptville and Merrickville, and southward towards Easton's Corners and Irish Creek. It thence continues on to North Augusta and to the shore of the St. Lawrence as far as Prescott and down the river to Cardinal. Development in Grenville Co.

"This formation is also seen on the Castor River, at about three and a-half miles south-east of Russell. Sandy calcareous basal beds of the same formation can be seen about two miles south of Smirleville, where they have been greatly altered, and hold pebbles and lenticular pieces of quartz.

"Rocks of this formation extend westward from the eastern half of the township of Grenville, and beds of the same can be seen near Hickston Corners, Hell Gate swamp and Spencerville station on the Prescott and Ottawa Railway. On the Nation River, near Spencerville station, the rocks have been disturbed and altered, so that, along with the ledges of characteristic brownish-weathering, dolomitic, fine-grained, gray limestone of Calciferous age, patches of banded sandy limestone occur, which probably are of Chazy age, or else represent much altered portions of the Calciferous.

"On the road from Mountain to Smirleville, similar outcrops (Calciferous) also appear, and at about one mile and a-half north of Mountain station, this limestone is full of rounded and angular pieces of quartz, varying in size from a pea to a melon, and angular pieces from a Grenville and Dundas counties.

Ontario—*Cont.*

fourth of an inch to a foot across. This conglomeritic rock has a very homogeneous matrix, which exhibits plainly all the characters of the Calciferous. The dip of these beds on the south of the exposure, is S. 20° E. < 18°, and on the north side is about 100 yards wide, the dip is N. 10° W. < 12°.

"The Calciferous also appears near Ormond Corner in the township of Winchester, Dundas county, in beds of limestone, as well as on the east point of Racket River, on the south side of the St. Lawrence, where ledges of dark-gray, sandy limestone outcrop. The south shore of the river, northward for some distance from this place, is low and without rock exposures, but Calciferous blocks are numerous.

"At the bottom of Hungry Bay, these limestones appear in a small knoll, holding large pockety vugs of pink and white calcite associated with iron-pyrites. Some of the upper beds are slaty, and where the calcite occurs the rock is of a grayish-buff colour, compact and with a very fine grain, almost fine enough to be used for a lithographic stone, were it not that it contains certain inclusions which unfit it for that purpose. The dip is here S. 30° < 5. This place has been opened for a quarry and some of the material used in the construction of the Canada Atlantic Railway bridge was obtained from it.

"The Calciferous also appears on a small brook which empties into the River à la Graisse, lot 17, range VII., Lochiel, but the dip could not here be ascertained.

Chazy formation.

"The Chazy, in this area, has not so wide a distribution, but is generally well defined, both by the character of its shales and sandstones and by the fossils contained in the upper or limestone portion. In the western part of the sheet, about one mile north of Manotick station, ledges of bluish-gray and grayish limestones appear, which probably belong to this formation. Not far from Berwick, also, are ledges of dark bluish-gray limestone dip S. 40° E. < 4°. These beds extend north-west from this place as far as Cannamore post-office, and continue on in this direction. A similar rock also occurs in the northern part of Dundas and the southern part of Russell.

"Limestones of this age are also seen about two and a-half miles west of Grantley, and at about three miles south of Chesterville. They also appear, associated with shales, about two miles north-east of West Winchester, as well as on lot 22, range XII., Winchester township.

"On the north shore of the St. Lawrence, at a small point opposite the north-east corner of Barnhart Island, there is a fine exposure of greenish and black Chazy shales. They are very concretionary and nodular in places. but no fossils were observed. The dip is N. 10° W $<2°$. These shales are exceedingly thin and splintery and are easily crushed in the hand. Ontario—*Cont.*

"At the north-east end of Sheick's Island, opposite Mille Roches, are fossiliferous flat-lying Chazy limestones. A quarry has been opened here and a quantity of material taken out for the construction of the canal. Specimens were collected from these quarries. The limestone at this place is bluish-black in colour, very hard, with a flinty fracture, highly fossiliferous, and holds small dots or specks of clear calcite. It is of fairly good quality, though somewhat seamy in places. On weathered surfaces, which are of a brownish-gray colour, it is seen to be concretionary, and the partings of the beds, which vary from six to twenty-four inches, are very rough, blackish and pitted. I am told that 15,000 cubic yards a year have been taken out. The rock, in some places, is in beds of nine to ten feet thick, with generally a parting at about five feet from the surface. **Quarry near Sheick's Island**

"The Trenton formation, with which is associated the Black River, has a very extensive development in this area. In the western part of the sheet, beds are well exposed from Billings Bridge along the main road to Britannia, where also the Chazy is well seen. The Trenton is also well exposed near Mr. Henry Onderdonk's, a short distance to the north-west of Aultsville, as well as in the township of Russell, on one of the branches of the Nation River. It also appears about Crysler in the township of Finch, Stormont county, and thence extends eastward towards Moose Creek. **Trenton limestone.**

"Near South Finch, the bed of the Payne River consists of Trenton limestone, and there are also fine exposures about South Finch, Lodi, and other points in the vicinity.

"A valuable quarry in rocks of this formation is located near Alexandria, on lot 27, range V., of Lochiel, about 200 yards to the south of the road. The rocks are heavily bedded and dip S. 10° E. $<7°$. They are vertically jointed and blocks of any dimensions can be obtained as the limestone is easily split horizontally. It is highly fossiliferous, and contains small seams of a black bituminous substance. It is rather hard to work but of very good quality. In places the rock contains small veins of white calcite, and in certain portions has a mottled pinkish aspect from the presence of pink calcite. In others it assumes a greenish hue, due to a thin coating of a shaly bituminous mineral. This stone is used in the construction of the new reformatory at Alexandria. **Quarry near Alexandria.**

Ontario—*Cont.*
Utica shales.

"The Utica is well exposed in the township of Cumberland, Russell county, near Navan Corner, and also about one mile and three-fourths south-east of Cyrville, in the township of Gloucester, county of Carleton. Near Ottawa, at Janeville and Billings Bridge, large outcrops of this formation are seen, as well as in New Edinburgh and in portions of the city of Ottawa itself. These black Utica shales pass upward into the grayish beds of the Lorraine formation which are well seen on the road south of Hawthorne Corner. A belt of these rocks occurs near Maxville, and fine exposures are visible on lot 16, range X., Caledonia, on Mr. McRae's property. The black shales were struck at about eight feet from the surface, and Mr. McRae penetrated these for about ten feet, obtaining excellent water. These shales have a very considerable development in the townships of Caledonia and Kenyon, but large areas are covered with drift and clay, so that the exact limits of the formation cannot be accurately ascertained.

"Red shales, probably of Medina age, occur in the township of Russell, lot 31, range III., but the distribution of these rocks has not been worked out.

"The glacial striæ, where observed, were uniform in a southerly direction, ranging from fifteen degrees east of south to five degrees west."

Mr. Giroux's field-work extended from the 1st of June to the 1st of October.

Quebec.

Work by Dr. Bell.

After the close of the season of field-operations last autumn and until the time for beginning the work of the present season, Dr. R. Bell was occupied in plotting his surveys of 1895 from his field-books and mapping the results; also in working up the geological data for the region covered by the French River sheet (No. 125, Ontario), and putting these upon the map for publication.

Dr. Bell reports as follows on the field-work of the past season, which was directed to the same region, between the Upper Ottawa and James Bay, in which his explorations of the preceding year had been carried out:—

Further exploration of Nottaway River basin.

"The region explored lies in a general way between the Upper Ottawa and Rupert River and thence eastward to Lake Mistassini. The exploration was in continuation of the work which had been commenced beyond the height-of-land in this region in 1887 and resumed in 1895. Grand Lake was an objective point on the journey from Ottawa to the field of operations, and I determined to make my way to it via the town of Mattawa aud Keepawa Lake. The newly opened Lake Temiscaming Colonization Railway facilitating this course, and another reason for choosing this route was that I could follow a chain of lakes between Keepawa and Grand Lake which I had never before travelled and would thus be enabled to make some useful geological notes by the way.

Quebec—*Cont.*

"Besides voyageurs and a cook, my party consisted of R. W. Brock, M.A., who had been my assistant during several previous seasons, Mr. J. M. Bell and Mr. D. A. Rankin. I relied on being able to hire competent Indian or half-breed voyageurs for the work in the north country at Keepawa or Grand Lake. Supplies were obtained partly from Ottawa and partly from Grand Lake. Mr. Brock left Ottawa on the 10th June and was joined by Mr. Bell at Mattawa on the following day. With the help of temporary canoemen they started as soon as possible to convey our outfit and other supplies as far as Grand Lake.

Journey to Grand Lake.

"I left Ottawa on the 19th of June in time to join Mr. L. Christopherson of the Hudson's Bay Company (who has charge of the Upper Ottawa district) a few days later at Keepawa on his way to Grand Lake house. Chief Factor Rankin had kindly arranged for my passage with this gentleman on his return to that post. It was not till the 27th, however, that Mr. Christopherson was able to leave Turtle Portage on Keepawa Lake, but we took only four days to cover the whole distance of about 160 miles, with some thirty portages, and reached Grand Lake on the 1st of July. Mr. Brock had already arrived with our outfit, and the above-mentioned supplies, and I obtained the heavier part of our provisions for the whole season through the accommodation of the Hudson's Bay Company at this post, thus saving much time which would otherwise have been required to transport them to this distance by my own party. Here I also obtained from the company a four and a-half fathom bark canoe, which proved of great service in navigating the strong rapids of the larger rivers. In the course of a few days I succeeded in securing four good Indian canoemen, and our party started from Grand Lake house in two sections on the 6th and 8th of July.

Extent of explorations.

"After leaving Grand Lake, my own share of the work consisted in making a combined geographical and geological exploration of eleven branches of the main river surveyed in 1895, and of a chain of lakes

Quebec—*Cont.*

and rivers extending from the Waswanipi to the Rupert River, while Mr. Brock explored the region between Shabogama and Waswanipi lakes by way of the Mekiskan, and afterwards the region lying east of the latter lake by way of the Waswanipi River and Lake Mistassini, from which he returned home by the Ashuapmouchouan River, Lake St. John and Quebec.

Observations made.

"The above explorations resulted in demonstrating the existence of large areas of Huronian rocks which give promise of valuable metallic ores and other economic minerals, as well as of extensive tracts of agricultural lands and forests of northern timber trees, which are no doubt destined to be of great future value to the country.

"Careful track-surveys were made of the lakes and streams on the routes followed by both Mr. Brock and myself. Numerous observations for latitude and the variation of the compass were taken wherever I went, so that, with the work of last year added, the topography of an extensive region can be laid down on a general map with sufficient accuracy for present purposes. We brought home as many specimens of the rocks of the country as could be conveniently transported, and also about twenty samples of quartz and other vein-stones for examination. Mr. J. M. Bell paid particular attention to the flora of the country traversed. Although many observations were made on the zoology of the country, neither time nor circumstances permitted of the preservation of specimens. A number of Lepidopterous insects, incidentally captured, have been handed to Dr. James Fletcher for determination.

Nomenclature of places.

"The geographical names to be made use of in describing the exploration from Grand Lake northward, are those which have been given by Indians, wherever such names exist; some were given by my late assistant Mr. Cochrane in 1887, and some by Mr. O'Sullivan in 1894, all of which I have adopted. But it often happened that owing to the absence of any name whatever—Indian or otherwise—I was obliged for the purpose of description to give appropriate designations to some of the geographical features. The few Indians of this great region attach little importance to geographical names, and such as they make use of are generally only temporary and recognized by but few families. They have no idea of a uniform or permanent geography, and each little band of natives coming from a different part of the region, when they have occasion to use the same lake or river, has usually its own name for it, irrespective of what other natives may call it.

"As pointed out in my summary report for 1895, the stream followed northward from the height-of-land near the north end of Grand

Lake, to Mettagami Lake, of which I made an instrumental survey last year, had been supposed to be identical with a river flowing into Hannah Bay, which, on the sketch-maps of the region, was called Hannah Bay River or Harricanaw River. This latter, however, proved to be an independent stream lying to the west of the one in question, reaching the sea direct and known to the coast Indians as Washahow or Bay River; while the one I surveyed had been confounded with it. At the time of Mr. Cochrane's visit in 1887 and his track-survey of about 70 miles of it from the Boggy portage downward, the river was believed by the Hudson's Bay Company's people and the Indians whom Mr. Cochrane met with, to fall into Hannah Bay. (See Summary Report for 1887, page 24 A.) The same notion prevailed in 1895 when I started on my survey of the stream, and even my guide for the upper part of the river assured me that it did not ultimately fall into Rupert Bay, but into the sea somewhere to the west of it.

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Erroneous notions as to geography of the country.

" In my report for 1895 (page 77) reference was made to the Hannah Bay River or Washahow River, above mentioned, and to a lake called Michigami or Michigama (big lake) lying east of it and discharging north-eastward by a large branch into the Noddawai (or Nottaway) River, not far from its mouth. From various sources I have learned that there is another lake of the same name (big lake) to the west of Washahow River, the outlet of which flows directly into Hannah Bay. The want of more definite names is apt to lead to confusion and difficulty of description. In addition to the various 'big lakes' in this region mentioned in the present report, the largest sheet of water between Waswanipi and the Ashuapmouchouan River of Lake St. John is also called Big Lake. Indeed, in every part of the Dominion, east of the Rocky Mountains, the Indians (who only know their own district) have their local 'big lake'.

Mudge Manitou River.

" After crossing the height-of-land, my first exploration of the main line of our route was from Simon Lake eastward, via the Mudge Manitou or Devil River to the lake of the same name. On the way, thither (from Simon Lake) our course for ten miles lay through a large unnamed lake whose existence is not yet indicated on any map. While engaged in this work, I sent Mr. Brock to explore a western branch coming in at two miles below Simon Lake and also a small river falling into Obaska Lake,—the next expansion of the main river below Simon Lake.

Route from Shabogama Lake to Waswanipi.

" On arriving at Shabogama Lake, Mr. Brock was given an efficient Indian voyageur and one of the cedar canoes, with instructions, as

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already stated, to follow a route leading thence to Waswanipi Lake, while I proceeded with the remainder of the party down the main river in order to explore its branches. This was on the 20th of July, and we arranged to rendezvous on the 10th of August at the first narrows of Gull Lake, and accordingly on the morning of that day we met at the appointed place.

Branches of upper Mekiskun.

" Mr. Brock reported that, having made a track-survey by the Mekiskun to a point about due south of Waswanipi Lake, he turned northward and passing over the watershed of this river, continued his survey through the chain of lakes and streams which had been followed by Mr. H. O'Sullivan in 1894 to the lake first mentioned. In this part of his route, the largest of the lakes traversed were successively Ash-pa-bonka, five miles, We-tet-nagami, seven miles, and Pus-ki-tam-ika, fifteen miles in length. Track-surveys showing the details of topography were made of these three lakes. He found that the river discharging We-tet-nagami Lake, instead of falling as supposed into Pus-ki-tam-ika Lake, flowed off north-eastward and joined the lowest southerly branch of the Waswanipi. The Mekiskun here proved to be a difficult stream to ascend, as it flows rapidly down the east slope of the great or leading depression of this whole region. At fourteen miles from Lake Shabogama, it is joined by the Ka-ge-tes-ki-nuk from the south. This branch forms part of a canoe-route to Mudge Manitou Lake, of which I have located the termination in the north-eastern bay of the latter. The Mekiskun also receives a second good-sized branch from the south and two others from the north side in the portion which Mr. Brock surveyed and which had never before been explored by a white man. In this part of its course, the river passed through a lake surrounded by hills and twelve miles in length, which Mr. Brock named Lake Millie.

Various tributary streams.

" During the three weeks between the above-mentioned dates, I was occupied in exploring and mapping the large north-east bay of Shabogama Lake, a long branch from the west, which I named the Coffee River, from its water bearing the colour of *café au lait*, the Kiaak River from the east, Kamshigama River, also from the east, and the lake of the same name at its head; Clay River from the west, the Florence River or first branch from the east below Wedding River, of Mr. O'Sullivan, a river from the south-west falling into Taibis Lake and a stream from the west which my Indians at once named Deer River from having shot a deer on one of its branches. In addition to these eight branches explored by myself and the three by Mr. Brock, I may here add that on my return journey, in the autumn, I explored and mapped the lower twelve miles of the considerable tributary which falls into the extremity of Mattagami Lake, and which my guide in 1895 called the 'way-to-Abittibi' river, and also the Shabogama River, a large stream entering the head of the north-east bay of the lake of the same name, but which, within four miles of its mouth, divides into three branches. Quebec—Cont.

"The geological facts ascertained in the explorations of the above-mentioned thirteen branches and the further geological examinations of the main river itself, together with Mr. Brock's observations between the Mekiskun River and Waswanipi Lake, will enable me to indicate, in a general way at least, the distribution of the principal rocks of this region; and some notes on this subject will be given further on.

Waswanip Lake to Rupert River.

"When Mr. Brock rejoined me, although we had already accomplished the work planned out for the season, there still remained six or seven weeks before the rivers might be expected to begin to freeze over, and I decided to devote all of this time not required for the homeward journey, to an exploratory survey of a chain of rivers and lakes from Gull Lake northward to Nemiskau Lake—an expansion of Rupert River,—while Mr. Brock was to proceed eastward by the Waswanipi River to Lake Mistassini, in order to make a track-survey of that large stream and to ascertain as much as possible of the geology of the country it traverses. This journey he successfully accomplished

"Leaving Mr. Brook at Waswanipi post, I proceeded northward making at the outset track-surveys of the east side of Gull Lake (of which I had surveyed the west side last year) and of its two northern expansions, which give it a total length of thirty miles. A considerable river from the east falls into the head of each of these expansions. Our route followed the second of these streams for a short distance and then turned up a northern branch and crossed the height-of-land to a river-system lying between the Waswanipi and the Rupert. Our course then lay northward through a number of large lakes, connected by a river which finally discharges them all into Rupert Bay, at a point eleven miles southward of the mouth of Rupert River.

Large lakes on this route.

"A track-survey was made of all these lakes, as well as of the connecting links of rivers. The Indians and the Hudson's Bay Company's people told us that some of these lakes had no names, but that the largest of them—about the size of Lake Simcoe, Ontario, was known simply as 'the big lake' and another as 'the long lake.' Several long streams from the eastward fall into this chain of waters, and Mr.

Quebec—*Cont.*

Brock was told at Lake Mistassini, that two of them rise near that sheet of water, and also that the two rivers flowing into the northern expansions of Gull Lake, south of the local divide already referred to, have their sources close to Mistassini post. The large river which discharges the collected waters of all the streams and lakes of the intermediate basin, comes within six miles of Nemiskau Lake on the Rupert. Here we left it, but from this point down it is said to be a very rapid stream with a course parallel and close to the Rupert all the way to Rupert Bay. It is named Broad-backed or Broad-back River by the voyageurs at Waswanipi Post, who follow the route which has just been described to Nemiskau Lake on their way to Rupert house, but at the latter post the same stream is known as Namaigoose's River, after the Indian who hunts at present along its course. The above chain of lakes and their connecting streams appear to receive no notable tributaries from the west, which would show that the country across which they lie slopes westward, like the channel of Rupert River itself, all the way from the rim of Lake Mistassini to Rupert Bay, and the rate of the inclination appears to increase from the line of lakes to the sea-level.

Broad-back or Little Nottaway River.

Character of country north of Waswanipi.

"The country between Gull Lake and Rupert River became poorer, in a general way, as we proceeded northward. As a rule, it may be described as tolerably level, but now and then isolated hills, several hundred feet high, could be seen from the canoe-route. A good deal of solid rock was exposed on the lake and river shores, but inland, much of the country appeared to possess a good soil. The waters of the upper lakes were tolerably clear, but those of 'the big lake' and the lakes below it were quite muddy, owing to the wash from the surrounding clay land. The timber on the whole became smaller as we went northward from Gull Lake, even where it had attained its full size, but much of the forest consists of second growths of various ages. The black ash does not appear to extend north of Gull Lake and the last white cedars were seen at the outlet of 'the big lake,' but all the other species of trees are known to continue far to the north of Rupert River.

Climate and agriculture.

"The general character of the country which was traversed this year, as far as Gull Lake, was described in my preliminary report of last year, as to its rocks, soil, timber, climate and agricultural capabilities. In regard to the last mentioned, at my request, Mr. D. Baxter, the gentleman in charge of Waswanipi post, kindly agreed to make some additional experiments with wheat, oats, barley and a variety of other seed which I obtained from Dr. Saunders of the Central Experimental Farm and sent to him during the past winter. When we visited his post on the 12th of August, the various grains looked well. They had headed out some time before and would soon be ripe. New potatoes were as large as hen's eggs, turnips six inches in diameter, and carrots and some other vegetables ready for use. Indian corn was showing its silk, tobacco plants were growing well and almost every kind of garden crop grown in an average district of Canada, was flourishing under Mr. Baxter's care

Quebec—*Cont.*

"In my preliminary report of last year, the rocks which had been met with in that part of the district then examined were briefly described. The following is now added as a general outline of the geology of the whole region, between the main height-of-land and Rupert River, and as the result of both years explorations. It is supplemented by Mr. Brock's account of the rocks he met with east of Waswanipi Lake.

Geology of the region.

"*Mr. Brock's Geological Observations.*—Mr. Brock, on his journey from Shabogama Lake towards Waswanipi, in ascending the Mekiskun River, found only granite in the first twenty-three miles, following the general course of the stream, but at this distance he came upon an exposure of chloritic schist. Thence, along his route, which has been already described topographically, gneiss of different varieties prevails as far as Pus-ki-tam-ika Lake. Granite and greenish schist occur around the western part of this large lake and gneiss and similar schist with a little granite around the eastern part. Around Waswanipi Lake the rocks were found to consist of granite with some green schist.

Observations by Mr. Brock.

"In ascending the Waswanipi River on his journey to Lake Mistassini, Mr. Brock observed only granite, like that of Waswanipi Lake, for the first fourteen miles by the general course of the stream. Then for the next seven miles, there are greenstones and green schists, with whitish quartzite in the central part of this distance and granite near its eastern extremity. At one mile further on, syenite containing epidote, occurs, and gneiss and granite occupy the next eight miles. Above this, still measuring along the general course of the river, schists of various kinds were the only rocks seen for the next twenty-six miles. At the end of this distance, or at about fifty-four miles in a straight line easterly from Waswanipi Lake, the route turns off the main river at a right angle and follows up a branch in a due south direction for four miles to Mik-wa-sash Lake, which connects by a short link of river with Opa-mis-ka Lake, eight miles in length. The general course of these two lakes and of this branch river above them is easterly. Greenstones, with a little granite and green schist, were found all

Rocks noted along Waswanipi River.

Quebec—*Cont.*

around the above lakes and along this branch above them, to a point thirty miles in a straight line eastward from its junction with the main Waswanipi. From this point, gneiss was found to within four miles of Wahwanichi Lake. The geology of the route followed by Mr. Brock from this lake to Mistassini post of the Hudson's Bay Company, has already been described by the late Messrs. Richardson and McOuat and by Mr. Low in the reports of the Geological Survey.

Great belt of Huronian.

" *General Geological Description.*—The rocks around Grand Lake consist of Laurentian gneiss, which appears to extend thence south-westward continuously all the way to Georgian Bay of Lake Huron; but when we leave the northern extremity of Grand Lake, we enter at once upon an immense tract of Huronian rocks, with intrusive granites and greenstones, and broken by some areas of gneiss. This great tract of mixed rocks has a breadth of about 150 miles on a line running due north from the head of Grand Lake, and it constitutes an expansion of what I have elsewhere described as the 'great belt' of the Huronian system, extending from Lake Superior to Lake Mistassini, a distance of about 700 miles. From the central point of the above north-and-south line, the southern extremity of Lake Mistassini lies about 170 miles in a north-easterly direction, and Mr. Brock's exploration continues the tracing of this belt of Huronian rocks, with a narrowing breadth, all the way to that locality. The northern boundary of this great belt passes through the northern portions of Gull and Mattagami lakes.

Boundaries of this area.

" Leaving the height-of-land near Grand Lake, on the route which I followed, schists, greenstones and granites are found as far as about five miles down Shabogama Lake, beyond which gneiss prevails to and also all around the north-east extremity of Shabogama Lake, and it probably connects with the gneisses which Mr. Brock found everywhere on his way from the Mekiskun River to Pus-ki-tam-ika Lake. I came upon the north-westerly boundary of this gneissic area on the south branch of the Kiaak River. Another area of gneiss begins at Clay River and extends for several miles down the main stream. Areas of the same rock, separated by others of Huronian schists, occur in two places between the one last mentioned and Mattagami Lake.

Smaller northern belt.

" North of the principal belt above referred to, a smaller band of Huronian rocks was found on the route from Gull Lake to Rupert River. It begins at the outlet of 'the long lake' and extends to the southern bay of 'the big lake,' and has a breadth of about seventeen miles. Deposits of iron-pyrites, sometimes with traces of copper, were found in several places along this band, and these may prove large enough to be of economic value. This Huronian band is flanked on its northern side by granite at the first narrows of 'the big lake' and this again is followed by gneiss, which continued all the way to Rupert River. Quebec—*Cont.*

"From Mattawa, on the Ottawa, northward to Rupert River, the average course of the glacial striæ changes very gradually from about south-south-west to about south-west (true), but it is very constant over large districts. From the neighbourhood of Shabogama Lake, northward, the drift or till contains a varying proportion of rock-fragments derived from the Manitounuck formation (Cambrian), which may have come from the east coast of Hudson Bay, as far as their lithological characters are concerned; but as the glacial striæ of the whole region, except along a part of the Nottaway River, all run south-westward, these fragments may have been derived from the rocks of the broad belt of the same formation which Mr. Low found running north-westerly through the central part of the Labrador Peninsula. Glacial striæ and erratics.

"On Mattagami, Gull and Waswanipi lakes, and for some distance up the Waswanipi River, many small and some good-sized boulders occur, of a grayish unaltered limestone, containing obscure fossils, but no fixed rock of this kind has yet been found in the surrounding country.

"The brownish clays, formed of thin horizontal layers and usually containing small nodules, which overspread the river-valleys and the lower levels of the country generally, are not confined to any particular elevation, but occur at all heights from about 100 feet below the watershed, down nearly to the sea-level, where they are replaced by clays of a bluish-gray colour. The brown clays rest upon the till and are sometimes covered by local deposits of sand or more rarely of gravel. Clay deposits.

"In returning from Rupert River to Grand Lake, I followed the same route as in going and reached the latter place on Saturday, 26th September. Owing to a continuous downpour of rain, we were unable to resume our journey southward till the 1st of October and on the 6th we arrived at Mattawa, where I settled with my men and started them off on their homeward journey.

"In carrying out the above explorations we were indebted for assistance in a variety of ways to several of the officers of the Hudson's Bay Company, among whom I may mention the Chief Commissioner Mr. C. C. Chipman, Chief Factor Rankin of Mattawa, Mr. L.

Quebec—*Cont.*

Christopherson of Grand Lake, Mr. David Baxter of Waswanipi, and Mr. William Miller of Lake Mistassini."

Work by Mr. Chalmers.

Throughout the winter of 1895-96, Mr. R. Chalmers was engaged in correcting final proofs of maps and report on the Surface Geology of Eastern New Brunswick, north-western Nova Scotia and Prince Edward Island, and in compiling the data obtained in the field during the previous summer in the "Eastern Townships" of the province of Quebec for publication. A portion of the field-work relating to the surface geology of sheets No. 1 N. W., and No. 2 S. W., New Brunswick, was also put down upon the maps, and the post-Tertiary fossils of that province were catalogued. The specimens of boulder-clays and other Pleistocene deposits which had been collected from time to time for the museum were also classified and labelled.

The field-work of 1896, which was again devoted to the "Eastern Townships" of Quebec, is reported on by Mr. Chalmers, as follows :—

Surface geology of the 'Eastern Townships.'

"On the 19th of May I left Ottawa to resume the investigation of the gold-bearing alluviums and to study some questions pertaining to the surface geology of the 'Eastern Townships' and adjacent portions of south-eastern Quebec, remaining in the field till the 19th of November. Operations, though somewhat restricted for a considerable portion of the season owing to the scarcity of funds, were, nevertheless, carried on continuously throughout the summer, and the region referred to, especially where it is occupied by auriferous deposits, has now been examined in as much detail as time and circumstances would permit. The glaciation and the deposits due to glacial action, especially in their relation to the gold-bearing gravels, have been closely studied.

Observations in gold mining districts.

"On entering the field, observations were first made in the different districts in which gold mining was in progress, especially where shafts, tunnels, etc., were open. Development work was found to be going on at Dudswell, Ditton, Massawippi Lake, and in Beauce county, though only to a limited extent. On the west side of Massawippi Lake, Mr. James Stark, representing an English company, was at work with twenty-two men, in the bed of a small stream on lot 14, range VI., Hatley, Stanstead county. Some gold was found in the gravels, but not sufficient quantities to pay for working. Mr. Stark's object was, however, to find it in the matrix. Broken quartz seams, with pyritous, slaty and talcose minerals, traverse the rocks mapped as pre-Cambrian there. Specimens of these were brought to the office for assay in the laboratory of the Survey. The work at this place was discontinued after a month or two.

Massawippi Lake.

"The stream along which the gold occurs runs entirely across pre-Cambrian rocks and falls into Massawippi Lake, and the gold seems, therefore, to be derived from these rocks. Their character is very much the same as that of the rocks in Dudswell Mountain. Quebec—*Cont.*

"On lot 5, range XV., Magog, near the foot of Orford Mountain, mining for gold was undertaken by a Mr. Lacroix, and several men were at work in a pit in the bank of a small stream, at the time of my visit. The Cambrian slates there contain some thin quartz seams accompanied by pyritous minerals; but Mr. Lacroix could not show me any gold obtained from this opening, and later on it was closed. Magog.

"*Gold Mining at Dudswell.*—From Magog I proceeded to Dudswell, where some time was spent, and repeated examinations were made during the summer as work progressed. At Harrison's, lot 1, range VI., Westbury, free gold was found in the autumn of 1895 in a thin seam of quartz in a sort of conglomerate rock.* The exposure in which it occurred was uncovered to a still greater extent, along a low ridge, during the winter, and an opening made in the conglomerate, but without any further result than as stated in the Summary Report referred to. It is evident, however, that this conglomerate exists here in much greater thickness and extent than at first supposed; but whether auriferous throughout has yet to be proved. Mr. John Armstrong, of Marlow, Beauce county, has leased this property and was preparing to have the auriferous character of these rocks tested preparatory to working them. Dudswell.

"In Kingsley Brook, a considerable amount of work has been going on this season. A company has been formed to operate the mines on this stream, called The Rodrigue Mining Company, and the mining rights along the whole stream have been secured. Mr. H. C. Donnell, of Boston, U.S., is manager. Early in the season a dam was constructed near the source of Kingsley Brook, and an 80-horse-power boiler and hydraulic pump were put in, principally to work the gravels, Mr. Donnell informed me that he finds gold in paying quantities in these, but his ultimate object is to find the auriferous quartz or matrix, which he hopes to do as he sluices the gravels and uncovers the rock surface in the valley of the stream from the foot of the mountain up towards the dam. The boiler, Mr. Donnell states, is large enough to furnish power to drive a 50- or 60-stamp mill, and can be utilized for that purpose when gold is found in the rock in sufficient quantity to warrant the purchase of a mill. Kingsley Brook.

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* Summary Report, Geol. Surv. Can., 1895, p. 93.

Quebec—*Cont.*

"The rocks of Dudswell Mountain are, like those on the west side of Massawippi Lake, pre-Cambrian slates and schists. Kingsley Brook crosses them nearly at right angles to the strike and has dropped considerable quantities of gold into the joints and crevices. Mr. Donnell informed me he was finding gold in these to a depth of two or three feet below the surface of the rock. Latterly, he was mining the decayed or partially rotten rock to that depth along with the overlying gravels and had sunk his sluice-boxes to that level. The discovery of gold in the rock-fissures means a continuance of operations for many years longer than if the gravels alone were worked.

Difficulties in mining.

"In regard to the difficulties encountered in gold mining in Kingsley Brook, and probably also in the valleys of the other small streams flowing off Dudswell Mountain, the first is the scarcity of water during the midsummer months, if operations are conducted on anything like a large scale. This difficulty can only be overcome by the construction of dams and reservoirs. The second is the presence of large boulders in the gravels. These interfere, to some extent, with hydraulic work, and have to be blasted or removed by derricks before the whole of the gravels can be sluiced. No quicksands occur in the valley of these small streams as they do in Beauce county, except in the terraces at the foot of the mountain. Mining has not yet been undertaken in any of these terraces.

Rowe's Brook.

"On a stream from one to two miles north-east of Kingsley Brook, called Rowe's Brook, lot 8, range IV., Dudswell, alluvial gold mining has been prosecuted this season by Messrs. Hayemal and Sotero, for some months and gold in paying quantities obtained by the ordinary process of sluicing. A clean-up which I witnessed while visiting this 'ocality, seemed to prove this statement. The character of the deposits is very much the same as in the Kingsley Brook valley, as described in the Summary Report for 1895 (p. 91), except that the thickness is perhaps, fully greater.

Ditton.

"*Gold Mining in Ditton.*—In the valley of the Little Ditton River, some work has been performed during the past season by Messrs. McCritchie and McKay of Scotstown, about a quarter of a mile above the bridge on the road to Chartierville. The gravels at this point were washed for some weeks by these men previous to the date of my visit and some gold was obtained. One nugget weighing an ounce was found at the bottom of the gravel, close to the bed-rock. The chief auriferous deposits here are those resting upon the rusty rotten rock, and are themselves highly oxidized, though stratified. Overlying them are alternating gravel and sand beds, which must be largely of post-glacial origin. The boulder-clay is, however, rarely seen in contact with these. They contain but little gold. Quebec—*Cont.*

"To the south of the locality mentioned, along the Little Ditton valley, gold has been washed from the gravels at several points, nearly as far up as the International boundary, *e. g.* at a point a mile north of the cross-road going west from Chartierville, also south of that road and near the source of the stream in the vicinity of Prospect Hill, where it is reported to have been found in quartz, but I could obtain no authentic information on this point. It has also been discovered in the alluviums of the main Ditton River to the south of Chartierville village. No work has been done, however, in the two last-mentioned localities.

Chaudière valley.

"*Gold Mining in the Chaudière Valley.*—Along the Chaudière River and its tributaries, very little gold mining has been carried on during the past season. Work in the tunnel at St. George, referred to in the Summary Report for 1895 (p. 87), was continued until September last, when it was found that the old pre-glacial channel of Slate Creek was not likely to be reached by following the course in which the tunnel was started, and it was abandoned for the present. At the time operations were suspended, the tunnel had been run in nearly 900 feet. Great difficulties were experienced in keeping it open, owing to the presence of quicksands and to the quantities of water in the ground overhead seeking outlet and carrying these sands with it. The succession of the deposits disclosed in the tunnel is interesting from a geological point of view. In descending order it is as follows:—(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 quicksands); (4) coarse, stratified gravel with 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 quartz bands running through it. It is apparently a decomposed slate which may have originally been thrown down as a talus at the base of a boss on the slope; (6) fine yellow sand with ochreous streaks through it, passing into rotten rock *in situ* beneath, the strata being in the same position as in the solid rock; (7) unglaciated rock. St. George.

"The most remarkable member of the series is number 6. It is unlike any other bed met with in connection with the gold-bearing deposits of Beauce county, and is noteworthy as showing the slight erosive action of the Pleistocene ice, exposed, as this slope of the Chaudière valley must have been to the full force of the glacier which moved over this distri t from north-west to south-east.

Quebec—*Cont.*

Rivière du Loup.

" In the valley of the Rivière du Loup, Mr. L. Gendreau is endeavouring to open up a series of gravel banks on the west side, which extend from three to five miles above its mouth. These gravels are reported to contain gold in workable quantities, but I have seen no competent tests made. The following is a section of one of these banks situated about four miles above the confluence of the du Loup and Chaudière rivers. (1) Surface soil; (2) boulder-clay, the upper part stratified in places; (3) a thin seam of stratified sand graduating into the following bed (4) stratified clay, (pipe-clay); (5) stratified sand and gravel, the latter usually in lenticular seams with ochreous bands, especially in the upper part. This is the deposit said to be auriferous; (6) fine, gray, stratified sand, the bottom not reached as it lies below the level of Rivière du Loup.

" Whether gold exists in paying quantities in these gravels does not appear, but Mr. A. A. Humphrey, of the Canada Gold Mining Association, formerly washed a good deal of gold out of the gravels of the du Loup valley in his No. 1 pit, just below the mouth of Gold Stream, *i.e.* about two miles lower down than the above section; and also in No. 2 pit near the river's mouth (see Summary Report for 1895, p. 89, where it is called No. 1 pit), though so far as known not in sufficient quantities to pay for hydraulic work.

Gilbert River.

" In the Gilbert River valley, some gold mining was carried on during the past season by the Leclerc Brothers, who are reported to have met with fair success and to have taken out in a few weeks about $400 worth. Two nuggets valued at $50 and $60, I am informed, were obtained by these men. One of these nuggets was shown to me.

Mill Stream.

" On Mill Stream, near St. François, Beauce, some work has been performed by Messrs. Copal and Pomerleau, and gold has been found in parts of the valley of that stream not hitherto prospected. In the valley of Black River, a branch of Des Plantes River, joining it from the south, gold was discovered in the gravels at the confluence of the main tributary.

General aspect of mining operations.

" The present languishing condition of the gold mining industry in Beauce county, appears to be due to causes other than the scarcity of gold in the alluviums. It would be invidious to make any remarks, however, concerning these causes. That gold still exists in a number of these valleys in paying quantities, *i.e.* in quantities sufficient at least to warrant a skilful and economic expenditure of capital in their exploitation, is a fact which no one who has examined the district can deny. But on the other hand it must be remembered that this district can show a total of a large number of failures in gold mining, and that there are other causes for this besides want of scientific knowledge or skill and want of capital. In much of the Chaudière district, the gold exists in a very thin and scattered condition, and the gravels containing it are capped by such thick beds of boulder-clay and quicksands that it is doubtful whether it can be profitably mined. In the deeper parts of the river-valleys there are still greater difficulties to contend with. In the old 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 shafts at these levels are likely to receive a portion of the drainage waters, the expense of exploration would be great and only deposits of considerable richness would probably prove remunerative.

Quebec—*Cont.*

"The failure hitherto to find workable gold-bearing qua rtz, ha given wrong impressions concerning the district, leading miners and mining engineers to suppose that it has been but very imperfectly explored. As a matter of fact a considerable number of geologists, mining engineers and experts have visited and examined this district, and the literature pertaining to it is somewhat voluminous. There are, of course, different local conditions existing here as regards the distribution of the gold in the alluviums from what prevail in non-glaciated countries, and these diverse conditions may not have been sufficiently taken into account. But the Chaudière district has not suffered for lack of competent and skilful exploration, nor for want of capital.

"Notwithstanding the backward condition of gold mining here, this district, or at least some portions of it, offers inducements to miners and capitalists equal in some respects at least to those of some other gold regions more favourably regarded.

Improvement in methods.

"The further development of the gold mines of the Chaudière area should, it seems to me, lie in the direction of introducing machinery and plant adapted to alluvial mining under the peculiar local conditions which are found there. But first the gold-bearing gravels, in a great number of places, should be tested anew and their gold content per cubic yard proved, with the view of ascertaining whether it is sufficient to pay for the expenditure in the direction indicated. To effect this exploration adequately, it would seem that boring machines are absolutely necessary. The great thickness of the boulder-clay, which never contains gold in paying quantities, but which must be penetrated by shafts or tunnels before the auriferous deposits can be reached and worked, as well as the difficulty of locating the old river-channels in which the auriferous deposits mainly lie, have hitherto proved serious obstacles to exploration in the deep-lying beds. With boring appli-

Quebec—*Cont.*

ances these difficulties could be overcome, at least to a much greater extent than by the methods hitherto employed, the position of the old channels could be located in less time and at much less expense, and the thickness of the auriferous beds in these ascertained before commencing actual mining operations.

Quartz veins.

"*Quartz Veins.*—In addition to the facts obtained relating to alluvial gold mines, a considerable body of data concerning quartz veins and other rocks which might be likely to yield gold was collected in the field, with a view of ascertaining, if possible, its primary source. The details regarding these will be given in my forthcoming general report ; while such specimens as were brought in from the field will, meantime, be subjected to examination and assay in the laboratory of the Survey.

Observations on glaciation.

"*Glaciation.*—A portion of the season, at intervals, was spent in the investigation of the glaciation of this region, which undoubtedly has a close relation to the distribution of the gold throughout the gravels of the river-valleys. The direction of movement of the ice of the glacial period, the causes of its greater accumulation in certain localities than in others, particularly in the depressions of the surface, the denudation of all the superficial material on portions of the higher grounds, the transport of the drift from one locality to another, are questions bearing intimately upon the problem, and in this respect are of economic importance. The facts now at hand have been collected from all parts of the region from the Lake Champlain valley eastward to Gaspé, and are sufficient to enable us to arrive at conclusions with some confidence. They are mainly in confirmation of the observations recorded in the last Summary Report (p. 94), viz., that the earliest glaciation of this region was caused by ice which moved northward from the Notre-Dame Mountains into the St. Lawrence valley, the striæ produced by it being still preserved on the south and west sides of ridges and hills where the Laurentian ice, which flowed southward and south-eastward subsequently, did not efface it. Each of these two glacier-movements seems to be represented by its own boulder-clay as as well as by striæ, and consequently the boulder-clay is found to have a two-fold division in a number of places. The lower, so far as it has been possible to examine it, consists of local material, while the upper contains Laurentian and other transported boulders from the north. The two boulder-clays were observed in the St. Francis River valley east of Angus station, Quebec Central Railway, where the intercalated bed consists of 12 or 15 feet of tough, stratified clay in a horizontal attitude. The boulder-clay was also seen in an upper and lower divi-

Two periods of glaciation.

sion in the bank of Clifton River, south of Sawyerville, Compton county, as well as in other places referred to in the Summary Report for 1895 (p. 95). It has been noted as occurring in the tunnel at St. George, Beauce county, on a preceding page, in the same two-fold bed. Quebec—Cont.

"*Changes of Level.*—A good deal of evidence has been obtained tending to show that this region has undergone remarkable changes of level in later geological ages and especially during the Pleistocene period. The basins of those long narrow lakes extending north and south, such as Memphremagog, Massawippi, Little Magog, Megantic, St. Francis, etc., appear to be merely dislocated portions of old river-valleys, interrupted by differential movements, the axes of these movements following mainly the direction of the present mountain ranges. The uplift of the range nearest the St. Lawrence, *i.e.* the range forming the extension of the Green Mountain Range into Canada, probably took place long before the Pleistocene period. It was this movement which principally affected the old valleys of the rivers referred to, and which appear to have flowed northwardly.

Changes of level.

Lake basins.

The great changes of level of which the evidences still remain in the form of raised beaches and terraces, however, took place in the later Pleistocene. These beaches and terraces extend along the slopes of the mountain range referred to, and face the open St. Lawrence valley from the Gulf to the International boundary in the vicinity of Lake Champlain. The uplift which raised these shore-lines has been unequal, or differential, as shown in the Summary Report for 1895 (p. 96), the gradient increasing in height above sea-level from Gaspé till we reach Arthabaska. Here a series of three shore-lines occurs at heights of 600 to 625 feet, 700 to 720 feet, and 875 to 885 feet, as levelled by aneroid, starting from the known elevation of the nearest railway station. From this point south-westward, they descend gradually towards the International boundary on the north-west slope of Sutton Mountain.

Beaches and terraces.

Amount of uplift variable.

The lower shore-lines are tolerably well preserved throughout, but the higher are greatly denuded, and on the slopes between St. Francis River and the Vermont boundary are very difficult to trace, owing to their broken, detached condition. These slopes are much intersected by valleys extending transversely to the direction of the ridge, as well as by others running longitudinally, and the Pleistocene shore-lines can be traced only around the denuded hills or along the sides of the broken ridges which remain. In many instances the hills are isolated. Two of these isolated hills, near the Canadian Pacific Railway at West Shefford

Quebec—*Cont.*

station, have furnished examples of Pleistocene shore-lines upon their slopes—Shefford Mountain and Brome Mountain. Here they occur at heights of 650, 700 and 820 feet. West of Sweetsburg two of these were observed at 600 to 610 feet and at about 700 feet. Near Frelighsburg and Abbott's Corner and north of 'The Pinnacle' in Sutton Mountain, the inner border of the marine plain is 475 or 480 feet high, the first shore-line above it from 600 to 625 feet, and another very broken and imperfect one, not yet accurately traced, at about 785 feet. This point is within a few miles of the International boundary. Further detailed examination and levelling of these shore-lines are desirable.

Shore-lines are marine.

" All the shore-lines noted face the open plain of the St. Lawrence valley, in the deposits of which marine fossils occur at various points. No barriers exist or could have existed, capable of holding in a body of fresh water at heights sufficient to allow the formation of these shore-lines; and the only reasonable theory as to their origin seems to be that they were formed along the margin of a sea which occupied the St. Lawrence valley in the Pleistocene period.

" Photographs of several of these shore-lines have been taken during the past season.

Differential uplift.

" Evidences of uplifts, with probably corresponding subsidences, were noted in other parts of the area under review. A differential change of level of this kind has occurred at the Devil's Rapids on the Chaudière River. As pointed out in the Summary Report for 1895 (p. 97) there must have been a local uplift here, with perhaps, a correlative subsidence in a parallel belt of country which crosses the Chaudière valley to the south between these rapids and the mouth of the du Loup. Further detailed observations during the past summer confirmed the conclusion previously arrived at. This uplift probably commenced before the Pleistocene, and may have been part of the movement which dislocated the old river-valleys and produced the lake basins referred to on a previous page.

Post-glacial dislocations.

" Dislocations or slips of the slates over each other, along certain zones or bands, since the glacial period, were observed in a great number of places, the displacements ranging in extent from two or three inches to five or six feet. One of the most remarkable examples of these movements in the rocks, was seen in the southern part of the seigniory of Aubert Gallion, Beauce county, where a band of slates from three to four feet thick and several hundred yards in length had sustained an upward shove of nearly six feet above the general level of the glaciated rock-surface, as evidenced by the parallel and well-marked striæ. The rocks on both sides of the protruding band were also more or less dislocated for several feet distant from it. Whether the upthrust is due to great lateral pressure, or to some other cause, remains to be determined." Labrador Peninsula.

Labrador Peninsula.

Work by Mr. Low.

Mr. A. P. Low, during the past winter, was engaged in writing a report on the previous season's work on the Manicuagan River, to be incorporated in his report on Labrador, also, with the assistance of Mr. Eaton, in the continued compilation of the map of the Labrador peninsula.

In the spring, plans were made for an additional traverse across the northern portion of Labrador, and Mr. Low was entrusted with the execution of this exploration. One principal object of the work was to trace out the northern continuation of the iron-bearing Cambrian rocks previously met with in Labrador. The results accomplished are outlined by Mr. Low as follows:—

"I left Ottawa on May 29th by the Canadian Pacific Railway for Missinaibie, to explore the country between the east coast of Hudson Bay and Ungava Bay. My party was made up as follows:—Mr. G. A. Young, assistant; Mr. W. Spreadborough, collector of natural history, and three canoemen, all of whom completed the entire trip. From time to time extra Indians were engaged as canoemen and guides as will be mentioned later.

Missinaibie to Moose Factory.

"Two days were spent at Missinaibie in securing four extra Indians to assist in conveying the outfit to Moose Factory. On the 30th we left the railway, with everything in one large bark canoe and two wooden ones. The next day Brunswick post was reached, at the outlet of Missinaibie Lake, where four more Indians were engaged to assist in passing the strong rapids which extend for twenty miles below the lake. Having passed these, we continued down stream with the spring freshet, and without mishap arrived at Moose Factory on June 8th.

Moose to Richmond Gulf.

"At Moose, a Collingwood fishing boat, the property of the Geological Survey was launched, but owing to its having been out of the water for several years, a number of repairs were necessary before it was fit for use, and in consequence we were detained until the 14th. The boat was heavily loaded with provisions and outfit for a three months' trip, and its deck was encumbered by the two wooden canoes, which could not be carried otherwise.

Labrador Peninsula—*Cont.*

"After crossing Hannah Bay, a course was taken to the east of Charlton and Strutton islands, and the east coast of James Bay was reached near Cape Hope, where a hurried examination of the rocks showed them to be chiefly green chloritic and hornblendic schists of Huronian age. From Cape Hope the coast was followed northward to Richmond Gulf, about 500 miles from Moose Factory. Stops were made at Paint Hills, some forty miles south of Fort George, at Fort George and at Great Whale River. At Paint Hills another area of Huronian rock was noted. Several interesting groups of Indians and Eskimo were photographed at Fort George and Great Whale River, and at the latter place an Indian guide, who had, in 1885, been over the route we proposed taking, was engaged for the trip across country to Ungava.

East coast of Hudson Bay.

"The east coast of James Bay is very irregular, being broken by long rocky points, and it is fringed with innumerable islands of rock and drift that extend outward from five to twenty-five miles from the mainland, often with very shallow water between them. To the northward of Cape Jones, the coast is higher and the water along shore much deeper, while the islands are arranged in chains parallel to the coast and often afford excellently sheltered channels for boats. For forty miles to the southward of Great Whale River, and for thirty miles in the vicinity of Little Whale River, there are no islands, and boating is somewhat dangerous, as the shores are high and rocky and landing is impossible with the wind from seaward.

"The past season was remarkable for the small quantity of ice in Hudson Bay and Hudson Strait. On our passage from Moose Factory to Richmond Gulf only one small field was seen, to the southward of Great Whale River, whereas usually ice blocks James Bay and the coast to the northward until July. The ice left the coast about Great Whale River early in the year and did not return. In Hudson Strait, Capt. Gray, of the H. B. Co's Steamer *Erik*, reports that on the passage to Churchill, in July, he encountered practically no ice, and similar conditions prevailed on the return trip late in August.

Richmond Gulf.

"Richmond Gulf is a body of water separated from Hudson Bay by a high ridge of Cambrian rocks. It is roughly triangular in shape, being about eighteen miles along the base, from the entrance eastward to the mouth of the Clearwater River, and about twenty-five miles from north to south. It is connected with the bay by a channel from 200 to 1000 yards wide and about one mile long, formed by a break in the ridge, which rises perpendicularly on both sides to elevations varying from 200 to 1200 feet. The rise and fall of the tide causes a tremendous rush of water in and out through the channel, which renders the passage dangerous to small craft, except at slack water at the change of tide.

Labrador Peninsula—*Cont.*

"The gulf is surrounded by sharp hills of Cambrian rock, which also forms several large islands. The hills rising abruptly from the water on all sides, vary in altitude from 500 to 1000 feet, and are quite barren on top, with small trees growing only in the lower gulleys and about the edge of the water. At the time of our visit, great patches of snow still remained on the tops and steep sides of the hills, and added to the wild and desolate aspect of the scenery of the place. Two days were spent here examining the rocks, collecting specimens and obtaining photographs.

Portage-route to Clearwater Lake.

"We then proceeded to the east side of the gulf where a portage-route to Clearwater Lake begins. This route was surveyed by me as far as the lake in 1888.* Having unloaded the boat we started over the first portage of three miles and a-half, up and over a hill 800 feet high, and ending on a small stream, which has a fall of 315 feet just below. This stream was ascended some twenty miles, passing a fall of sixty-five feet, to another portage of two miles up hill, to the beginning of a chain of small lakes nearly on a level with the country of the interior, or about 800 feet above sea-level. The next week was spent mostly in carrying loads over portages between small lakes, and in this manner Clearwater Lake was reached on July 11th.

Clearwater Lake.

"This lake is about thirty-five miles long from north-west to south-east, and about eighteen miles across in its widest part. The coast-line is very irregular and many islands are scattered over its surface, especially along shore. The surrounding country is broken by rounded hills of granite and gneiss that vary from 100 to 400 feet in elevation above the lake, which is about 800 feet above sea-level. All the hills are bare and rocky with very little soil on or about them, the valleys being chiefly filled with boulders. The summits of the higher hills rise above the tree-line, and are clothed only with white lichens and arctic shrubs. The trees about the lake are all very small black spruce or larch. The water, as the name of the lake implies, is remarkably clear, and is well stocked with fish.

Seal Lake.

"Having finished the survey of the lake on July 20th, we next crossed a portage-route fourteen miles long to Seal Lake. This route follows the course of a small stream, which empties into Clearwater Lake near its north-east corner. It passes through several small lakes

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Annual Report, Geol. Surv. Can., vol. III. (N.S.), pp. 80-82A and 55-62J.

Labrador Peninsula—*Cont.*

connected by rapids, and ends in an irregular narrow bay that stretches southward from the main body of Seal Lake. This lake takes its name from the number of seals living in it. During our stay we saw three seals, but unfortunately could not kill one. From skins seen in possession of the Indians they are known to be either the true Harbour seal (*Phoca vitulina L.*) or a variety of the same species.

"Seal Lake is a long and comparatively narrow body of water lying nearly east-and-west. Its greatest length is about fifty miles, and it varies in breadth from one to five miles. Its western end is situated some twenty-five miles north of Clearwater Lake, where it discharges by the Nastapoka River into Hudson Bay. About the middle of the lake there is a short narrows, with strong current, which practically divides it into two lakes. About fifteen miles from its east end it is split into two long bays, and the northern of these is again divided by a deep bay running north-west from near its mouth. Like Clearwater Lake it is studded with islands, but its water is not nearly so transparent and has a brownish tinge. The surrounding country is similar to that about Clearwater Lake. The hills toward the east end are higher than elsewhere, the trees are smaller and the barren areas more extensive.

Height-of-land Portage.

"Seal Lake was left on August 4th, by a small stream flowing into the head of its northern bay at the east end. This stream was ascended nine miles, through four small lakes, to the watershed between the rivers of Hudson Bay and Ungava Bay. The height-of-land portage is about 900 feet above sea-level, and is only fifty yards long, ending in a narrow lake seven miles and a-half long, out of the east end of which flows the main stream of the Natuakami or Stillwater Branch of the Koksoak River. This stream was surveyed to its mouth.

Stillwater Branch.

"For the first fifty-five miles it is an almost continuous succession of rapids, there being sixty-four such in that distance. The general course is nearly east-north-east with minor bends to the north and south. At first it is small and narrow, but is soon enlarged by the addition of several branches from the northward. At the end of the above distance, it is joined by a large northern branch, and then flows with slackened current for nine miles, when it widens out into a delta as it enters Natuakami or Stillwater Lake. This lake is fifteen miles long and varies from a quarter of a mile to four miles in width, merely occupying an expansion of the river-valley.

"The country surrounding the river, from its head to Stillwater Lake, is very rugged and barren. The river flows in a distinct valley from an eighth to a half mile wide, and the valley is bounded by rocky hills, that rise from 100 to 800 feet above the river, being highest for about twenty miles above Stillwater Lake. Trees are confined to the valleys and are very small.

Labrador Peninsula—*Cont.*

" Below Stillwater Lake, both the valley and the river widen, the former varies from a half to two miles between the hills, and the latter from a quarter to a half mile across. Several heavy rapids occur in the next thirty miles, to the junction of the Kenogami Branch, but none of them are sufficiently bad to entail a portage in descending.

" In the valley, the trees are somewhat larger and in several places small straggling trees of balsam poplar were seen. Between the river and the hills there is usually a wide swamp, from twenty to fifty feet above the river, caused by the impervious stiff clay of the valley. Below Stillwater Lake, terraces are almost continuously seen along the hillsides.

Kenogami Branch.

"The Kenogami Branch joins from the southward, and has at least twice the volume of the stream descended. We ascended it about six miles, and then climbed a hill from which a good view was obtained of its course, showing continuous rapids for several miles. The Indians state that the rapids continue for about thirty miles, or to where the river divides into two branches to the southward of Stillwater Lake.

River below the Kenogami

"Below the junction of the Kenogami, the river averages half a mile in width, and to the mouth of the Kaniapiskau River, sixty-five miles below, it flows generally with an even current from three to four miles an hour, and is broken by three heavy rapids, the last one being nearly five miles long, immediately above the junction with the Kaniapiskau. From the Kenogami the course is nearly north-east for twenty-five miles, when the river takes a sudden bend to the southward as it passes out of the Laurentian region into an area underlain by bedded Cambrian rocks. It then again slowly bends back to a nearly north-east course, and continues so to the forks. The character of the country changes with the underlying rocks, and in the Cambrian area the hills are lower and sharper with frequent cliff-faces. As the Kaniapiskau is approached, these sharp hills increase in height and at the forks attain elevations of more than 1000 feet above the river.

"The river below the Kaniapiskau widens out to about a mile across, and from there to its mouth, ninety-five miles below, it varies in width from one mile to two miles and a-half. The valley is also wide and the hills soon decrease in attitude, so that as the sea is approached they seldom rise more than 300 or 400 feet above sea-level. The river

Labrador Peninsula—*Cont.*

has everywhere a strong current, and its shallow channel is often obstructed by sand and shingle bars and islands. Only one rapid occurs along this portion, being situated at the head of tide, or sixty-three miles above the mouth.

Reach Ungava Bay.

"We arrived at Fort Chimo on August 26th, and finished the remaining thirty-three miles of survey to the mouth of the river on September 5th. From Fort Chimo, passage was taken on the Hudson's Bay Company's steamship *Erik*, on September 13th. On the way down the Labrador coast, stops were made at George River, Nachvak and Davis Inlet, and Rigolet was reached on September 28th. Here an exchange was made to a schooner, which had been luckily delayed, and in which we took passage directly for Quebec, thus escaping a long trip by way of Newfoundland. Rigolet was left on October 2nd, and after a remarkably quick passage Ottawa was reached on the 10th.

Distances travelled and results of the work.

"The distance travelled in all is approximately estimated at 4200 miles—in canoes, 700 miles; in boat on Hudson Bay, 500 miles; by steamship and schooner, 2000 miles, and by railway 1000 miles. The results of the exploration include a micrometer survey of the route from Hudson Bay to Ungava Bay, together with observations on the resources and climate of that region. A large collection of plants was made, useful as an index to the climate and also in extending the range of many species. Collections of bird-skins, birds' eggs, small mammals, shells and insects were also made and are at present in the museum, together with a small collection of Eskimo carved ivory.

Geology.

"The rocks of the country were carefully examined and a number of interesting and practically valuable facts observed in connection with the geology, including the location of a large area of valuable iron-bearing rocks which form an extension of the Cambrian area of the Kaniapiskau River previously discovered.* Iron ores were also discovered in the gneisses along the upper part of the Stillwater River. Attention may further be called to the areas of Huronian rocks at Cape Hope and Paint Hills on the east coast of James Bay, which from their resemblance to those of the same age elsewhere, may yet be found to contain valuable ores.

Glaciation.

"Interesting notes were also made as to the glaciation of this northern region, and it was found that the ice flowed downwards and outwards on both sides of the present watershed.

Climate.

"The climate of the region is such as to totally unfit the country for agriculture. Along the coasts it is almost arctic, owing probably

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* Annual Report, Geol. Surv. Can., vol. VII. (N.S.), p. 67A.

to the low temperature of the sea. Inland, although much less severe, as is shown by the plants, it is yet too cold to grow crops. Snow was seen in gulleys until the middle of August, and on the 8th of that month ice one-eighth of an inch thick formed during the night. Snow flurries occurred throughout July. The value of the region will be found in its minerals and fisheries. All the lakes and streams are abundantly stocked with fish, including large lake-trout, brook-trout. whitefish and suckers. Salmon are abundant in the rivers flowing into Ungava Bay and young salmon were caught on the Stillwater River to within a few miles of Stillwater Lake. A northern trout, probably Hearn's salmon, is very plentiful in the lower parts of the rivers and along the northern coasts from Cape Jones to Ungava Bay. This fish is not quite as fat and fine flavoured as the salmon, but has a good red colour and may be found to answer well for canning. It is as before mentioned, abundant, especially about Ungava Bay, where it varies in weight from 2 lbs. to 15 lbs. and averages about 5 or 6 lbs. Barren ground caribou were found in large numbers along the route eastward from Clearwater Lake to the Kenogami Branch, while everywhere throughout the region the willow grouse or ptarmigan breeds in thousands. Other game is scarce."

Labrador Peninsula—*Cont.*

Fish.

Nova Scotia.

The general geological examination of the south-western part of Nova Scotia, was continued by Professor L. W. Bailey during the past summer. Prof. Bailey, who was assisted by Mr. Roy Van Wart, reports as follows on the work accomplished :—

Work by Prof. Bailey.

"These explorations were made in compliance with your letter of instructions of May 28, directing me 'to continue and if possible to complete, for a final general report, the geological examination of south-west Nova Scotia, filling as far as possible the gaps in our knowledge of the geological structure of the part of Nova Scotia indicated, and giving particular attention to the character and mode of occurrence of minerals of economic value.' At the same time, at my request, the two manuscript reports previously submitted and accepted for publication, were returned for revision, with directions that they should be combined into a single report in connection with the work of the season just passed.

South-western counties of Nova Scotia.

"The special objects to which my efforts were directed and the results relating thereto may accordingly be summarized as follows :—

Particular objects of the work.

"1. The more complete delimitation of the Cambrian system and the granite in portions of Queens and Shelburne counties. The tracts

Cambrian rocks.

Nova Scotia—*Cont.*

more particularly examined for this purpose were portions of Lunenburg county bordering on that of Queens, portions of the coast of Queens county west of Liverpool Harbour, the peninsula between Shelburne Harbour and Jordan Bay, and the region about the Brookfield mine. Among the results attained were the recognition of some anticlines not previously worked out, the more exact limitation of others, and the establishment of the staurolitic and andalusitic schists of Shelburne county as the metamorphosed equivalents of the green slates (Div. 1.*b*) of the Cambrian succession. The facts ascertained have also an important bearing on the age of the similar strata in Yarmouth county.

"2. The determination, by the evidence of fossils, of the rocks referred to the Cambrian system. Much time was devoted to the solution of this question, but without result, prolonged search at many different points or wherever there seemed to be any promise of success, uniformly failing to show any trace of undoubted organic remains.

Boundaries of the Devonian.

"3. To determine the position and extent of the Devonian rocks of Digby county as distinguished from the rocks of supposed Cambrian age, and to fix the boundary between these two systems. This was found to be a work of much difficulty, and the conclusion reached can hardly yet be regarded as final. While evidence is abundant as to the co-existence of both systems in the region referred to,—the evidence in the one case being the occurrence of fossils and in the other the close correspondence, both in the nature and succession of the beds, to the so-called Cambrian rocks of Queens and Shelburne counties,—there are many points of resemblance between the two, while the difficulty of identification is greatly enhanced by the metamorphism to which both groups of rocks have been subjected. The areas as to which this uncertainty still attaches, include certain tracts about Mistake River, a branch of the Sissaboo, the vicinity of Cape Cove near Cape St. Mary, and portions of the high land between the Grand Joggins and Bear River. The data obtained during the past summer have not yet been sufficiently studied to permit of any definite conclusions being stated here.

Age of the Devonian and Silurian.

"4. To ascertain the exact age of the rocks referred to the Devonian system at Mistake settlement, Bear River and Clementsport, whether wholly Devonian or partly Silurian; to fix the order of succession of these beds, and their structural relations.

"These points were of the first importance, not merely as tending to settle questions as regards the age of the beds themselves, about which in past years there has been much controversy, but also as bearing upon economic questions, such as the distribution of iron ores, and as helping to afford data for the more certain separation of the Devonian and Cambrian strata as referred to above. For the reasons mentioned, a large part of the summer was devoted to the study of these rocks, and the results were most satisfactory. In addition to large collections of fossils from localities previously known, many new localities were ascertained, and these in such relations to each other and to the principal ore-beds, as to leave no doubt as to the general structure of the whole region. In pursuance of these investigations it was found necessary to devote especial attention to the rocks at and about Nictau, and thence to the vicinity of the Torbrook mines, while a short excursion for the purpose of comparison was made as far eastward as New Canaan. Through this great tract, for a distance of over fifty miles, the beds were found to be essentially the same as regard both their nature and succession, the latter occurring in inverse order on either side of a general axial line, and thus revealing a general synclinal structure. The fossils referred to are now in the hands of Dr. Ami for examination. Other results were the recognition of fossiliferous strata well within the areas assigned in all previous maps to the granite, and the working out of the often intricate contacts of these two groups of rocks.

Nova Scotia—*Cont.*

"5. The occurrence of economic minerals. These embrace gold, iron, copper, ornamental stones, sand, brick-clays, infusorial earth, and asbestus.

Economic minerals.

"*Gold.*—In addition to the work of ascertaining and defining the position of anticlines not previously made out, a visit was made to the Brookfield mines in Queens county, which have recently assumed a position of great importance as a gold producing centre. This visit afforded a striking illustration of the uncertainties of gold mining, as also of the fact that mines regarded for a time as unproductive may under more effective treatment prove highly remunerative. Thus, at the time of my first visit to Brookfield in 1890, the work then in progress was confined to what was known as the Philadelphia mine, employing about 40 hands, to reach which it was necessary to pass the McGuire mine where work had wholly stopped for want of satisfactory returns. On the second visit, made last summer, but little was being done at the Philadelphia mine, while the McGuire mine was making returns of from $7,000 to $10,000 per month. About 50 men are at present employed here as miners, with as many more in other ways, the proprietors being so encouraged by what has been already done as to have entered upon the construction of a new and large mill of 40 stamps, in which the ore will be subjected to combined processes of

Gold.

Nova Scotia—*Cont.* amalgamation and chlorination. It is also proposed that all the tailings resulting from former workings shall be subjected to the same process.

"At Molega also, as well as at Whiteburne, there have been similar vicissitudes, the Parker Douglas mine, which for several years past has been lying idle, having resumed work. The Ballou mine is also being worked here, with good results. At Whiteburne, on the other hand, formerly a centre of much activity, but little is now being done, a 10-stamp mill being the only one in operation, on ore from what is known as the 'Graves Mine,' formerly owned by the Whiteburne Mining Company.

"In Yarmouth county, work, chiefly of a prospecting character, was being carried on both at Kempt and at Carleton, but as yet with very meagre results.

"Gold is reported to have been found in small quantities in some parts of Digby county, but reliable information on this point is wanting.

Iron.

"*Iron.*—The study of the iron ores of Annapolis county was wholly incidental to the working out of the geological structure of the region, but led to some important results. Thus ores of this character were recognized as occurring on not less than thirty-four different properties, these being further so disposed as to indicate the existence of several parallel belts, which are, in part at least, repetitions of the same beds along the crests of anticlinal folds. The diversity in the nature of the ores, whether red or black hæmatite or magnetite, seemed apparently to have no direct relation to the neighbourhood of granite, all these varieties being sometimes found in close proximity to each other. At Nictau, the ores are abundantly fossiliferous, even though the rock be magnetite. At Torbrook the rock, though hæmatite, is without fossils, these being confined to the associated beds. Some of the latter, were it not for the fossils, could not well be distinguished from the hardest quartzites of the Cambrian system. Work at Torbrook had been suspended and the pumps removed from the mines, as a result of diminished demand for the product.

Copper.

"*Copper.*—The trappean rocks of the North Mountains and Digby Neck, frequently exhibit green stainings resulting from the presence of this metal, and occasional strings of native copper are met with. One of the best localities for the latter is the shore about the eastern side of the entrance of Digby Gut. There is, however, no reason to suppose that any workable veins will be found either at this point or elsewhere in the rocks referred to.

"*Ornamental stones.*—Varieties of quartz, such as agate chalcedony, amethyst and jasper, were frequently observed, but not of such quality as to deserve special notice here. Thomsonite, sometimes associated with *analcime*, was found rather abundantly either side of the entrance of Digby Gut. At Paradise, in Annapolis county, veins in the granite sometimes exhibit quartz penetrated by black acicular crystals of tourmaline. Garnets were observed abundantly in different parts of Yarmouth county, but of poor quality.

Nova Scotia—*Cont.*

Ornamental stones.

"*Sand.*—The only deposits of this material deserving special notice here, are the dunes or hills of blown sand which occur at various points upon the southern coast. The largest beds are those found on the west side of Port Mouton Harbour and the east side of Barrington Bay. In each case they cover many acres of surface, and are piled up to heights of from 50 to 60 feet. Though destructive to the soil and trees of the region they invade, their purely siliceous character would seem to fit them admirably for glass making, for the manufacture of artificial stone and for kindred purposes.

Sands and clays.

"Fine white sands were also observed at several points in the Annapolis valley, especially near Middleton.

"*Brick-clays.*—Clays suitable for brick making are also found in the vicinity of Middleton. They are tough, brick-red in colour and of unknown depth. Bricks are manufactured here in considerable quantities. About a mile south-east of Marshalltown Church, Digby county, is a deposit of fire-clay. This has not been visited by me, but it is described by Mr. J. Lonergan, of Saulnierville, as extensive. Specimens received from this gentleman are reported by Dr. Hoffmann to be non-calcareous, fusible with difficulty and susceptible of employment in the manufacture of fire-brick.

"*Infusorial earth.*—Specimens of this material, said to have been found in the vicinity of Meteghan River, in Digby county, and of good quality, have been shown to us, but we are without definite information as to location or amount.

Other minerals.

"*Asbestus.*—Veins of this mineral occur in connection with dioritic rocks between Clementsport and Bear River, and some specimens of good quality as to purity and length of fibre, have been shown to us, but such as we have seen *in situ* have been small in amount and of inferior character.

"*Scheelite.*—Among some specimens sent to the Geological Survey by Mr. W. H. Prest, from the Ballou mine, Molega gold district, Queen's county, Dr. Hoffmann has detected this mineral, valuable as an

Nova Scotia—*Cont.*

ore of tungsten. It is not known to be present in any considerable quantity but may be worth looking for in connection with future mining operations.

"The following additional results of the summer's work may be noticed here as of some interest :—

Rocks possibly newer than the Trias.

"In connection with the examination of the red sandstones and associated beds about Digby and in the Annapolis valley, and which have generally been regarded as having antedated in origin the traps of the North Mountain, these were at several points found to contain numerous and in some instances very large blocks of the same traps. It would seem to follow from this observation that the beds in question are either of later origin, as has been supposed by Dr. Ells in the case of certain *whitish* sandstones observed by him in Scott's Bay, near Blomidon, *resting on the traps*, or that they are agglomerates of contemporary origin. As similar beds, often whitish, but as far as known without embedded traps, occur all the way from Digby to Kentville, underlying the fertile Annapolis valley, the observations referred to and the conclusions to be drawn have a wide application.

Marine organisms in clays.

"In the brick-clays in the vicinity of Middleton, remains of marine shells and star-fishes, (Ophiurans) have been found, as well as remains of true fishes. This would indicate that the Annapolis valley was in the post-Tertiary (Champlain) period wholly occupied by salt water, the North Mountains being then an island in the Bay of Fundy.

"The work of revision of the two large reports previously submitted, and covering the whole of the four south-western counties, is now in hand, and will be carried on to completion, in connection with the work of the past season, as rapidly as circumstances will permit."

Work by Mr. Fletcher.

Mr. Hugh Fletcher was engaged during the winter of 1895-96 in plotting his surveys and in revising those made by his assistants in Cape Breton; in reducing his plotting sheets, the Dominion Coal Company's map and plans of Sydney Mines, North Sydney, and other places, as well as in compiling on a scale of one mile to an inch, many surveys made in Cumberland county by the late Mr. Scott Barlow, Mr. McOuat and others in the immediate neighbourhood of Springhill Mines, on twenty chains to an inch, with a view to further operations in that part of Nova Scotia. Some time was also spent in connection with the preparation of the map-sheets including the Pictou coal-field. As preparatory to this, all Mr. Poole's field-maps were compared with Mr. Rutherford's twenty-chain plan. Sir William

Logan's large plan and other sources of information were also consulted and the map finished to date by the addition of roads, brooks, crops, faults and other geographical and geological features.

Nova Scotia—*Cont.*

Sections constructed from borings.

During the winter, connected sections were also made from the various holes bored by the diamond drill in the Sydney coal-field, for comparison with others measured on the sea-coast. One of these, Mr. Fletcher states, seems to show that in the bore-hole near the crossing of the Hines road and old Louisburg railway, the Tracy seam lies only about four hundred and fifty feet from the surface, where it had previously been supposed to be more than fourteen hundred. A recent opening at the Tracy mines gave an opportunity to examine the coal of this seam which showed :

Top coal....................	2 feet	7 inches
White fire-clay..............	0 "	3 to 9 "
Bottom coal................	0 "	11 "

By miners who have worked in this seam and by Lyman, the clay parting is said to run out or decrease to one or two inches in thickness. The quality and thickness of the coal at the bore-hole above mentioned are still to be tested by careful boring or by a deep trial-shaft.

Respecting operations during the past summer, Mr. Fletcher writes as follows :—

Outline of field-work.

"Leaving Ottawa on June 10th, 1896, to resume field-work in Nova Scotia, I remained in Cape Breton until August 1st, to make additional surveys, particularly in the neighbourhood of the Cow Bay, Morrison and Macpherson roads, and on the west side of Sydney Harbour, necessary to complete information for the new editions of the Little Glace Bay, Sydney, and Cape Dauphin map-sheets in the Sydney coal-field, and returned twice afterwards (Sept. 23-25 and Dec. 4) to examine the results of explorations subsequently made by Mr. E. T. Moseley and the Messrs. Burchell at the west end of the Cow Bay basin and along the anticline between the Lingan and Glace Bay coal-basins. I was in Pictou county with Dr. Dawson and Dr. Ami (August 3rd to 19th and again on September 19th,) to make supplementary surveys required near New Glasgow, also from Nov. 20th to 25th, to discuss with Mr. Poole geological relations of the rocks of certain portions of the sheets of the Pictou coal-field. The remainder of the season was spent in an examination of the country covered by the Springhill map-sheet, between Thompson and Athol railway stations; and from November 9th to 18th, a section was measured of the strata exposed on the shores of Chignecto Bay, between Shulee and Spicer's Cove, for comparison with Sir William Logan's Joggins section

Nova Scotia—*Cont.*

on the opposite side of the basin, with the object of endeavouring to fix the age of the various groups of rocks.

Observations in Cape Breton.

"In Cape Breton, the coal seam at the head of Bridgeport Basin (Summary Report 1895, p. 109) has been successfully traced round the anticline by Mr. Burchell's explorations, and its identity with the seam found in Macdougall's pits, I find apparently established. The bottom of the Cow Bay basin has been defined more precisely, as well as the position of the anticline between the basin and that of Glace Bay, by a continuation of the explorations of Messrs. Moseley and Kennelly; but more work is necessary to prove the existence of workable coal seams among the lower strata of these basins. It has been already stated that the axis of the former anticline lies further north than was at first supposed. To verify this, pits were sunk at Allan Nicholson's, Lauchlin McLean's and Angus McDonald's (Shoemaker) some distance north of the Cow Bay road, in all of which a low northerly dip was obtained. Consequently, the coal-seam of the Martin pit and those underlying it, must be carried for some distance to the westward, unless an easterly dip of the bottom of the basin throws the crops to the surface, of which there is no proof from the dip observed, while a line of strong springs points to the continuity of the strata as far as John D. McDonald's.

"It was also stated in last Summary Report, that the steep dips of the Cow Bay basin pass the old Louisburg Railway. Southerly dips have also been found on the west side of the Macpherson road. Here and on both sides of the Cow Bay and Morrison roads, certain belts of rock were followed as an indication of the structure, and the Buchanan seam was traced by the shale or coherent flag which overlies it. Near the shore of Bridgeport Basin, above Lingan Bar, a seam of coal about four feet thick, but twisted, dirty and unfit for burning, with a roof of coherent argillaceous shale and sandstone, was lately opened in a shaft and level on the line between the General Mining Association and Mr. Rabbit.

"Several bore-holes, some of them more than two hundred feet in depth, have been sunk by the Messrs. Routledge in search of the Tracy seam, in the grey sandstone of the North-west Brook and towards Sydney Harbour. At Mira Bay red strata cease some little distance above the Tracy seam, very few bands being found beneath it, whereas at the Cow Bay road it is overlain—if it be the equivalent of the Fitzpatrick seam, as has been generally assumed—by a great thickness of gray sandstone with thin layers of grey argillaceous shale, as far as Mr. Hugh Cusack's, where a belt of gray coherent flag is associated with one of red sandstone and shale. The line of replacement of the red rocks by the gray has not yet been definitely determined.

Nova Scotia—*Cont.*

"A section was made of the strata overlying the Coalbrook seam of Mira Bay, not before closely measured, but necessary for comparison with the rocks of the bore-holes along the old Louisburg Railway. They were found to be all regular, to contain no coal and to lie flatter than estimated, so that only 457 feet 4 inches was found instead of 683 feet of the alternations immediately overlying the Coalbrook seam given in the Report of Progress for 1874-75 (p. 177).

Coal mining.

"The Dominion Coal Company continues to develop its mines, and a larger coal-washer has been erected at Morrison Lake. There was no interruption to the shipment of coal from Louisburg last winter. At the North-west Arm of Halifax Harbour, the People's Heat and Light Company has built works capable of converting annually 20,000 tons of coal from their mine into "crushed coke" for domestic, foundry and manufacturing purposes and all the uses to which anthracite is generally applied, gas for illuminating and heating purposes, and coal tar, sulphate of ammonia, ammonia, ferrocyanide of potash, benzol and other bye-products.

Copper ore.

"On December 10th I visited, in company with Mr. C. P. Moffat of North Sydney, the copper mine at George River, where a considerable quantity of chalcopyrite, remarkably free from admixture with other sulphides, has been taken from a shaft 80 feet deep, on a vein said to vary in thickness from 12 to 28 feet, with 6 feet very rich, but not accessible at the time of my visit because the shaft was full of water. The ore is associated chiefly with quartz, calcite, chlorite, serpentine and other minerals of the George River limestone formation (Laurentian?) described in the Report of Progress for 1875–76, pages 381 to 387. Specimens of this ore were collected for the museum.

Other mineral products.

"At Long Island Barachois, 300 or 400 tons of rich hæmatite have been taken from the contact between the Carboniferous and pre-Carboniferous rocks.

"From St. Anns about 10 tons of infusorial earth were shipped last year by the Victoria Tripolite Company, from a deposit three or four feet thick, in a lake.

"About 60,000 bricks were made last summer by Mr. A. D. McLeod from a large clay deposit near the Cossitt mine, about 2¼ miles south-east of Sydney.

"Graphitic shales, said to be suitable for the manufacture of carbons for electric lights, have been worked near Christmas Island, Nova Scotia—*Cont.* among quartzites and dark slates underlying soft, red, Carboniferous marl and conglomerate and perhaps of Cambrian age.

Work in Cumberland county.

"Of the work in the neighbourhood of Springhill Mines, but little can be said at present, as the district requires more study and closer examination. The scarcity of outcrops and similarity of composition of the different groups of rocks, makes the determination of the geological structure difficult and has led to the different views held regarding their age and relative position. Surveys were made of various branches of Black and Maccan rivers, River Philip, Polly Brook, and other streams not already mapped by Dr. Ells and the late Messrs. Scott Barlow and Walter McOuat, whose reports contain much valuable information concerning the geology of the district. A general description of the rocks of the section on the Chignecto Bay, may be found in the Summary Report for 1892 (p. 42).

Infusorial earth.

"Near Castlereagh in Cumberland county, a large deposit of infusorial earth has been worked in Bass River Lake, which has been drained for the purpose. Buildings have been erected for the workmen and for cleaning and drying the 'silica,' a considerable quantity of which has been transported over a pole railroad to a shipping-place on Minas Basin.

"I have again to express my appreciation of the work done by Mr. M. H. McLeod in the capacity of assistant in the field."

Work by Mr. Faribault.

Mr. E. R. Faribault's office work, since the date of the last Summary Report, has been wholly in connection with the compilation of the results of his surveys in the gold-bearing regions of Nova Scotia. The first part of the winter of 1895-96 was spent plotting the surveys made during the previous summer, and revising those made by assistants, as described on pages 111-114 of the last Summary Report. Much time was also occupied in compiling, from these surveys and other sources, the manuscripts for the four following sheets, on the scale of one mile to an inch :—

Map-sheets in course of completion.

No. 53—Lawrencetown sheet.

" 54—Preston sheet.

" 55—Middle Musquodoboit sheet.

" 56—Stewiacke sheet.

These sheets are now almost completed for the engraver. They cover an area of 864 square miles, extending along the Atlantic coast from Musquodoboit Harbour to Halifax Harbour, and inland to the

Stewiacke and Shubenacadie rivers, and are included in the counties of Halifax and Colchester. A structural section has also been made for the Fifteen-mile Stream sheet, and similar sections have still to be prepared for the seven sheets numbered 49, 50, 51, 53, 54, 55 and 56, in order to complete these.

Nova Scotia—Cont.

A special plan of the central part of the gold-mining district of Goldenville was also plotted on the scale of 150 feet to an inch, and a cross-section prepared.

Mr. Faribault's report on the work accomplished during the season is as follows :—

Districts surveyed in 1896.

"According to your instructions, received May 23rd, I left Ottawa on May 25th, to resume field-work in Nova Scotia and to continue the mapping and study of the structural geology of the gold-bearing rocks of the Atlantic coast region, including the completion of the surveys required for the sheets numbered 67, Waverley sheet, 68, Halifax City sheet, 69, Prospect sheet and 88, Mahone Bay sheet; but a severe illness prevented me from reaching my field of operations before June 17th. My assistants, Messrs. A. Cameron and J. McG. Cruikshank, however, began field-operations on the date appointed, June 5th, and they completed the surveys required for the Waverley sheet, the Halifax City sheet and the Prospect sheet, on August 14th, when they proceeded to survey the Mahone Bay sheet. The intervening granitic country between this sheet and the Halifax City sheet, being of relatively small importance geologically or from an economic point of view, has been passed over for the time being, in conformity with instructions received.

"Continued heavy rains in September and October interfered greatly, however, with the progress of work in the field, and bush-work had to be discontinued on September 29th. From that date Mr. Cruikshank was engaged surveying the sea-shore from East Chester westward, reaching La Have River on October 26th, and Mr. Cameron resumed the surveys, by odometer, of the roads included in the Mahone Bay sheet, and those in the Lunenburg sheet on the east side of La Have River, ceasing field-work on November 19th.

"My own time in the field was principally devoted to the study of the structural geology of the Waverley sheet and the Halifax City sheet. The area covered by these two sheets and the Prospect sheet, is nearly all included in Halifax county, the north-west corner of the Waverley sheet only being included in Hants county. It comprises the country surrounding Halifax City and extending along the Atlantic coast from Devil's Island, at the eastern entrance of Halifax Harbour,

Nova Scotia—*Cont.*

to Dover Bay, and inland to the Shubenacadie Grand Lake and Mount Uniacke.

Waverley sheet.

"The Waverley sheet is almost entirely occupied by rocks of the gold-bearing series, only a small area at its eastern limit, to the east of Soldier Lake, being covered by the western extremity of the granite ridge extending from here to Sheet Harbour; while, at its western end, the gold-bearing rocks are cut by the mass of granite forming the back-bone of the country, extending from here to Yarmouth.

Halifax City sheet.

"The Halifax City sheet is about equally divided, the north-east part being occupied by gold-bearing rocks and the south-west part by the most eastern extremity of the last above-mentioned granite ridge, which also entirely covers the Prospect sheet.

"The gold-bearing rocks of the region examined have been forced into a series of folds, almost parallel to each other, bearing a general easterly and westerly course. Eight double folds, each composed of one anticline and one syncline, were located across the belt of twenty-five miles extending from the coast to Mount Uniacke. The structure of these plications was carefully studied and the anticlinal axes were traced and worked out with as much accuracy as possible, on account of their importance in regard to the occurrence of gold.

Anticlines between Cow Bay and Mount Uniacke.

"The names given to the eight anticlines, in order of their occurrence from Cow Bay to Mount Uniacke, and their location, with notes in the gold mines worked and quartz veins observed along their course, are as follows:—

De Said Lake anticline.

"1. *De Said Lake Anticline*—Crosses the middle of McNab Island about the Garrison pier, where only the upper strata of the lower quartzite group are brought up to the surface on the axis; and, extending eastward, it passes at the outlet of De Said Lake. The fold ends at the beach, before reaching Cole Harbour, where a few quartz veins, especially on the east side of the harbour look promising. About three-quarters of a mile south of this anticline, a true fissure vein running north and south and cutting at right angles the highest strata of the lower quartzite group at their junction with the upper slate group, was discovered to contain gold in the autumn of 1895. Since then a number of other fissure veins quite similar and parallel to each other have been found to be auriferous at this place on the Hill and Thompson, the Foster and other properties. A crusher was built last summer, and development is being pushed with activity.

Lawrencetown anticline.

"2. *Lawrencetown Anticline*—Crosses the city of Halifax between Buckingham and Jacob streets, and running westward traverses the north end of the Citadel Hill and the Commons about Egg Pond, whence following the south side of Quinpool Road about Shirley street, it crosses the North-west Arm at Melvin Island Cove, where it is cut off by granite. Only rocks of the upper slate group are brought up to the surface by this fold in the city of Halifax, but on the east side of the harbour, it has brought up to view the lower quartzite group. Passing near the lunatic asylum, the axis then crosses the middle of McDonald Lake and the Big Salmon River at its discharge into Cole Harbour, on its course to Lawrencetown gold district. Gold has often been found in the rock débris while trenching along Quinpool road and the streets to the south; and a few small quartz veins cut across between Pepperell and Shirley streets are reported to have exhibited a few 'sights' of gold. Promising quartz veins, a few of them prospected, have been observed at the head of Cole Harbour. Nova Scotia—*Cont.*

"3. *Montague Anticline*—Crosses the west side of Bedford Basin at Birch Cove, and comes in contact with the granite but a short distance west of the basin. Eastward, it passes about Navy Island in the basin, at the foot of Lake Charles and through the Montague gold district. The belt of numerous quartz veins so extensively worked in length and depth at Montague for over thirty years, is wholly comprised in the south dip of this fold, nothing but exploratory work having so far been done on the northerly dipping veins. A rich vein, however, was reported to me to have been found on the north dip last autumn. Numerous very promising quartz veins, many of them of a barrel-structure, have been noticed on the west side of Bedford Basin at Birch Cove and on Carney Road, also directly west of the cove as far as the granite, and on the east side of the basin, about Taylor and Spectacle lakes. Montague anticline.

"4. *Waverley Anticline.*—From the edge of the granite south of Hammond's Plains, this runs eastward and crosses the Hammond's Plains road, at its junction with the new road to Bedford. Then it crosses Sandy Lake, and from the Windsor road it follows the old Cobequid road to the Intercolonial Railway, passing thence through the gold district of Waverley and terminating at the south end of Soldier Lake, where it is cut off by granite. The wide belt of quartz veins occurring at Waverley has been extensively worked both in depth and length, especially on the north side of the axis, but a number of veins have also been worked on its south dip, some of them having been traced on the surface completely around the westerly end of the elliptical dome of the fold. Waverley anticline.

"*Caribou Anticline.*—This fold only brings up here the upper black slate group. Leaving the granite west of Hammond's Plains, it passes Caribou anticline.

Nova Scotia—*Cont.*

the post office of this place and crosses the Sackville River at the outlet of Middle Sackville Lake, runs about the middle of Lake Fletcher and Kelley Long Lake, and crosses the road to Oldham, half a mile north of Goff post-office. A few quartz veins have been prospected along this line, and some have been found to contain gold on the road to Oldham and at Hammond's Plains, but most of them are small and not promising.

Horn settlement anticline.

"6. *Horn Settlement Anticline*—Leaves the granite at the west end of Pockwock Lake, and, following the south side of this lake eastward, it crosses the Windsor road at the south end of Lewis Lake, the Windsor and Annapolis Railway at the saw-mill, one mile north of Long Lake, the Beaver Bank River at the north end of Square Lake and the Beaver Bank road on Joe. Shaunahan's farm. Thence, passing on the north side of Sandy Lake and following down King's Meadow Brook, it strikes the north-west side of Shubenacadie Grand Lake at Sleepy Cove, and its south-east side at the Horn settlement. Very promising quartz veins, showing free gold, were opened up at the Horn settlement a few years ago, but no exploratory work of any importance has since been done on them. Gold-bearing drift is reported to have been found in many places along this line between the Beaver Bank road and Shubenacadie Grand Lake, mining areas have been taken up from time to time, and a few quartz veins tried between Sandy Lake and Gold Lake. Quartz veins were also observed south of Lewis Lake and along Pockwock Lake, some having a barrel structure.

South Uniacke anticline.

"7. *South Uniacke Anticline.*—Leaves the granite east of Lacy Mill Lake, crosses the Windsor road one mile north of the county-line, passes 700 feet south of the belt of quartz veins worked at South Uniacke, to the east of which it degenerates into an undulation crossing the Beaver Bank road half a mile south of North Beaver Bank post-office. Only a few veins have so far been worked at South Uniacke, one of them, however, the Hard lead has been mined 1000 feet along a very rich and most regular and persistent pay-streak, dipping at an angle of 30° and averaging 50 feet broad and 4 to 5 inches thick, with a uniform yield from the outcrop to the bottom of the pay-streak of 7 to 12 ounces to the ton. It is most probable that good pay-streaks exist in this district in parts of other quartz veins which occupy the same structural position as that held by the pay-streak of the Hard lead with reference to the anticlinal fold. On veins south of the Hard lead, pay-streaks should then be looked for to the west of the outcrop of the pay-streak of that lead; and on veins north of the Hard lead, pay-streaks should be sought for to the east of the same outcrop. These conclusions have been arrived at from the study of the structure of the principal gold districts in the province. They are of the most practical importance in locating pay-streaks in a gold district, and should be well understood by gold miners. As the anticline at South Uniacke dips east, so does the pay-streak, and the interbedded quartz veins, like the strata, curve to the south-east around the eastern end of an elliptical dome; but, as the south side of the anticline has an almost flat easterly dip, the veins will not in this district curve completely around the anticline, and there will be no southerly dipping veins.

Nova Scotia—*Cont*

"8. *Etter Settlement Anticline.*—Leaving the granite at the north-east cove of West Lake, this crosses the Windsor road 500 feet north of the Etter settlement church and Lewis Mill road at the bridge on the head of Sackville River, where the lower quartzite group is capped by the upper slate group to the eastward beyond the limit of the Waverley sheet. No quartz vein has been observed along this line within the latter sheet.

Etter settlement anticline.

"Detailed observations have been made of the structural geology of the city of Halifax and its immediate surroundings, by taking advantage of the many miles of trenching made along the streets by the People's Heat and Light Co., to lay their pipes.

"I have done so far but little geological work in examination of the area covered by the Mahone Bay sheet, (No. 88), the surveys of this sheet having been made entirely by my assistants. It has been observed that the upper slate group of the gold-bearing rocks predominates in the area covered by this sheet, and the lower quartzite group is only brought up in narrow belts along anticlinal folds. On the northern limit of the sheet the gold-bearing series comes in contact with the granite mass of the interior; and along the sea-shore, at Indian Point and East Chester, it is overlain by small patches of Lower Carboniferous limestones, conglomerates and sandstones, apparently denuded outlyers of a great Carboniferous basin extending far into the Atlantic. Beds of Carboniferous limestone are quarried at East Chester on Indian Point and on the shore of Goat Lake. The gold mining districts of Chester Basin and Blockhouse are included in this sheet, but have not yet been surveyed. Operations were being carried on at both places last summer.

Rocks near Mahone Bay

"A few faults, bearing a general north-and-south course, cut the stratification at right angles, and some time was taken up in tracing these and working out the magnitude of the displacements. Some very interesting facts have also been gathered bearing on the surface geology.

Nova Scotia—*Cont.*

Report in progress.

"A report is now in progress, which will, it is hoped, be ready for the printer next spring, on the gold-bearing rocks covered by the following eight sheets, which are in different stages of advancement toward publication.

No. 39 Tangier sheet.
" 40 Sheet Harbour sheet.
" 41 Fifteen-mile Stream sheet.
" 42 Trafalgar sheet.
" 48 Eastville sheet.
" 49 Upper Musquodoboit sheet.
" 50 Moose River sheet.
" 51 (& 52) Ship Harbour sheet.

"The area covered by these sheets contains the gold districts of Tangier, Killag, Fifteen-mile Stream, Caribou, Moose River, Mooseland, Salmon River, Ragged Falls, Little Liscomb Lake, Beaver Dam and Gold Lake. Plans of the six first-named districts have also been prepared on the scale of 500 feet to an inch, the intention being that they shall accompany the report above referred to."

Chemistry and Mineralogy.

Report of Dr. Hoffmann.

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, in pursuance of the practice of former years, almost exclusively confined to the examination and analysis of such minerals, ores, etc., as were considered likely to prove of more or less economic value and importance. Briefly summarized, it embraced:—

Character of analyses and assays made.

"1. Analyses of natural waters—with the object of ascertaining their suitability for domestic or manufacturing purposes or probable value as a remedial agent—from various parts of the provinces of Nova Scotia, Quebec and British Columbia.

"2. Analyses of various fossil fuels from the province of Nova Scotia, the North-west Territory and the province of British Columbia.

"3. Analyses of iron ores from the provinces of New Brunswick, Quebec, Ontario (chiefly from the townships of Bedford, Palmerston, Storrington and Portland, in Frontenac county; the townships of South Sherbrooke, Bathurst, Darling and Lavant, in Lanark county; and the township of Bagot, in Renfrew county), and British Columbia.

"4. Analyses of limestones and dolomites—in continuance of the series of analyses of limestones and dolomites already carried out, in connection with an enquiry into the individual merits of a number of these stones, from various localities, for structural purposes, for the manufacture of lime, or of hydraulic cement, *etc.*

Chemistry and mineralogy—*Cont.*

"5. Assays, for gold and silver, of ores from the provinces of Nova Scotia, New Brunswick, Quebec and the Ungava district of the Labrador Peninsula; from the districts of Nipissing, Algoma, Thunder Bay, Rainy River, and other parts of the province of Ontario; from the districts of Alberta and Athabasca, in the North-west Territory; and from the East and West Kootanie districts, Interior Plateau region and Coast Ranges and Coast region, of the province of British Columbia.

"6. Analyses of several highly interesting and, in most instances, from a commercial standpoint, important minerals, comprising, among others—'altaite,' a lead telluride, from a new locality; 'scheelite,' a tungstate of calcium, also from a new locality; and the following, not previously recognized as occurring in Canada, namely, 'tetradymite,' a bismuth telluride; and a mineral obtained by Mr. R. G. McConnell, which proves to be 'stromeyerite,' a sulphide of silver and copper; and which was found to contain over fifty-one per cent of silver. A specimen has also been received of another somewhat recently discovered mineral, which is new to Canada, that is to say 'hessite,' a silver telluride, which also contains a very high percentage of silver, and not unfrequently more or less gold. An analysis has also been entered upon of another mineral, collected by Mr. McConnell, which is evidently a highly cobaltiferous mispickel, most probably referable to 'danaite,' and which also carries free gold. This, if occurring in quantity, would, apart from its gold content, be of some economic importance as an ore of cobalt. Among other minerals identified in this laboratory, and which were not previously known to occur in Canada, may be mentioned 'bismite' or bismuth-ochre, a trioxide of bismuth; 'smithsonite,' a carbonate of zinc, and some few others of lesser importance.

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

"8. Miscellaneous examinations, such as the partial analysis or testing, as the case might be, of samples of manganese ore, graphite, carbonaceous shales, iron-sand, clay, marl, and of other material not included under the above headings.

Mineral specimens examined.

"The number of mineral specimens received, during the past year, for identification or for an expression of opinion in regard to their economic value, amounted to six hundred and ninety-seven. Of these, Chemistry and mineralogy—*Cont.*

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—chiefly 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 two hundred and ten; and the number of those received to one hundred and fifteen.

Work of assistants.

"Messrs. R. A. A. Johnston and F. G. Wait, assistants in the laboratory, have, by their application and assiduity in carrying out the work respectively entrusted to them, proved most efficient aids. Of these, the former has, apart from the carrying out of a very lengthy series of gold and silver assays, made many important mineral analyses, and likewise conducted a great variety of miscellaneous examinations; whilst the latter has made very many analyses of natural waters, iron-ores, limestones, etc., as also many miscellaneous examinations.

"In the work connected with the mineralogical section of the museum, I have been, as heretofore, diligently assisted by Mr. R. L. Broadbent. He has, in addition to the general museum work—such as the labelling and cataloguing of all newly received specimens, and the maintaining of the collection generally in an orderly condition—been engaged in correcting printer's proof of labels for the collections illustrating the distribution of iron, copper, lead, antimony, and other ores; and in preparing the manuscript of similar labels for the collection of gold and silver ores from certain sections of the province of British Columbia, and from the Thunder Bay district of the province of Ontario.

Contributions to museum.

"The additions to this section of the museum—which now contains some nine thousand specimens, of which about seven thousand are on exhibition in the cases, and two thousand placed away in drawers—during the past year, amounted to one hundred and thirty-one. Of these, the following were:—

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

Ami, Dr. H. M.:—

a. Pyrolusite from Teny Cape, Hants county, N.S.
b. Limestone from the St. Louis de MileEnd quarry, Montreal, Q.
c. Limestone from the St. Laurent quarry, Montreal, Q.

d. Raw cement stone from the Gale Farm, Hochelaga, Montreal, Q. Contributions to museum—*Cont.*

Barlow, A. E., and Adams., Dr. F.D. :—

a. Sodalite from the township of Dungannon, Hastings county, O.
b. Nephelite " " "
c. Hastingsite " " "
d. Magnetite " " "
e. Pyroxene from the township of Herschell, Hastings county, O.
f. Biotite " " "
g. Diabase showing concretionary structure from two miles west of Sudbury, district of Algoma, O.

Ells, Dr. R. W. :—

Calcareous nodule attached to crystalline limestone boulder from Besserer's Wharf, Ottawa River, Carleton county, O.

Faribault, E. R. :—

a. Limestone from quarry at Indian Point, East Chester, Lunenburg county, N.S.
b. Limestone from quarry at Goat Lake East Chester, Lunenburg county, N.S.

Ferrier, W. F. :—

a. Andradite from the Emily mine, Tudor, Hastings county, O.
b. Stilpnomelane (var. chalcodite) from the Wallbridge mine, Madoc, Hastings county, O.
c. Pyroxene from the township of Carlow, Hastings county, O.

Low, A. P. :—

Crystal of pyrite from the Ungava River, Labrador Peninsula.

McEvoy, J. :—

a. Alunogen from Blair Creek, a branch of Bolean or Six-mile Creek, Salmon River, Grande Prairie, Yale district, B.C.
b. Clinochlore from Fadear Creek, a branch of Louis Creek, North Thompson River, B.C.

McConnell, R. G. :—

a. Stromeyerite from the Silver King mine, Toad Mountain, West Kootanie district, B.C.
b. Cobaltiferous mispickel with erythrite from the Evening Star mine, Rossland, B.C.
c. Sphalerite from the Enterprise mine, Ten-mile Creek, Slocan mining district, B.C.

Contributions to museum—Cont.

McInnes, W. :—

a. Tourmaline from a small island near Partridge Point, Eagle Lake, Rainy River district, O.

b. Auriferous quartz from the main shaft, Regina mine, loc. 566 P, Whitefish Bay, Lake of the Woods, O.

c. Auriferous quartz from the west shaft, Regina mine, loc. 566 P, Whitefish Bay, Lake of the Woods, O.

(B.) Received as presentations :—

Ahn, Robert H., Rat Portage, O. :—

a. Auriferous quartz from the Mikado claim, Bag Bay, Shoal Lake, Lake of the Woods, district of Rainy River, O.

b. Auriferous quartz from the Cornucopia claim, Bag Bay, Shoal Lake, Lake of the Woods, district of Rainy River, O.

Appleby, B. H., St. John, N.B. :—

Granite from Spoon Island quarry, Hampstead, Queen's county, N.B.

Armstrong, Wm., Armstrong's Mills, Hastings county, O., per W. F. Ferrier :—

Tremolite in dolomitic limestone from the township of Lake, Hastings county, O.

Bache, R. P., Buckingham, Q., per E. D. Ingall :—

Prepared graphite from the Weart mine, Buckingham, Ottawa county, Q.

Baker, Hon. James, Victoria, B.C. :—

a. Auriferous quartz from the Câche claim, Cayoosh Creek, Lillooet district, B.C.

b. Lignite from St. Mary's River, West Kootanie, B.C.

Baycroft, Thomas, Copper Cliff, O.

Anthraxolite from the township of Balfour, district of Algoma, O.

Chambers, F. H., Westville, N.S., per Dr. H. M. Ami :—

a. Manganite from Bridgeville, East River, Pictou county, N.S.

b. Limonite from Bridgeville, East River, Pictou county, N.S.

c. Stalactites from cave in Lower Carboniferous limestone at Springville, Pictou county, N.S.

Cinnabar Mining Company of British Columbia, Savona, B.C., per F. C. Innes, Managing Director :— Contributions to museum—*Cont.*

a. Cinnabar (retort ore) from the Yellow Jacket claim, Kamloops Lake, B.C.

b. Average furnace ore from the Yellow Jacket claim.

c. Cupriferous ore from the Big Dyke claim, Kamloops Lake, B.C.

d. Average furnace ore from the Big Dyke claim, Kamloops Lake, B.C.

Cowie, Isaac, Edmonton, N.W.T.

a. Iron-pyrites from a little below Vermilion River on the Athabasca River, N.W.T.

b. Iron-pyrites from a point between Pelican and Vermilion rivers on the Athabasca River, N.W.T.

c. Iron-pyrites from above Pelican Rapid, Athabasca River, N.W. T.

Doyle, Owen :—

Felspar from the township of March, Carleton county, O

E. B. Eddy Company, Hull, Q :—

Sandstone used for the manufacture of pulp grindstones :—

a. Scotch sandstone.

b. Ohio (U.S.) sandstone.

Fraser, J.D., Ferrona, N.S. :—

Malachite from Cameron's mine, Bridgeville, Pictou county N.S.

Gray, Robert T., Madoc, O., per W. F. Ferrier :—

a. Erythrite on magnetite from the Dominion mine, Madoc, Hastings county, O.

b. Hæmatite (var. specular iron) from the Kane mine, Huntingdon, Hastings county, O.

Grüner, H. :—

Coke from Sheep Creek (Alberta) coal.

Hill, A. J., New Westminster :—

a. Pyrrhotite with arsenopyrite from Capt. Jones' claim, Jervis Inlet, B.C.

b. Chalcopyrite and pyrrhotite " " "

Contributions to museum—*Cont.*

Jennings, Herman, Johannesburg, Transvaal, S.A.R. :—

Auriferous conglomerate—

a. From the Main Reef, Ferreira mine, Witwatersrand, S.A.R.
b. " " (Leader) " " "
c. " South Reef " " "

Johns Manufacturing Company, The H. W., 87 Maiden Lane, New-York :—

a. Asbestus Roofing.
b. " Fire-proof Rope.
c. " Sewing Twine.
d. " Building Felt (about 6 lbs. per 100 sq. ft.)
e. " " " (" 10 " " .)
f. " " " (" 14 " " .)
g. " Fire-felt covering.
h. " " " with Superated Jackets.
i. " National covering.

King, J. G., Port Arthur, O. :—

Specimen showing weathering of dolomite.

Lanigan, R., Calumet, Q. :—

a. Kaolin from the township of Amherst, Ottawa county, Q.
b. Quartz " " " " "

Martineau, Salomon, Rivière Desert, Q. :—

Molybdenite from the township of Egan, Wright county, Q.

McKenzie, H. R., Sydney, N.S. :—

Chalcopyrite from the Old French Road, Gabarus, Cape Breton county, N.S.

McKellar, John, Fort William, O. :—

Auriferous quartz from the Empress location, Jackfish Bay, Lake Superior, district of Thunder Bay, O.

McRae, Hector, Ottawa, O. :—

Graphite (core from boring) from the township of Brougham, Renfrew county, O.

Moberley, Frank, Rossland, B.C. :—

a. Chalcopyrite and pyrrhotite from the Josie claim, Trail Creek mining district, B.C.
b. Galena and pyrite from the Mayflower claim, Trail Creek mining district, B.C.
c. Pyrrhotite with chalcopyrite, Monte Cristo claim, Trail Creek mining district, B.C.

Contributions to museum—*Cont.*

d. Chalcopyrite and pyrrhotite, from the LeRoi mine, Trail Creek mining district, B.C.

e. Chalcopyrite and pyrrhotite, from the Commander claim, Trail Creek mining district, B.C.

f. Galena with pyrite from the Deadwood group.

g. Bornite from the Silver King claim, Nelson, B.C.

Nadeau, J. A., Iberville, Q. :—

Two specimens of nepheline-syenite (polished) from the Mt. Johnson Quarries, Iberville county, Q.

Nadon, F. X. :—

Molybdenite from the township of Egan, Wright county, Q.

North American Graphite Company, Ottawa, O., per H. P. H. Brumell, manager.

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

b. Flake plumbago, grade L.A.

c. " " " L.B.

d. " " " L.C.

e. " " " L.D.

f. " " " L.K.

Pennock, J. T., Ottawa, O. :—

Magnetite from the township of Grenville, Argenteuil county, Q.

Poole, H. S., Stellarton, N.S. :—

Coal from the Acadia Colliery, Westville, Pictou county, N.S.

Prest, W. H. :—

Mineral associations of gold from the Jumbo vein, Westfield and the Ballou mine, Molega, Queen's county, N.S.

Rutherford, J. G., Stellarton, N.S. :—

a. Coal from the main seam, Fan pit, Albion Mines, Pictou county, N.S.

b. Coal from the McGregor seam, McGregor pit, Albion Mines, Pictou county, N.S.

Saunders, H., Victoria, B.C. :—

Chalcopyrite and molybdenite from the Van Anda Copper Company's mine, Texada Island, B.C.

Selwyn, Dr. A. R. C., Ottawa, O. :—

Carbonaceous schistose quartzite traversed by vein of quartz, from Quesnel, B.C. :—

Contributions to museum—*Cont.*

Seymour, T. F., Madoc, O., per W. F. Ferrier :—

a. Calcite crystals in hæmatite, from the Kane mine, Huntingdon, Hastings county, O.

b. Magnetite crystals from the Seymour mine, Madoc, Hastings county, O.

c. Garnets in mica-schist from Green Island, Moira Lake, near Madoc, Hastings county, O.

Sparham Fire-proof Roofing Cement Company, Montreal, Q. :—

Specimens of fire-proof roofing cement.

Spotswood, G. A., C.E., Parsons Pond, west coast of Newfoundland :—

Borings from great Greenland meteorite.

Stewart, Archibald, Ottawa, O. :—

a. Limestone (six inch cube) from the Rockland quarries, Clarence, Russell county, O.

b. Sandstone showing dendrites from the Soulanges Canal, Q.

Todd, Wm. :—

Steatite from Kennington Cove, four miles W. of Louisburg, Cape Breton county, N.S.

Turner, G. H., Mission City, B.C. :—

Bog-iron ore from Mount Leaman, vicinity of Mission City, New Westminster district, B.C.

Von Müller, Baron, Melbourne, Australia :—

Forty-seven specimens of borings from Oodnadotta, Lake Harry and William Creek, South Australia.

Vye, George A., Digby, N.S. :—

Limonite from Bridgeville, Pictou county, N.S.

Wakeham, Commander W., Gaspé Bay, Q. :

a. Petroleum from Block 42, Galt, Gaspé county, Q.

b. Petroleum from Block 40, Larocque, Gaspé county, Q.

c. Mineral tar from near the west line of York township, Gaspé county, Q.

Whitton Granite Company, per L. J. Frechette, M.P., St. Ferdinand, Q. :—

Granite from lot 34, range IV, of Whitton, Compton county, Q.

Wilkinson, Lieutenant-General H. C., Rat Portage, O. :—

Asbestus from Island S. E. of Rendezvous Point, Long Bay Lake of the Woods, District of Rainy River, O.

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

1. Leslie Street School, Toronto, Ont........	consisting of	80	specimens.
2. Board of Trade, Edmonton, N.W.T......	"	120	"
3. Collegiate School for boys, Windsor, N.S..	"	120	"
4. Church School for girls, Edgehill, Windsor, N. S................................	"	80	"
5. Collegiate Institute, Niagara Falls, Ont...	"	120	"
6. High School, Port Elgin, Ont............	"	120	"
7. Dist. School No. 14, Sharp, Kings Co., N. B................................	"	80	"
8. Public School, Apohaqui, N. B...........	"	80	"
9. Collegiate Institute, Portage la Prairie, Man.	"	120	"
10. Model School, Robinson (Bury), P.Q......	"	120	"
11. Public School, Surrey, Hillsborough, N.B.	"	80	"
12. High School, Omemee, Ont...............	"	120	"
13. Pictou Academy, Pictou, N.S.............	"	160	"
14. Monument National, Montreal, P.Q......	"	108	"
15. Public School, Dist. No. 3, Hampton village, Kings Co., N.B..................	"	80	"
16. Public School, Sheet Harbour, Halifax Co., N.S................................	"	80	"
17. Institute of Mines and Forests, Georgetown, British Guiana.................	"	120	"
18. Villa Maria Convent, Notre Dame de Grâce, P. Q................................	"	120	"
19. Truro Academy, Truro, N.S..............	"	120	"
20. High School, Florenceville, Carleton Co., N.B................................	"	120	"
21. Queen's University, Kingston, Ont.......	"	77	"
22. High School, Wolseley, N.W.T..........	"	90	"
23. High School, Hawkesbury, Ont..........	"	120	"
24. Public Library, New Westminster, B.C...	"	120	"
25. Public School, Indian Head, N.W.T.....	"	80	"
26. Public School, Whitewood, N.W.T......	"	80	"
27. Public School, Moosomin, N.W.T........	"	80	"
28. Public School, Doaktown, N.B..........	"	80	"
29. High School, Maitland, Hants Co., N.S..	"	120	"
30. High School, New Glasgow, N.S.........	"	120	"
31. Kings County Academy, Kentville, N.S...	"	120	"
32. County Academy, Annapolis, N.S........	"	120	"
33. Mother House Congrégation de Notre Dame, Montreal, P.Q..................	"	80	"
34. Sisters of Charity, Mt. St. Vincent, Halifax, N.S............................	"	80	"
35. Graded School, Norton Station, N. B.....	"	80	
36. McGill University, Montreal, P.Q........	"	77	"

Educational collections supplied—*Cont.*

37. Toronto University, Toronto, Ont........	consisting of	56	specimens.
38. Laval University, Quebec, P.Q...........	"	50	"
39. Public School, Memramcook, N.B........	"	80	"
40. Grammar School, Shediac, N.B..........	"	120	"
41. Public School, Clifton, Kings Co., N.B....	"	80	"
42. Convent of Holy Names, Hochelaga, P.Q..	"	80	"
43. Public School, Shubenacadie, N.S........	"	80	"
44. Fredericton University, Fredericton, N.B.	"	37	"
45. Sisters of the order of Notre Dame, Antigonish, N.S.........................	"	80	"
46. High School, Springhill, N.S.............	"	120	"
47. Bureau of Mines, Victoria, B.C..........	"	100	"
48. Public School, Harcourt, Kent Co., N.B..	"	80	"
49. Our Lady of Good Counsel, Montreal, P.Q.	"	80	"
50. Central School House, Middle Sackville, N.B...............................	"	80	"
51. Weymouth School, Weymouth, N.S......	"	80	"
52. Minister of Agriculture, Dunnville, Ont...	"	80	"
53. Montreal College of Commerce, Montreal, P.Q...............................	"	25	"
54. School of Mining, Kingston, Ont.........	"	60	"

"Making a total of 5,040 specimens, aggregating over two tons in weight of material.

Minerals collected by Mr. Willimott

"Mr. Willimott subsequently spent some time in rearranging and cataloguing the contents—representing balance of material on hand—of two hundred and eighty-eight drawers, one hundred racks and forty-eight shelves; and afterwards visited with the object of procuring further material for future collections, the townships of Hull, Wakefield, and Calumet, in the province of Quebec; and those of March, Bagot and Burgess in that of Ontario. Whilst so engaged he collected:—

	Specimens.	Weight.
Apatite, crystals........................	100	
" in calcite......................	....	100 pounds.
Anorthosite	....	200 "
Biotite..................................	....	200 "
Celestite................................	....	250 "
Calcite..................................	....	215 "
"	70	
Calcareous conglomerate................	40	
Diorite..................................	....	125 "
Felspar..................................	2	
Graphite.................................	....	225 "
Garnet...................................	....	220 "
Galena...................................	....	130 "
Gneiss...................................	88	
Perthite.................................	....	165 "

	Specimens.	Weight.
Pyrite....................................	....	300 pounds.
Phlogopite, crystals........................	100	
Sphalerite................................	....	210 "
Serpentine limestone......................	....	200 "
Scapolite.................................	....	120 "
Serpentine................................	....	150 "

"Mr. Willimott has, in addition, received—

(*a*) in exchange.

Stellarite................................	....	75 "
Bituminous shale..........................	....	125 "
Hæmatite..................................	....	100 "
Limonite and pyrolusite...................	....	125 "

(*b*) by purchase,

Chromite..................................	....	275 "
Chrysotile in serpentine..................	....	450 "

and further—

Anthracite, presented.....................	....	170 "
Sodalite, through Mr. A. E. Barlow......	....	350 "
Nephelite, " " "	....	75 "
Magnetite, " " "	4	
Pyroxene, " " "	50	
Hæmatite, through Dr. H. M. Ami.......	....	200 "

"In all, some four hundred and fifty-four hand specimens, and four thousand seven hundred and fifty-five pounds of massive material."

Lithology.

On the work accomplished by him during the past year, Mr. W. F. Ferrier makes the following report:—

"In the museum label-holders have been prepared for the upright cases of the Stratigraphical Collection of Rocks, and will shortly be placed in position. Cabinets, furnished with locking doors, are now ready for the reception of those rock specimens which are undergoing petrographical investigation, and drawers have been set apart in the museum, and for the most part filled, with sets of rocks from various localities which have already been examined and reported on. Museum.

"Since the appearance of the last Summary Report two petrographical reports have been printed, and one is ready for the printers. Of those printed, one, entitled Petrographical Characters of some Rocks from the Area of the Kamloops Map-sheet, British Columbia, appears as Petrographical reports.

Lithology—*Cont.*

an appendix to Dr. Dawson's report on that region* whilst the other, under the title of Notes on the Microscopic Structure of some Rocks from the Labrador Peninsula, is to form an appendix to Mr. Low's report on the interior of Labrador.† Separate editions of both appendices have been issued.

Examinations in progress.

"The report on Mr. Barlow's rocks from the areas of the Nipissing and Temiscaming sheets is now almost ready for printing. The study of these rocks has yielded many important and interesting facts regarding the origin of the Laurentian.

"Mr. McConnell's rocks from the West Kootanie district, British Columbia, are now being examined. One hundred and thirty thin sections of specimens collected by him during the past season have been prepared to supplement those already in hand. Much interest attaches to these rocks because of their association with the rich ore-deposits of this important mining district.

"Various blowpipe examinations of rocks and minerals have been, as usual, undertaken during the year, and memoranda of results furnished to those from whom the specimens were received. A new microscope, model II, made by Fuess of Berlin, Germany, with all the latest improvements, has been purchased, and is giving good satisfaction and greatly facilitating the petrographical work.

Discovery of corundum.

"One of the most interesting occurrences upon which I have to report, is the recent discovery of corundum in Hastings County, Ontario. This came about in a somewhat unusual way. In 1893 I came into possession, by purchase, of a number of specimens collected by Mr. John Stewart, formerly of Ottawa, amongst them being a package labelled 'Pyroxene crystals, south part of Carlow.' On examining these specimens some time ago I recognized them as corundum, and immediately took steps to ascertain, if possible, the precise locality from which they came. As you are aware, I communicated the facts to you and was authorized in October to visit the township of Carlow, endeavour to locate the mineral, and determine the extent of the deposit. I was accompanied by Mr. Cole, and after considerable difficulty found the mineral on lot 14, con. XIV. of the township of Carlow, Hastings county, Ontario.

Its mode of occurrence.

"It was there found to occur in a coarse-grained, red, felspathic rock having the appearance of a pegmatite. Microscopic sections are in course of preparation, and the precise nature of the rock will then

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* Annual Report, Geol. Surv. Can., vol. VII. (N.S.) part B, Appendix I.

† Annual Report, Geol. Surv. Can., vol. VIII. (N.S.) part L, Appendix V.

Lithology—*Cont.*

be fully determined. The difficulty of preparing sections, consequent on the hardness of the contained corundum, has rendered it impossible to make the examination in time for this report. This rock, together with a red and brown micaceous gneiss, forms a perpendicular cliff from 80 to 100 feet high, at the base of a sloping mountain. The corundum-bearing rock runs into the gneiss on the side of the mountain along the strike, which is about N. 65° E., as well as occurring, as already stated, on the face of a cliff across the strike.

"Well developed crystals, often of large size, and generally of a grayish or brownish colour, as well as irregular masses of the corundum, are thickly distributed through the rock, and the mineral was observed throughout this rock for a distance of about 300 feet across the strike, more or less continuously and traced along the strike for about 700 feet. The grain of the mineral varies with that of the rock. The quantity is not uniform throughout the mass, portions of the rock being more thickly studded with the crystals than others, and in places they seemed to form 'stringers' in the rock.

"The interest of the find lies not so much in the possibility of the discovery of the gem varieties of the mineral, ruby and sapphire, about which so much has lately been said in the press, and which is improbable in view of the mode of occurrence, but in the fact that this is the first time that the mineral has been found to exist in Canada in any quantity and that it is valuable as an abrasive material on account of its great hardness, which is, in the pure mineral, next to that of the diamond.

Where previously reported in Canada.

"In the *Geology of Canada* (1863) p. 499, mention is made of corundum in the following words :—'Corundum has been observed on the second lot of the ninth range of Burgess, and in the immediate vicinity of a deposit of copper-pyrites. Here, in contact with the crystalline limestone, occurs a rock made of felspar, quartz, calcite, silvery white mica and sphene. Disseminated throughout this aggregate were small grains of a mineral whose colour varied from light rose-red to sapphire-blue, while its hardness, which was greater than that of topaz, showed the mineral to be corundum. Small crystals of light-blue corundum have been found elsewhere in the limestone of the vicinity.

"No specimens of this occurrence have found their way into the collections of the Survey, and I have not met with anyone who has seen the mineral from this place. It is the only locality cited for Canada in the report on American corundum by Francis P. King,* the information being furnished by Dr. F. D. Adams.

*A Preliminary Report on the Corundum Deposits of Georgia, by Francis P. King, Assistant Geologist. Bull. No. 2, Geol. Surv., Georgia, 1894.

Lithology—*Cont.*

Nature of the mineral.

"Corundum is an oxide of aluminium, the crystallized varieties being essentially pure, whilst the granular variety, to which the name 'emery' is given, contains more or less impurities, chiefly magnetite and hæmatite. The transparent purer kinds of red and blue colours constitute the gems ruby and sapphire. These usually occur as rolled pebbles in river beds, or as crystals embedded in various rocks, such as limestone, as in the famous ruby mines of Burma.

Sources of supply.

"Statistics show that as an abrasive material there is an extensive market for the corundum. The supply of the mineral in the United States comes chiefly from North Carolina and Georgia, small quantities of emery being also obtained in Westchester County, New York State. The finer grades of emery continue to be imported from Turkey and Greece.

Mode of preparation

"Since the present discovery was announced by the Geological Survey, numerous inquiries have been received regarding it, and samples have been furnished to interested parties. Some of these have been tested in the United States, and the corundum pronounced to be of the finest quality. It may be well here, I think, to allude to the proper preparation of the material, essential to its introduction for commercial purposes. It is necessary that it should be completely freed from the gangue and this can only be accomplished by a special process. The corundum-bearing rock is first crushed, and then washed by means of sluice-boxes or revolving barrel-shaped cylinders through which a stream of water passes. But this is not all, for if the fragments of corundum be examined, it will be found that a large proportion of them are coated with a micaceous mineral having in many instances the composition of margarite, and resulting from the alteration of the corundum. This is removed by passing the mineral through another machine, which, in a form used at one of the principal Georgia mines, contains two discs armed with points which are revolved with great rapidity, and soon wear away the soft coating. After undergoing this process the mineral is again washed, crushed, and sifted to the various degrees of fineness required. Great care is necessary to prevent its reduction to 'flour' as this has only a small value compared to that of the coarser grades.

"The purpose of all the manipulation it undergoes is to secure uniformity of hardness in the finished material.

Further discoveries probable.

"Pending further investigation, the lands (which belong to the Crown) on which the corundum occurs in Carlow, have been withdrawn from sale by the Ontario Government, and it is hoped that the deposit will prove as valuable as the surface conditions seem to indicate. It is more than likely that this is not an isolated occurrence, but that other deposits will be found in the Hastings district, now that attention has been called to it. The very circumstances attending the present discovery show that the mineral is liable to be passed over or mistaken for something else.

Lithology—*Cont.*

"As instructed, I visited a number of other localities in Hastings county for the purpose of obtaining minerals, and collected a number of fine specimens for the museum, amongst them being good examples of the stilpnomelane described by me in 1895. Also erythrite, fine crystals of andradite garnet, hæmatite, limonite, hornblende, pyroxene, and various felspars."

Mining and Mineral Statistics.

Mr. E. D. Ingall reports of the work under his control as follows :—

Mineral statistics.

"During the year the work of the section was carried on as usual, Mr. L. L. Brophy acting as assistant in connection with the statistical work. Mr. A. A. Cole acted as assistant for a short time in the spring, but for most of the year the technical part of the work has fallen to myself to do.

"The collection of statistics relating to the various mineral industries of the Dominion, together with the necessary compilation and checking of information gained, has occupied much of the time of the diminished staff of the section. The Preliminary Summary of the Mineral Production of Canada for 1895, was completed by 22nd February, 1896, a very much earlier date than ever before attained.

"Beside this, much time has been occupied preparing memoranda covering technical points relating to the mining and smelting of Canadian minerals, and in giving information to many inquirers regarding minerals and mining in Canada.

"Some work was also done in adding to our catalogue and reference system of the mineral deposits of Canada. The object in view in this system is to enable us, when it is completed, to have an entry for each of the mineral deposits in the country with references embodying every available source of information. Thus when information is asked about any mineral deposit, district, or mineral industry, it will be possible at once to get all the data available. To attain to anything like completeness in this matter would, of course, require a larger staff than we have at present

Mineral statistics—*Cont.*

"As opportunity permitted, attention was paid by myself to the detailed report on my field-work of 1895 in the Kingston and Pembroke Railway iron district. This has included examination of specimens and the selection of a certain number for analysis, with a view to determining the contents of the magnetite itself in phosphorus, and titanium in relation to the iron content.

"In October, short trips were made east, through Ontario, to collect outstanding returns regarding mineral production for 1895, which it had been impossible to get in by correspondence, and in the latter months of the year preparations were made toward getting information for the report for 1897.

Asbestos mining.

"The eastern trip was undertaken by myself, and a short visit was made to the asbestos mining centres of Black Lake, Thetford and Danville. In this industry the low prices ruling for the past few years have caused all but the larger producers to suspend operations, and have resulted, in the case of those still operating, in a much larger use of machinery and the extraction of much fibre that used to be considered too short to be worth treatment. The processes in use consist, in a general way, of some method that while crushing the rock frees the fibre without breaking it; followed generally by the passage of the crushed material over travelling picking tables, where the longest fibre is selected out, and then over shaking screens having a slight slope. The effect of these screens is to sort out the remaining shorter fibre into lengths, and also by reason of a funnel with strong up-draft, over-hanging the lower end of the screen, to lift the fibre away from the rock particles, the latter then passing off over the ends of the screens. At Danville this latter material is being stored outside the mill in dump, as it is now coming into use to replace ordinary sand and hair in wall plastering. It is claimed that this 'Asbestic,' as it is called, takes a better finish than ordinary plaster, does not crumble under the action of fire, and that it will not crack or crumble when nails are driven into it."

Of his trip in the peninsula of Ontario, Mr. Brophy reports as follows:—

"Leaving Ottawa on the 8th October, I visited, among other places, Toronto, Windsor, Sarnia, Clinton, Seaforth, Petrolea, London, Buffalo, Caledonia and Hamilton, returning to Ottawa on the 28th of the same month. No difficulty was experienced in obtaining all particulars required, when asked for in person, and the failure of some operators to reply to our circulars and letters is, in most instances, due to oversight and not to a desire to withhold the information. Although the trip was made almost entirely with a view to acquire the statistical data essential to the completion of the report, yet some general information was incidentally secured. Mineral statistics—*Cont.*

"The following notes on natural gas and on iron smelting may be of some interest at the present time.

"At Windsor, through the courtesy of Mr. S. T. Copus, secretary-treasurer of the Natural Gas and Oil Company of Ontario, Ltd., some interesting particulars were obtained regarding the operations of the company up to date (October 12th, 1896). This company, which succeeded to the business and plant of the Ontario Natural Gas Company some three years ago, now practically controls all the principal wells in the Essex field, and is piping large quantities of gas from their main field in the townships of Gosfield and Mersea, to Walkerville, Windsor and Detroit. Two lines of pipe have been laid into Windsor, a distance of about 32 miles. Some 2000 families in Walkerville and Windsor are now supplied with the gas, while the number of connections in Detroit is in the neighbourhood of 6000. The total number of miles of piping laid is about 130, including all branch lines and connections. The gas, which is used almost entirely for fuel purposes, is sold for twenty cents per thousand (M) cubic feet in summer and twenty-five cents in winter; the extra price in the latter season being due to the increased cost of keeping the regulators, mains, etc., in working order during the cold weather. The total number of wells drilled by both the old and new company, up to the time of my visit, was twenty-six and of these seventeen are still active producers. The rock-pressure at the wells is given at 400 pounds to the square-inch, and their estimated output is about 35,000,000,000 cubic feet per annum. Natural gas at Windsor.

"While no very marked decrease has been noticed in the rock-pressure at the wells in the Essex fields no doubt owing to the comparatively recent date at which the consumption became other than of a local character, a very different condition of things prevails in the Welland field, where the wells have been supplying the city of Buffalo with a considerable portion of its fuel for a number of years past. The reason for this statement will become apparent on a perusal of the following information, kindly furnished by Mr. D. Coste, manager of the Provincial Natural Gas and Oil Company, which corporation operates most of the large wells in the Welland peninsula. Their whole output is piped into Buffalo, N.Y., through two large mains running from the field to the Niagara River. The length of pipe laid, including the mains and all connections, is about 120 miles. Up to the 20th of October, 1896, the number of wells drilled by this company and also by the Gas wells in Essex county.

Mineral statistics—*Cont.*

Erie Company, (whose rights were acquired in 1893) was 124, of which 65 are still producing, When the first wells were bored some years ago, the initial rock-pressure was 520 pounds to the square-inch, but the supply of gas in the meantime decreased to such an extent that the average pressure of all the wells is now barely 175 pounds to the inch. The large compressor plant erected near Sherk's Station in the fall of 1893 was in operation for some nine months, but is now seldom used except to pump out a well of which the pressure has fallen below 70 pounds to the square inch. When a well reaches this stage the pumps are put on, the hole is pumped dry and permanently closed down and plugged. This procedure is rendered necessary by reason of the fact that the pressure in the supply mains is so much higher than that in a failing well, that instead of such a well being a source of supply it really becomes a drain on the main pipe-lines and absorbs a large quantity of gas from other wells which would otherwise be available for immediate consumption. Wells which were at one time large producers are sometimes purposely fed in this way, being used as temporary storing chambers for such gas as is not required for immediate use, the reservoirs of these wells being more readily accessible when the gas is really wanted, than in those formerly having but a small producing capacity. According to the opinion expressed by several of the leading authorities on the subject, it would appear to be merely a question of a few years before the gas supply in the Welland field will be exhausted, at least for commercial purposes, though a small flow may still continue for a much longer period which will be of service for domestic uses to farmers and others with wells on their premises and requiring only a very limited daily supply. In support of this opinion, mention may be made of the Provincial Company's well No. 63, drilled in 1893, which yielded when the gas was struck, a flow of over 10,000,000 cubic feet per day. The flow from this well has now decreased to such an extent that it does not produce 400,000 feet in the same time, although it has in the interval been several times fed from the other wells.

Iron smelting at Hamilton.

"While in Hamilton, I was, through the kindness of Mr. Robert Hobson, secretary-treasurer of the Hamilton Blast Furnace Company, enabled to obtain some details as to the company's operations since the completion of the plant. Their furnace was blown in on the 31st of December, 1895, though no pig-iron was made until some weeks later. Production, has, however, been going on continuously ever since. The ore used is derived both from Canada and the United States, the Canadian ore coming from the Wallbridge and other mines in Hastings county; from the north shore of Lake Erie, between

Port Rowan and Port Dover, and also from the district near Smith's Falls and Merrickville. The United States ore is obtained from Escanaba, Mich., and Two Harbours, Minn. The Canadian ore used to the 17th September, 1896, was 9062 tons, producing pig iron to the amount of 5890 tons. The quantity of United States ore charged was, at the same date, 16,781 tons, turning out pig to the amount of 13,247 tons, thus showing the total amount of ore charged to have been 25,843 tons; and producing pig iron amounting to 19,137 tons during a period covering about nine months. The fuel used is entirely coke, which is procured from the Reynoldsville district in Pennsylvania and costs, laid down at the works, about $3.60 per ton. The flux is a limestone obtained from Port Colborne, Ont." Mineral statistics—*Cont.*

Palæontology and Zoology.

Mr. Whiteaves submits the following summary of the palæontological and zoological work accomplished in 1896 :— Palæontology and Zoology.

"The manuscript of the third part of the third volume of *Palæozoic Fossils*, referred to in the last Summary Report as having been commenced, has since been completed and is now ready for the printer. This publication will consist of a descriptive report upon all the fossils from the Galena-Trenton and Black River formations of Lake Winnipeg and the Red River valley, in the museum of the Survey. It will contain identifications, with references, &c., or detailed descriptions of 145 species, and when printed, will make a little more than 100 pages of text, illustrated by seven full-page lithographic plates and by several woodcuts. Its preparation has entailed considerable correspondence with specialists in the United States and Europe. Publications. Galena-Trenton.

"By permission of the Director, a paper on 'Canadian Stromatoporoids' has been prepared and published in the July number of the *Canadian Record of Science*. This paper is essentially a stratigraphical and systematic list, with references, &c., of all the species of *Stromotoporoidea* (about thirty-five in number), that have either been recognized or even supposed to have been recognized in Canada, or described from Canadian localities.

"In the Quarterly Journal of the Geological Society of London for May, 1896, Dr. Henry Woodward, F.R.S., has published descriptions and illustrations of the four species of fossil crabs from the Cretaceous rocks of Vancouver and the Queen Charlotte Islands, sent to him by the writer last year, and a small series of long-tailed decapods

Palæontology and zoology—*Cont.*

or lobster-like crustaceans, from the Nanaimo group of the Vancouver Island Cretaceous, has been forwarded to him this year for identification or description.

Cambro-Silurian fossils.

"Collections of fossils recently made by Mr. J. B. Tyrrell from the Cambro-Silurian rocks near Fort Churchill, Hudson Bay, and at Sturgeon Lake, Wekusko (or Herb) Lake, and Hill Lake on the Mināgo River, Saskatchewan; from the Silurian rocks at Pine Island Lake, Saskatchewan; and from the Cretaceous rocks at seven different localities in the district of Athabasca, have been examined and notes upon the species represented prepared for publication in his reports.

"Several small consignments of fossils from the Guelph formation at Elora and from the Corniferous drift near Kincardine, Ontario, have been named for Mr. R. A. Farquharson of Kincardine.

Triassic fossils.

"Thirteen specimens of fossils from rocks apparently of Triassic age at Texada Island, B.C., and three from the basal beds of the Cretaceous at Lasqueti Island, B.C., collected last summer by Mr. Walter Harvey, of Comox, were sent to the writer for examination, and as much information as possible in regard to them has been furnished to Mr. Harvey.

Cretaceous fossils.

"Six additional consignments of the rarer fossils of the Cretaceous rocks of the Queen Charlotte and Sucia Islands, B.C., have been received from Dr. C. F. Newcombe, of Victoria, who has kindly presented five unique or remarkable specimens from Skidegate Inlet to the museum of the Survey. Some of these fossils have been named and returned, but about one half of them have been retained for further study. A few of the more critical forms among them have been sent to Dr. Franz Kossmat, of Vienna, for comparison with European and Asiatic types, also to Mr. F. W. Stanton, of the U. S. National Museum at Washington, and to Professor John A. Merriam, of the University of California at Berkeley, for comparison with Californian fossils.

"Numerous small boxes of fossils from the Cretaceous rocks on the Comox and Trent rivers, Vancouver Island, and from Hornby and Denman islands, B. C., have been forwarded, for examination, by Messrs. W. Harvey, J. B. Bennett, F. W. Robbins and Dr. G. D. Beadnell. Among these fossils there are some unusually fine specimens and a few species not previously represented in the Survey collection. Most of these have been kindly presented to or acquired for the museum, as will be seen from the list of donations. The remainder have either been named and returned, or kept a little longer for further study and comparison. These specimens, together with those sent by Dr. Newcombe last year and this year, upon which copious notes have been kept, will enable the writer to make a much more complete revision of the fossil faunæ of the Cretaceous rocks of the Queen Charlotte and Vancouver groups of islands, than would otherwise have been possible.

Palæontology and zoology—*Cont.*

Zoological collections.

"In Zoology every effort has been made to increase and improve the collections in the museum. Fifty-one additional specimens of birds and one mammal have been mounted by Mr. Herring during the year, and 346 birds have been placed upon new and smaller stands in order to economize space. Fine specimens of the Glaucous-winged, Short-billed and Heermann's Gull, a male Black-vented Shearwater and a pair of Tufted Puffins, from Vancouver Island, have been received from Mr. John Fannin, curator of the Provincial Museum at Victoria. A Dusky Shearwater from the Queen Charlotte Islands, and eggs of some of the rarer sea birds of British Columbia, have been presented by Dr. C. F. Newcombe, of Victoria. A female White-fronted Goose, a pair of the White-tailed Ptarmigan in winter plumage and a fine pair of the American Three-toed Woodpecker, from Alberta, have been acquired by purchase. Specimens of about 100 species of shells, mostly from Japan and previously unrepresented in the museum, have been received in exchange for duplicate shells from the coast of British Columbia.

"An interesting series of small mammals, birds, and the eggs of about thirty-five species of birds from Labrador and Hudson Bay, were collected by Mr. A. P. Low. Among the latter are one egg each of the Long-tailed Jager, Snow Goose, Hutchin's Goose, Gyrfalcon, Labrador Jay, also 'clutches' of eggs of the Old Squaw, Eider, Willow and Rock Ptarmigan, Redpoll, Snowflake, Lapland Longspur, Fox, Tree and White-crowned Sparrows.

"Skins of an adult male Sea Lion and Fur Seal, and of the young of each, with several separate skulls of both, also twenty bird's skins, and eggs of Kotzebue's Gull and of the Least Auk, all from the Pribyloff Islands, in Behring Sea, have been received from Mr. Jas. A. Macoun.

Want of space in museum.

"The space available for the exhibition of mounted mammals and birds in the museum is already overcrowded and there are many large birds which have been recently set up, for which no room can be found in the cases.

Work by Dr. Ami.

"Dr. Ami reports that during the past year he has continued the work of determining palæontological collections obtained by officers of

Palæontology and zoology—*Cont.*

the Geological Survey, and others, in Ontario, Quebec and the Maritime Provinces.

"To the local lists of fossils prepared to accompany Dr. Ells's report on the geology of the south-western portion of the province of Quebec, referred to in the Summary Report for 1895, he has made several important additions. These are for the most part the result of an examination of numerous fossils from the Cambro-Silurian and Silurian rocks in the vicinity of Montreal, which form part of the collection in the Peter Redpath Museum of McGill University. These completed lists were published early in June and form an appendix to Dr. Ells's report. Systematic lists of fossils, arranged zoologically and chronologically, were also prepared by him with a view of bringing together the palæontological data available for the following geological maps, in course of preparation :—

Sheet No. 119, Quebec and Ontario—Perth sheet.
" 120, Quebec and Ontario—Ottawa City sheet.
" 122, Quebec and Ontario—Pembroke sheet.
" 126, Ontario—Manitoulin Islands sheet.
" 131, Ontario—Lake Nipissing sheet.
" 138, Lake Temiscaming sheet.

Field-work in Pictou county.

"On the 23rd of June, Dr. Ami was instructed to proceed to Nova Scotia, there to continue the palæontological work upon which he had been employed for a short season in the autumn of 1895. The main object of this work was to obtain sufficient palæontological material, from as many localities as possible, to fix the age of the rocks in these localities for mapping. He remained in Nova Scotia until September 14th. Most of his time was spent in the county of Pictou, but some time was also spent examining the Cambro-Silurian and Silurian rocks of Rights River and James River, of Eigg and Brown Mts., and along the I. C. Ry. above and below Marshy Hope, in Antigonish county. At McArras Brook and in other places along the shore of Northumberland Strait, interesting collections were also made.

"Some progress has since been made in determining the palæontological collections obtained in 1895 and 1896 from various horizons in Pictou county, and in preparing local lists of fossils from them. This work necessarily involves a study of all the available material in the possession of the Survey and of the literature on the subject.

"In connection with the work of Dr. L. W. Bailey of Fredericton, who has been examining the geology of the south-western portion of Nova Scotia, Dr. Ami has just completed a preliminary determination of the fossils comprised in twelve new collections from Bear

River, Nictau, Torbrook and other localities in the iron-bearing district of Annapolis county, N.S.

Palæontology and zoology—*Cont.*

"Several collections of duplicates far educational institutions have also been prepared, and some time has been devoted to a detailed palæontological and microscopical examination of specimens of drillings, from the gas, petroleum and salt regions of western Ontario.

"Attention has also been given to the determining and classification of other palæontological collections which have come in to the office from time to time, as well as to the preparation of labels for the Devonian fossils from Lake Winnipegosis in the museum cases, and progress has been made in the re-classification of the collections of fossils in the museum drawers. Besides the lists of fossils published with Dr. Ells's report, several papers on Canadian palæontology have been contributed to scientific journals.

Work by Mr. Lambe.

"Mr. L. M. Lambe has continued the study of the Canadian fossil corals, and during the year has been engaged, almost continously, in a revision of the *Tabulata*, which is now nearly completed and includes all the genera known to occur in Canada, with the exception of about two, represented by the same number of species. In the revision of this section of the *Actinozoa*, seventeen genera, including about sixty-three species, have been exhaustively studied and descriptions prepared of the different forms giving details of their structure with remarks as to their generic and specific affinities. Drawings of the minute details of structure of some of the species have been completed and it is proposed to prepare further drawings for the illustration of the remaining species with as little delay as possible.

"A short paper entitled 'Description of a supposed new genus of Polyzoa from the Trenton limestone at Ottawa' was written in the early part of the year and published in the April number of the *Canadian Record of Science.*

"In the early part of May, a week was spent by Mr. Lambe in the field with Dr. Ells in the vicinity of Arnprior, Renfrew, Cobden and Eganville, west of Ottawa, examining certain exposures of rock with a view to determining their exact geological horizon. Collections of fossils were made at different localities at or near the above-named places and a list was afterwards prepared of the fossils for a paper by Dr. Ells entitled 'Palæozoic outliers of the Ottawa River' now being published in the Transactions of the Royal Society of Canada for 1896.

"A small collection of fossils, made by Mr. J. B. Tyrrell in 1893, at Markham Lake, Doobaunt River, Lat. 62° 44′, Long. 103°, was also

Palæontology and zoology—*Cont.*

examined; the fossils, principally corals, were named and a list of them was prepared.

"Mr. Lambe also made drawings at various times during the year of a number of fossils from the Cretaceous of the Pacific coast and of some from the Cambro-Silurian rocks of Lake Winnipeg for the illustration of papers or reports by Mr. Whiteaves, already mentioned as published during the year or in course of preparation."

Contributions to museum.

The following is a list of specimens collected by or received from officers of the Survey, during the year 1896, in addition to those already mentioned:—

Dr. R. W. Ells, and L. M. Lambe:—

Specimens of fifty species of fossils from the Black River and Utica formations at Renfrew county, Ont.

R. G. McConnell:—

A few fossils from rocks apparently of Carboniferous age at Grouse and Sophy mountains, near Rossland, B.C.

J. B. Tyrrell:—

About seventy-five fossils from Pine River, Herb and Cumberland lakes in eastern Saskatchewan.

Head of Moose (*Cervus alces*, L.)

A. P. Low:—

Skull of Eskimo.

Model of kyak and umyack (Eskimo boats) from George River, Ungava District.

Specimens of four species of fresh-water mollusca from Ungava.

Donald Gillies, Great Whale River, Hudson Bay; per A. P. Low:—

Collection of birds' eggs, including an egg of the Snow Goose; a stone deer-skin scraper, fish-hook and line, whalebone ptarmigan snare, and ivory implement, all from Great Whale River.

G. B. Boucher, Ungava Bay; per A. P. Low:—

Collection of birds' eggs from Ungava Bay.

John Ford, George River, Ungava district; per A. P. Low:—

Collection of birds' eggs from George River.

— Guy, Rigolet, Labrador; per A. P. Low:—

Collection of birds' eggs from Rigolet.

A. E. Barlow:—

Eggs of three species of birds from Central Ontario.

N. J. Giroux :—

Several hundred Cambro-Silurian and Pleistocene fossils from Eastern Ontario.

Contributions to museum—*Cont.*

Dr. H. M. Ami :—

Extensive collections of fossils from the Silurian, Devonian, and Carboniferous systems at Pictou and Antigonish counties, N.S.

About fifty fossiliferous nodules from the south bank of the Ottawa, near Besserer's grove.

"The additions to the palæontological, zoological and ethnological collections during the year, from other sources and in addition to those previously mentioned, are as follows :—

By presentation :—

(A.—*Palæontology.*)

J. G. S. Hudson, Glace Bay, Cape Breton :—

Fifteen specimens of fossil plants from the Coal Measures at Glace Bay.

Dr. C. F. Newcombe, Victoria, V. I. :—

Fine specimen of a large and undescribed species of *Turrilites*, two specimens of *Olcostephanus cepoides*, one *Phylloceras ramosum* and a new *Cercomya*, all from the Cretaceous rocks of the Queen Charlotte Islands.

The Provincial Museum, Victoria, V. I. (per Mr. John Fannin) :—

The three Ammonites figured on Plates 2 and 3 (Section 4) of the first volume of the Second Series of Transactions of the Royal Society of Canada.

The Harrogate Museum, Yorkshire, England ; per Dr. Beadnell :—

Fine specimen of *Hamites* (*Anisoceras*) *Vancouverensis*, Gabb, from the Cretaceous rocks at Hornby Island.

J. B. Bennett, V. I. :—

Fine specimen each of *Pachydiscus Ootacodensis*, *Desmoceras Gardeni*, *Capulus* (or possibly *Anisomyon Meekii*) *Palæocorystes Harveyi*, and two claws of crustacea, from the Cretaceous rocks of the Comox River, V. I.

F. W. Robbins, Denman Island, B. C. :—

One specimen of *Hamites* (*Anisoceras*) *Vancouverensis*, two specimens of *Phylloceras ramosum*, one *Baculites Chicoensis* with an *Anomia* or young oyster attached, and two *Nucula truncata*, all from the Cretaceous rocks at Hornby Island B. C.

Contributions to museum—*Cont.*

S. J. Cliffe, Comox, B. C. :—

Portion of the vertebral column of a fossil fish from the Tsolum River, Vancouver Island.

L. M. Lambe, Ottawa :—

A small collection of fossil sponges from Metis.

Archibald Stewart, Ottawa :—

Four fossils from the Trenton limestone at Rockland, Ont.

R. N. Slater, Ottawa :—

Two specimens of *Calamites* from a railway cutting between the 'Narrows,' and North Sydney, C. B.

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

Two fossils from the Medina sandstone and eighteen from the Niagara limestone at Hamilton. Nine fossils from the Hudson River drift at Winona, Ont., and four from the Iroquois Beach at the Desjardins Canal.

Owen P. Schreiber, Kirkfield, Ont. :—

Thirty-seven fossils from the Trenton shales at Kirkfield.

Adam Brown, Hamilton, Ont. :—

Fossil wood (according to Prof. Penhallow, *Picea nigra*) found in the Erie clay at Hamilton.

T. C. Weston, Ottawa :—

An unusually perfect specimen of *Metoptoma Melissa*, from the Quebec Group at Point Levis.

J. R. Chamberlain, Ottawa :—

Specimen of a species of *Calamites* from the Carboniferous rocks at Springhill, N. S.

J. D. Fraser, Ferrona, N.S. (per Dr. Ami) :—

Thirty specimens of fossils from the Cambrian or Cambro-Silurian rocks at Great Bell Island, Newfoundland.

S. W. Wilkins, Ottawa :—

Fossils from the Cretaceous rocks at the Belly River.

(B.—*Zoology*.)

The Provincial Museum, Victoria, B.C. :—

Two eggs of the Black Oystercatcher and two of the Pigeon Guillemot, collected by Dr. Newcombe, June 1, 1896, at Sea

Bird Islands, Barclay Sound, V.I. Three eggs of the Glaucous-winged Gull collected by Dr. Newcombe, June 18, 1896, at Mittlenatch Island, near Cape Mudge, in the Strait of Georgia.

Contributions to museum—*Cont.*

Dr. C. F. Newcombe, Victoria, B.C. :—

Named specimens of five rare species of Chitonidæ and three specimens of *Chrysodomus tabulatus* from the coast of British Columbia.

Dr. G. D. Beadnell, Denman Island, B.C. :—

Egg of the Black Oystercatcher, from Mittlenatch Island.

Walter Harvey, Comox, V.I. :—

Nest and eggs of the Rusty Song-sparrow from Comox.

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

Cocoons and silk of *Bombyx mori* grown at New Westminster.

L. M. Lambe, Ottawa :—

Recent marine shells and starfishes from Metis.

Miss Norah Lewis, Ottawa :—

Five starfishes *(Asterias polare)*, from Little Metis, P.Q.

Rev. J. Lofthouse, Fort Churchill, Hudson Bay :—

Nineteen eggs of seven species of birds, from Fort Churchill.

Louis J. Coursolles, Ottawa :—

Specimen of the Green Heron *(Ardea virescens)*, shot at Billings Bridge.

(C.—*Ethnology.*)

A. M. Campbell, Perth, Ont. :—

Stone spear-head and copper gouge, from the north shore of Mud Lake, Lot 5, Concession VI., township of Bedford, Frontenac county, Ont.

Lieut.-Col. Percy G. B. Lake, Grenfell, Assa :—

Spear-head from Grenfell, Assa.

Matthew Riddell, Moores Corners, near Galetta, Ont. ; (per W. J. Wilson) :—

One flat stone scraper from Lot 19, Concession V., Fitzroy, Carleton county, Ont.

Natural History Society of New Brunswick :—

Fifteen stone implements and seven fragments of Indian pottery, from various localities in New Brunswick.

Contributions to museum—*Cont.*

C. Coutlee :—

Stone gouge from Cascades Point at the lower end of the Sou langes Canal.

James Lusk, Eardley, P.Q. :—

Fragment of pipe bowl, piece of pottery, quartz spear-head and partially chipped quartz implement, from Lot 20, Range XI., Eardley.

By purchase :—

Fifteen rare fossils from the Cretaceous rocks of Vancouver, Hornby and Denman islands, B.C.

Two eggs of the Western Horned Owl, and a clutch of twelve eggs of the Blue-winged Teal, from Alberta.

Stone pestle found at Lot 10, Concession IV., Township of Torbolton, Carleton county., Ont.

NATURAL HISTORY.

Natural History.

The work carried out by Prof. J. Macoun, or under his supervision, in the office and museum, is thus reported on by him :—

"The office-work connected with the Botanical Section continues to increase and at present no little portion of my time is taken up with the determination of obscure species of all classes sent from almost every province of the Dominion. During the year just closed, I find by my letter book that I have named, of difficult forms, no less than 1983 species, chiefly for the collectors mentioned below.

Botanical specimens determined.

"Mr. John McSwain, Charlottetown, P. E. I; Mr. John Moser, Queen's Co., New Brunswick; the authorities of St. Laurent College Que.; Mr. William Scott, of the Toronto Normal School; Mr. Roderick Cameron, Queen Victoria Park, Niagara Falls; Mr. J. M. Dickson, Hamilton, Ont.; and Mrs. A. Hollingworth, Beatrice, Muskoka, Ont. All the above are actively at work and are doing much to promote the knowledge of botany in their respective districts. In Alberta Mr. Willings, of Olds, and Mr. Gaetz, of Red Deer, have contributed many fine specimens, Mr. A. J. Hill, C. E., and Rev. Herbert H. Gowen, New Westminster; Mr. J. Henry, High School, Vancouver, and Mr. A. J. Pineo, of Victoria high school, as well as Mr. J. C. Gwillim, of Slocan City, have sent many hundred specimens.

Collections presented.

"Last winter a fine collection of plants made at the mouth of the Mackenzie River and on Herschel Island in the Arctic Sea, was placed in our hands, by Rev. J. D. Stringer, for determination. These localities gave together eighty-five species which were entirely Arctic and most interesting on that account. Through the kindness of Mr. Stringer, we have retained a set of his plants for the herbarium.

Natural History—*Cont.*

"This autumn another large donation has been made to the herbarium by Charles A. Hamilton, M. D., Mahone Bay, Nova Scotia. This collection consists of over 600 species and contains many duplicates. It is the joint work of himself and his sister Miss Harriet R. Hamilton. The specimens are well preserved and the greater number correctly named. They are a valuable addition to the herbarium and of much interest as they are a representation of the Atlantic coast flora of our most eastern province. The thanks of this Department are certainly due to Dr. Hamilton and his sister for their donation.

Collections made in Labrador.

"Under your instructions, Mr. A. P. Low took my field-assistant Mr. William Spreadborough, with him to Labrador in connection with his expedition of last season. Besides doing good service for Mr. Low, he made a very fine collection of the plants of Northern Labrador. A partial examination of this material shows that the interior of Labrador has a far higher degree of summer heat than any part of the coast, and further that the Atlantic coast is colder than that bordering on Hudson Bay. Other collections made by Messrs. Low and Spreadborough, are referred to by Mr. Whiteaves.

Catalogue of Lichens.

"The Catalogue of Lichens and allied forms has been in progress, but has been delayed by want of help in the office, due to the absence of my assistant.

Office-work.

"Between January and May, 1896, Mr. James M. Macoun, my assistant, distributed 1559 sheets of botanical specimens, for the most part in exchange for plants sent to our herbarium.

"Since my last summary report, 1946 sheets of specimens have been added to the herbarium. Several thousand specimens are ready for mounting, when time may permit.

"During the winter months my assistant, in addition to the routine work of the office, compiled a list of the plants of Labrador Peninsula for Mr. Low's report and contributed to the *Canadian Record of Science* three papers on the distribution of Canadian plants. On the first of May last he was sent on special service to the Behring Sea, and since that time has been working for the Marine and Fisheries Department."

A considerable part of the summer was spent by Prof. Macoun in field-work in Manitoba and the North-west. The results of this are briefly given by him as follows :—

Natural History—*Cont.*

Field-work by Prof. Macoun.

"Acting on your instructions to proceed to Manitoba and the North-west Territories and still further carry on my observations and collections of the Natural History of the region, I left Ottawa on May 27th and reached Winnipeg on the 29th. On the 30th I collected and noted at Victoria Park, near West Selkirk, all the species seen there. June 1st found me at Otterburne, on Rat River. I visited Stonewall on June 3rd, and on the 4th Stony Mountain. On the 5th I examined River and Elm parks of the city of Winnipeg, and in these four days, and an additional five days in August, noted 401 species and collected all that were in flower at the above dates. Owing to the almost incessant rains during May, vegetation was backward and the open prairie all but impassable.

"On the afternoon of the 5th, I went to Brandon, and for the next nine days collected botanical specimens, listed all plants observed growing there, and made observations on the birds breeding in the neighbourhood.

"On June 12th, I visited Sewell and went south to a tamarack swamp about two miles from there. This is the most western tamarack swamp in Manitoba and is the home of numerous species of eastern plants that are seen no more in the prairie regions.

Wind-breaks on the prairie.

"Visits were made to the Experimental Farm at Brandon, for the purpose of seeing the value of shelter belts and the results of tree planting. Having seen these at Indian Head I was prepared for what I found at Brandon. The first day I visited the farm, (June 9th) a heavy north-west gale prevailed, so strong that I was scarcely able to make headway against it. On the west side of the farm where the tree belts were, there was a perfect calm but away from the influence of the trees the severity of the gale began to be felt. I was so satisfied with the value of the experiments that I desire now to place on record my matured opinion as to the great value of tree planting throughout the north-west.

Why trees do not thrive.

"Later in the season I made collections at Prince Albert and in southern Manitoba and was struck with what I shall call the hardiness of the trees and shrubs in these regions. I had seen that the Canadian Pacific Railway gardens at Moose Jaw and Medicine Hat grew trees and shrubs without being winter-killed and that the cause of the want of hardiness must be looked for in other directions than severity of climate. I had long suspected that the trees on the prairie died for the want of nourishment and exposure to biting winds and not from severe cold, and this year I became convinced of it. Were a supply of moisture given to trees, grown from seed, so that they could mature their wood in July or early August for a couple of years, and the grass allowed to grow around them without being cut or pastured over, enough snow would gather in the winter to give all the moisture needed for the next summer's growth. A study of any thicket on the prairie will prove this. Did the farmer but realize the importance of collecting the snow on his farm, he would begin at once to grow hedges around, say, ten-acre fields. These hedges besides being valuable wind-breaks, would be snow gatherers, and in a very few years belts of trees would spring from the seed sown within the hedge, and while the hedge would protect the young trees it would also gather the snow for the next year's growth. Success in tree planting will only be assured when steps are taken to collect the snow by means of hedges or some other way, and successful tree growing means the settlement of the prairies.

Natural History—*Cont.*

"From Brandon I proceeded to Moose Jaw (June 15th) where I remained collecting until June 26th, when I went to Regina and the next day to Prince Albert where I remained until July 17th.

Rainfall in the North-west Territory.

"Before I left Ottawa, you had instructed me to make further observations on the question of rainfall and water supply, and I went to Moose Jaw chiefly for that purpose. In the autumn of 1895, I had noticed that the drought was broken, and on page 148A of the Summary Report for that year I stated my belief that owing to the saturation of the soil there would be a surplus of moisture in the following spring, and that the ponds would fill up. The results were far beyond my expectation. More rain fell then than usual and all the ponds were full, the ground was saturated and as the warm weather began, all vegetables grew vigorously, so that where grass was scarcely three inches high in the spring of 1895, it was from a foot to eighteen inches in 1896. On June 18th, I went to Chaplin on the border of Old Wives Lake and found the water much higher than it was the year before. At Parkbeg where I was on June 23rd, I found all the ponds full and the grass fit to mow. Inquiries, at Moose Jaw, made of farmers and others, brought out the statement that owing to the saturation of the soil they had moisture enough now to insure them two more good crops. The same conditions prevailed at Regina and from there to Saskatoon. The whole prairie was covered with waving grass that by the end of June was all in seed and looked more like a field of grain than a pasture. From my own observations and the accounts of others, I am led to believe that grass produced seed everywhere on the prairie last year, and should the coming spring be fairly moist, in May and June, much of the western prairie will be re-seeded and a great change will take place in the value of the pasture.

Natural History—*Cont.*

" A striking effect of the long continued drought was the almost total absence of water-fowl on every part of the prairie. Their disappearance is caused by the absence of cover consequent on the drying up of the ponds and the burning or stunting of the reeds around their borders. Last summer the ponds were full, but there were neither old reeds nor birds. Next spring there will be reeds and water, and I confidently look for the birds as well.

" Between Saskatoon and Duck Lake, the rainfall had been light, and as a consequence the vegetation was sparser and shorter, but from Duck Lake to Prince Albert we passed through a different region, within the poplar belt, and on the prairie the vegetation was more that of the forest than that of the true plains to the south.

Climate indicated by flora

" Very large collections were made in the three weeks I remained at Prince Albert, and enough material was obtained to show what its summer climate is like compared with Moose Jaw and Brandon. Although Prince Albert is more than 200 miles north of Brandon, its climate is about the same, and that of Moose Jaw from five to ten days earlier than either. The real cause of the early season of Moose Jaw is its dry and consequently warmer soil. Prince Albert is almost due north of Moose Jaw, with a less altitude but damper atmosphere, and hence is more subject to summer frosts, but this may be expected to decrease as the subsoil is drained.

" North of Prince Albert is a large muskeg, caused by the springs oozing out of the sand-hills near by. This bog contains at least one hundred species of eastern plants, and it is quite evident that very many of the Atlantic coast and Quebec species pass westward, in the forest region, to, and into the Rocky Mountains; while to the south the prairie now forms, and very likely did in the past, an effective barrier to prevent this.

" During the time I was at Prince Albert, I collected 438 species of flowering plants and ferns, and in the whole collection there were fewer indications of a cool climate than at Wood Mountain, 300 miles to the south. I have noticed this everywhere, and am satisfied that 300 miles north of the boundary the climate is as good if not better (especially to the west), than it is at any point on the 49th parallel. There may be more liability, at present, to local white frosts, owing to the more humid soil and air, but as the ponds are drained and the superfluous wood and brush cleared away, a permanent change for the better will come.

Country best fitted for settlement.

" My three season's experience have convinced me that, while the prairie is even richer and more valuable than we have believed it to be, the brush and aspen district to the north of it is best suited for immediate settlement, as shelter, which is necessary for comfort, is to be found everywhere, and although more labour is necessary to make a beginning, the settler from the first has more conveniences and needs far less capital. The soil is good, there are no droughts, blizzards cannot prevail, water is good, wood is plentiful and farming just as we have it in Ontario will be the outcome of settlement. Railway communication is a necessity and the settlement of the northern belt must of course depend largely on this being provided.

Natural History—*Cont.*

"After leaving Prince Albert, on July 17th, I proceeded to Brandon and made a collection of the flora of that district until July 30th. The collections made in June, added to those made in the latter part of July, gave a list of 514 flowering plants and ferns. Nearly all the plants of the ravines and river-bottoms are of eastern species, but the prairie flora is a mixed one, containing both eastern and western forms with others that have their home to the south.

Collections made.

"On the completion of my work in Brandon, I went south-west to Napinka to obtain a more complete knowledge of the flora of the southern district. The first ten days of August were spent at Killarney, Morden and Morris where I made excursions and collections and noted the changes both in the flora and growth of the species.

"A question I had often asked myself and others was why the basswood, elm, grape-vine, wild plum and certain other species, ceased to grow in the river-valleys west of Manitoba. It was supposed that cold and exposure was the probable cause. This may be the cause, and a case in point occurs to me as I write. Last November and December we had very cold weather at Ottawa without snow, and as a result a serious loss of the less hardy trees and shrubs took place at the Experimental Farm. The exposed prairies are always or nearly always bare, and it is this exposure, in my opinion, and not the intensity of the cold that causes the death of the trees. Wherever trees are growing naturally the cold is just as intense as elsewhere, but where they are, snow lies, and where they are not snow does not lie. The conclusion is irresistible that tree planting and the planting of shrubs must go hand in hand with snow gathering and where the snow accumulates and protects the roots there trees will live and thrive.

Western limits of certain species.

"Fine basswood trees were found by the brook at Morden, which no doubt had three or four feet of snow around them in winter. One hundred yards from these trees, seedlings from them would not succeed under present conditions. How then can we expect less hardy stock to survive? At Lumsden, twenty miles north of Regina, in the Qu'Appelle River valley, I found the last Elm towering above all the

Natural History—*Cont.*

shrubs and small trees in its vicinity and having a graceful spreading top like the elms of the east. Yet a few hundred yards from where this elm stood, its own seedlings could not grow owing to unfavourable conditions.

"Since my return, I have been engaged working up various collections sent in for determination, and in the intervals in putting in shape my own collections, which amount for the season to over 1200 species, more than 900 of which are from the prairie and the others (fungi) chiefly collected near Ottawa."

Report on Entomological Collection.

Dr. James Fletcher, F.R.S.C., Entomologist and Botanist to the Central Experimental Farm, furnishes the following report upon the Entomological collections in the Geological Survey museum, in connection with which he is kind enough to tender his services as honorary curator :—

"I have the honour to report that the Entomological collections of the Geological Survey Department are in a good state of preservation. Some additions have been made during the past year, the most important being by purchase of a collection made in the Okanagan valley by Mr. C. De Blois Green. Twelve species were previously unrepresented in the museum and nineteen species were insufficiently or poorly represented. A small but very interesting general collection has been presented by Mr. W. Ogilvie, D.L.S., made by him near Fort Cudahy, latitude 64° 26′ longitude 140° 32′. This collection includes Coleoptera, Hymenoptera and some Arachnida and Hemiptera, every one of which is of great scientific interest from the locality. Mr. Ogilvie says : 'I have secured one at least of every kind of insect I have seen. Butterflies seem to be very scarce, only one or two varieties. Notwithstanding the great abundance of mosquitoes and other pests of that kind, dragon-flies are very scarce.'

"A small collection was presented by Mr. J. C. Gwillim, of Slocan City, B. C., consisting of eleven species of Lepidoptera, seven of Coleoptera, and two of Hymenoptera. These were for the most part in poor condition.

"Of collections made by officers of the Geological Survey the most important are : No. 1 by Dr. Robert Bell, in the Nottaway basin, consisting of eighteen species of Lepidoptera with the exact date and locality attached to each specimen.

"No. 2 by Mr. J. McEvoy at Fadear and Louis Creeks in the last week of June, 1895. This collection contained specimen of *Lycæna*

Anna and *Papilio Turnus*, the latter very interesting for the locality. There was a beautiful suffused variety of *Melitœa Whitneyi*. Maps.

"In accordance with your instructions I am preparing for the Banff Park Museum a collection of Rocky Mountain Lepidoptera, which will be placed before the spring opens."

MAPS.

Mr. James White, Geographer and Chief Draughtsman, makes the following report on the progress of mapping work, and on a further measured line run by him in Ontario for the purpose of fixing geographical positions for the geological map-sheets in progress there:— Maps.

"The assignment of work was much the same as in former years. Mr. C. O. Senecal has compiled and drawn, for photo-lithography, the map of Doobaunt and Kazan rivers, and has also drawn, for photo-lithography, the map of the country between Lake Athabasca and Churchill River and the Labrador maps (4 sheets), besides autographing the Red Lake sheet. Mr. L. N. Richard has drawn sheets 43 to 47 inclusive and sheet 51 of the Nova Scotia series, for the engraver, and the map of Argenteuil, Terrebonne, etc., counties for photo-lithography. Mr. W. J. Wilson was engaged in arranging and cataloguing the maps and plans and in reducing and compiling material for the N. W. sheet of the 'Eastern Townships' map and for a general map of Canada. Mr. O. E. Prudhomme drew sheet 138, Ontario, and sheets 40, 41 and 42, of the Nova Scotia series for the engraver, and, since August, has been compiling and tracing material for the general map above mentioned. Mr. D. I. V. Eaton was engaged on the compilation of sheets 122, Ontario, and 12A of the Nova Scotia series from Feb. 9th to the date of his resignation, July 20th. Mr. J. F. E. Johnston was employed to assist in draughting work on Nov. 30th and has since been at work in the office. Mr. Hugh Cameron was employed from Jan. 27th to Feb. 26th, in cataloguing and numbering plans.

"The number of maps published this year is considerably less than usual, in consequence of the commercial embarrassment of one of the contracting firms, which stopped all work, for about two months, on several of the maps.

"At the present time 15 sheets are being engraved on stone and 2 on copper, while 9 are being photo-lithographed. Of the above 26 sheets, about 11 should be ready early in 1897, so that the number of maps published in 1896 and 1897 combined, will be much above the average. The engraving of the Lièvre Phosphate Map is suspended pending the completion of the geological work. Mapping work in progress.

Maps—*Cont.*

"A new map of the Dominion of Canada, on a scale of 50 miles to 1 inch, was commenced in the latter part of August, and the reductions for it are now well advanced. Wherever possible the original plans and surveys have been used, to avoid all errors that may have been introduced in subsequent publication. It will also include a large amount of topographical and geological information hitherto unpublished. The method adopted, viz., that of reducing the original plans by photography to the uniform scale of 40 miles to the inch and then tracing from the photographic reductions, has so far given excellent results, the details of the topography being exactly reproduced. The compilation being on a scale of 40 miles to the inch will require a further reduction by photography to the publication scale of 50 miles. The original will, however, remain available if, at any time, it be deemed advisable to publish on the larger scale. The geographical features of the tract of country between the Nelson and Albany rivers are somewhat doubtful, owing to the uncertainty as to the position of any of the principal points along the coast of Hudson and James bays between York and Albany. The determination of the longitude and latitude of a few of the principal points, such as Capes Smith, Jones and Henrietta Maria and mouths of Richmond Gulf and Severn and Weenisk rivers, by the Hudson Bay expedition in contemplation for next summer, would be very useful geographically.

"The oblique secant cylinder projection has been adopted for the above-mentioned general map, as giving less distortion at all points than any other. The figures used are those calculated by Capt. E. Deville, Surveyor General, for a cylinder cutting the sphere along two small circles perpendicular to the central meridian—in this case 110° W.—and intersecting it in Lat. 51° N. and 67° N., respectively.

Survey made to fix positions in Ontario.

"As the geographical position of the townships in the southern part of Sheet 118 Ontario (Haliburton Sheet), was in doubt, it was arranged that I should, for the purpose of determining this, take over Mr. Barlow's party when he left the field. I accordingly left Ottawa on September 7th and proceeded to L'Amable, where Mr. Cole, Mr. Barlow's assistant, was encamped. From this point a transit and chain line was carried southward by the Hastings road to Ormsby and north-westward by the Hastings and Baptiste Lake roads to the terminus of the Irondale, Bancroft and Ottawa railway at Baptiste Lake station; thence down the railway to my line of 1895, at the Irondale and Grand Trunk Junction. Returning to Ormsby I carried the line down the Central Ontario Railway to Eldorado, where it connected with the northern part of my work of 1886. Resuming the traverse at the southern part of my 1886 work, near Moira Lake, I carried it via the Grand Trunk Railway to Crookstown, Canadian Pacific railway from Crookstown to Tweed and Kingston, Napanee and Western railway to Enterprise; thence by road to Verona on the Kingston and Pembroke railway, where it intersected my line of 1894 on September 29th. This completes the line from Waubashene on Georgian Bay to Kingston, and fixes the geographical position of the townships in the southern part of Sheet 118, and those along the line through Sheets 112 and 114 and the Madoc and Marmora map. Maps—*Cont.*

" The cataloguing of the maps and plans is suspended at present, as there is no one available for this work. About 4500 out of the 13,000 (estimated) plans have been catalogued in temporary lists and numbered. These include (*A*) charts, (*C*) township plans, Quebec, and (*V*) foreign maps.

" An enumeration of the maps published during the past year or in course of preparation, is appended herewith.

Maps Printed in 1896.

		Area in square miles.
578.	Keewatin and Ontario—Vicinity of Red Lake and part of Berens River—Scale 8 miles to 1 inch..........................	8,240
589.	Western Ontario—Sheet No. 9—Lake Shebandowan Sheet. Scale 4 miles to 1 inch..	3,456
571.	Quebec—South-west quarter-sheet of the "Eastern Townships" Map (Montreal Sheet.) Scale 4 miles to 1 inch	7,200
565.	Nova Scotia—Sheet 39—Tangier Sheet. Scale 1 mile to 1 inch..	216

Maps, Engraving or in Press.

——	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...	4,760,000
604.	British Columbia—Shuswap Sheet—Scale 4 miles to 1 inch.....	6,400
594.	Athabasca and Peace Rivers—Sheet I—Scale 10 miles to 1 inch..	39,700
595.	" " " —Sheet II— " "	39,700
596.	" " " —Sheet III— " "	41,000
597.	North-west Territory — Country between Lake Athabasca and Churchill River—Scale 25 miles to 1 inch..................	137,100
570.	Ontario—Sheet No. 125—French River Sheet—Scale 4 miles to 1 inch..	3,456
605.	Ontario—Sheet No. 126—Manitoulin Island 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

Maps—*Cont.*	599. Quebec—Lièvre River and Templeton Phosphate District. Sheets 1 and 2. Scale 40 chains to 1 inch......................	220
	590. Quebec—Parts 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 mile to 1 inch..	216
	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
	611. Nova Scotia—Sheet No. 51 (and 52)—Ship Harbour Sheet.—Scale 1 mile to 1 inch....................................	256

Maps, Compilation Completed.

603. North-west Territory.—Doobaunt and Kazan Rivers and North-west Coast of Hudson Bay.—Scale 25 miles to 1 inch.......	250,000
Ontario—Kingston and Pembroke Mining District—Scale 4 miles to 1 inch..	1,700
Ontario—Sheet No. 129—Mississauga River Sheet—Scale 4 miles to 1 inch..	3,456
Nova Scotia—Sheets Nos. 48, 49, 50, 53, 54, 55 and 56—Scale 1 mile to 1 inch..	1,512
Nova Scotia—Plans of Goldenville, Wine Harbour, Tangier, Killag, Caribou, Moose River and Mooseland mining districts—Scale 500 feet to 1 inch.	

Maps, Compilation Incomplete.

British Columbia—West Kootanie Sheet—Scale 4 miles to 1 inch.....	6,400
North-eastern Manitoba—Lake Winnipeg Sheet—Scale 8 miles to 1 inch. Area about..	20,000
Quebec—North-west quarter-sheet of the "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. 10A—Cape Dauphin Sheet. Scale 1 mile to 1 inch..	216	Maps—*Cont.*
Nova Scotia—Sheet No. 12A.—Sydney Sheet. Scale 1 mile to 1 inch	216	
" —Sheet No. 12B—Little Glace Bay Sheet. Scale 1 mile to 1 inch..	216	
" —Sheets Nos. 56 to 65, 76, 82, 100 and 101 scale 1 mile to 1 inch..	3,024	
" —Sheets Nos. 66, 67, 68, 69. Scale 1 mile to 1 inch....	864	

Library.

Dr. Thorburn, Librarian, reports that during the year ending 31st December, there were distributed 9833 copies of the Survey publications, comprising reports, special reports and maps, of these 6682 were distributed in Canada, and the balance, 2951 were sent to other countries. Library and publications.

Sales of publications by the Librarian during the year, including reports and maps, numbered 2642, the amount received therefor being $450.28.

During the year 1896, the number of publications received as donations or exchanges was 2559, the number purchased 90, and the periodicals subscribed for 31.

The letters received in connection with the distribution of the publications were 1080, besides 1306 acknowledgments.

The number of letters sent out from the library was 914, and in addition to these 513 acknowledgments were sent to our exchanges and to others from whom publications were received.

The number of books bound during the year was 161.

Visitors.

The number of visitors to the museum during the past year was 31,595. In 1895 it was 26,785. With a more attractive and commodious building, in which the collections could be properly displayed, there is no doubt that even greater attention would be given to the museum by the public. Visitors.

Staff, Appropriation, Expenditure and Correspondence.

The strength of the staff at present employed is 46, being one less than at the close of last year, consequent on the death of Mr. N. J. Giroux, of the technical staff, which took place on the 30th November. Staff.

Appropriation and expenditure.

The funds available for the work, and the expenditure of the Department during the fiscal year ending 30th June, 1896, including appropriation for boring in Alberta, were:

——	Grant.	Expenditure.
	$ cts.	$ cts.
Civil list appropriation	49,742 50	
Geological Survey appropriation	45,054 25	
Artesian boring "	8,311 18	
Civil list salaries		49,432 38
Exploration and survey		14,903 08
Wages of temporary employees		10,831 69
Boring operations. Deloraine (unsettled claims)		58 50
" Athabasca Landing		6,927 09
Printing and lithography		11,603 99
Purchase of books and instruments		643 56
" chemicals and chemical apparatus		182 06
" specimens		80 27
Stationery, mapping materials and Queen's Printer		881 99
Incidental and other expenses		1,303 17
Advances to explorers on account of 1896-97		9,261 56
		106,109 34
Less—Paid in 1894-95 on account of 1895-96		4,773 87
		101,335 47
Unexpended balance Civil list appropriation		310 12
" Geological Survey appropriation		78 25
" Artesian boring "		1,384 09
	103,107 93	103,107 93

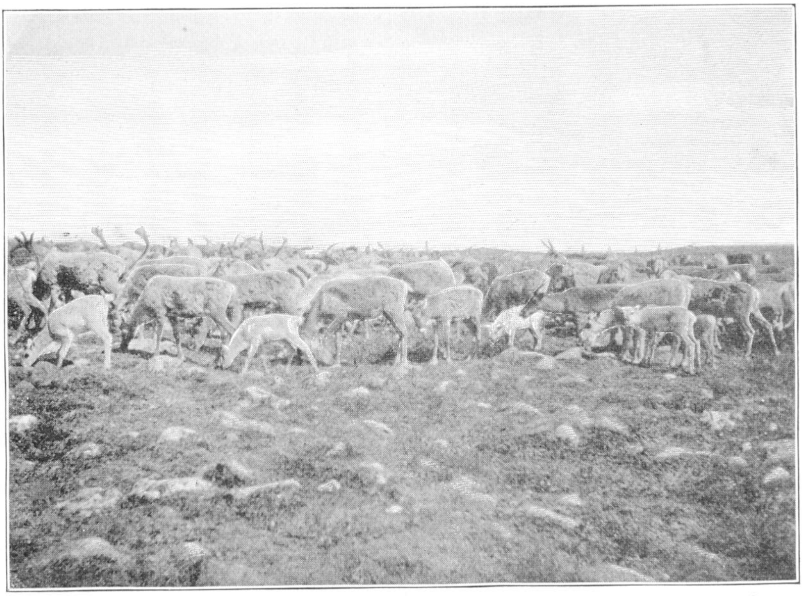
The correspondence of the Department shows a total of 7992 letters sent, and 8110 received.

I have the honour to be, Sir,

Your obedient servant,

GEORGE M. DAWSON,

Deputy Head and Director



July 30, 1893.

J. B. TYRRELL.—Photo. July 30, 1893.

BARREN-GROUND CARIBOU ON THE SHORE OF CAREY LAKE.

Latitude 62° 10′. Longitude 102° 45′.

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

REPORT

ON THE

DOOBAUNT, KAZAN AND FERGUSON RIVERS

AND THE

NORTH-WEST COAST OF HUDSON BAY

AND ON

Two overland routes from Hudson Bay to Lake Winnipeg

BY

J. BURR TYRRELL, M.A., F.G.S., &c.

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

No. 618

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

Director, Geological Survey of Canada.

SIR,—I beg to present a report on the geology and general resources of the region explored in 1893 and 1894, embraced in an area of about 200,000 square miles, lying north of the 59th parallel of latitude, and west of Hudson Bay. The explorations included the examination and survey of Telzoa or Doobaunt, Kazan, Ferguson, Chipman and Cochrane Rivers, Chesterfield Inlet, and the coast of Hudson Bay from Chesterfield Inlet to Churchill, and two overland routes, travelled in winter with dog-teams and sledges, between Churchill and Nelson Rivers.

That portion of the report giving an account of the explorations carried out in 1894 was prepared in the winter of 1895, but the part on the work of 1893 has been necessarily delayed because of the late arrival of the rock-specimens collected.

The surveys were originally plotted on a scale of two geographical miles to one inch, and are now shown on the accompanying map, reduced to a scale of twenty-five miles to one inch.

The illustrations, chosen from more than 400 photographs taken during the explorations, give a better idea of the characteristic features of the country than extended descriptions.

I have the honour to be, Sir,

Your obedient servant,

J. B. TYRRELL.

OTTAWA, 10th May, 1897.

NOTE.—*The bearings throughout this Report refer to the true meridian.*

REPORT

ON THE

DOOBAUNT, KAZAN AND FERGUSON RIVERS

AND THE

NORTH-WEST COAST OF HUDSON BAY

BY

J. BURR TYRRELL.

INTRODUCTION.

The present report, and its accompanying map, is the result of two explorations made in the years 1893 and 1894, the former occupying eight and the latter seven months, counting in each case from the time of our departure until the time of our return to civilization. Dates of exploration.

The vast wilderness through which the lines of exploration passed, lies for the most part north of latitude 59°, and extends from the coast of Hudson Bay, westward to Lake Athabasca, comprising an area of not less than 200,000 square miles. The work of the party embraced a survey of the north shore of Lake Athabasca, the Chipman, Cochrane, Telzoa or Doobaunt, Thlewiaza, Kazan and Ferguson rivers, in whole or in part, Chesterfield Inlet, and the shore of Hudson Bay from Chesterfield Inlet to Churchill, as well as a line overland in winter, from Churchill to York Factory, and another from Churchill to Split Lake. Extent.

Since a large portion of this region lies north of the country where fur-bearing animals are abundant, it had not been travelled over by fur-traders, or even by voyageurs or Indians in search of furs, and the characters of the lakes and streams were, therefore, unknown to any but the few Indian and Eskimo deer-hunters who live on their banks, and who come south once or twice a year to trade wolf or fox skins for ammunition and tobacco. Country hitherto unknown.

Objects of exploration.

It, therefore, seemed highly desirable to determine, not only the geographical features of the region, but also the question of the occurrence of minerals of value in it. The main object of these two expeditions was to obtain some clear idea of the character of the rocks that underlie this vast wilderness. While this object was constantly kept in view, surveys were made of the routes followed, and of any natural features observed on the lines of travel, observations were made on the range and character of the native population, the fauna, flora, climate and other features that seemed to be of interest.

Assistance.

During the season of 1893, I was assisted by James W. Tyrrell, C.E., D.L.S., who had spent one winter on the north shore of Hudson Strait, and had served for two seasons as assistant to Commander Gordon in the survey of Hudson Bay. He acted in the capacity of topographer and Eskimo interpreter to the expedition, and in addition made a large collection of plants, a list of which is given in Appendix III. In 1894, both the geological and topographical work devolved on the writer, but Mr. R. Munro-Ferguson, A.D.C. to His Excellency the Governor General, who accompanied him, did all in his power to further the general objects of the expedition.

Character and extent of surveys.

The sextant, solar compass and chronometer, with prismatic compasses and boat-logs, were the instruments chiefly employed. With them a survey was made of the north shore of Lake Athabasca, from Fort Chippewyan to Fond du Lac, where it was connected with the survey made in 1892; Chipman River to its source at the north end of Selwyn Lake; Telzoa or Doobaunt River, from its source in Daly Lake to its mouth in Chesterfield Inlet; Chesterfield Inlet; the shore of Hudson Bay from Chesterfield Inlet to Churchill; Cochrane River from its mouth in Reindeer Lake to its northern bend; two of the upper tributaries of Thlewiaza River; Kazan River from its source in Kasba on White Partridge Lake to a short distance below Yath-kyed Lake; Ferguson River from its source to its mouth; the winter trail from Churchill to York Factory; and a line travelled in winter from Churchill to Split Lake.

Length of surveys.

The total length of these surveys amounts to rather more than 2900 miles. Of which 1073 miles, on lakes and quiet water, were measured with Massey's floating boat-log; 1312 were estimated by the rate of travel in the canoes; 515 were travelled on foot, the distances being in part estimated, and in part determined by pacing. Of this distance 475 miles were travelled in winter, while 40 miles were travelled in summer across portages over which it was necessary to make three or four trips in order to carry the canoes and cargo.

In order to accomplish the above surveys it was necessary to travel 6100 miles beyond the lines of railway. Of this distance 3850 miles were travelled in canoes, 1200 miles on snowshoes, while the remainder was performed in conveyances drawn by dogs, horses, &c.

The above surveys were plotted by or under the direction of the writer on a scale of two geographical miles to one inch. These plans have been reduced to a scale of twenty-five statute miles to one inch, and are so shown on the accompanying map, and on the map accompanying the writer's "Report on the Country between Athabasca Lake and Churchill River."* Map

Wherever the rocks seemed to be of peculiar interest, or their characters could not readily be determined in the field, specimens three by four inches or larger were collected. Of some of these thin sections have been prepared for examination under the microscope. Those collected in 1893 have been submitted to a preliminary examination by the writer, with the occasional assistance of Mr. A. E. Barlow, of this Survey. Those collected in 1894 have not yet been examined. Rocks collected

SUMMARY OF PROCEEDINGS.

On receiving instructions, in 1893, to make an exploration across the unknown country to the west of Hudson Bay, canoes for the trip were provided, and Mr. James W. Tyrrell, of Hamilton, Ontario, who had spent a winter among the Eskimos at Ashe Inlet, on the north side of Hudson Strait, and who spoke the language of that tribe of Eskimos with reasonable fluency, was secured as topographer and Eskimo interpreter. With the kind assistance of Mr. McLae Walbank, of Montreal, three Iroquois from Caughnawaga—Pierre, Louis, and Michel French—were engaged as canoemen. John Flett, a Loucheux half-breed, living at Prince Albert, Saskatchewan, was also engaged in the same capacity. Later on two additional canoemen were obtained at Fort McMurray, through the kindness of Mr. Henry Moberly, of Ile à la Crosse, Churchill River. Work of 1893. Canoemen.

After making the necessary arrangements at Winnipeg with Mr. C. C. Chipman, Commissioner of the Hudson's Bay Company, for supplies to be obtained from any posts of the company, we proceeded by rail to Edmonton, and thence by team to Athabasca Landing, on the river of the same name. At the Landing, the steamer *Athabasca* was ready to start on her trip down the river, but as much of her freight had not yet arrived, I decided to go on with the two canoes, and a start was made on the evening of May 31st. The next three days Reach Athabasca River.

* Annual Report, Geol. Surv. Can., vol. VIII. (N.S.)

were occupied in descending the river to Grand Rapids. A day was spent there, the steamer having in the mean time arrived, and during the 7th, 8th and 9th of June, we descended the river to Fort McMurray, at the mouth of Clearwater River. Here we were joined by the two canoemen from Ile à la Crosse with an additional canoe, and thenceforward our party consisted of eight men, all told, in three canoes.

Ft. McMurray.

The latitude of Fort McMurray was determined as 56° 42′ 56″. After some detention, we left this place on the morning of 15th June, and towards evening of the same day, we met the Hudson's Bay Company's steamer *Grahame* ascending the river. Dr. McKay, who was in charge at Fort Chippewyan, was on board. He informed us that he had employed a Chippewyan named Moberly to go with us as far as the Barren Lands, that Moberly knew the route well and would probably be able to get another Indian to accompany him from Fond du Lac.

Ft. Chippewyan.

On the afternoon of June 17th, we reached the mouth of the river, and on the evening of the same day crossed Lake Athabasca to Fort Chippewyan, where observations were taken to rate the chronometer. Late on the evening of June 19th, the steamer *Grahame* arrived from Fort McMurray, with our supplies for the summer on board. The next day the steamer was unloaded, and our supplies, brought down by her, amounting to 2200 pounds, were made up in proper bales for portaging, any stuff that would be liable to be damaged by water being put in waterproof sacks. Letters, and photographs that had been taken up to that time, were left to be sent south on the next trip of the steamer up the river.

Begin survey of Lake Athabasca.

On the morning of 21st June, we left Fort Chippewyan, with our canoes loaded down to the gunwales, and started eastward along the north shore of Lake Athabasca, and as Moberly was not able to travel very fast with his family in their canoe, we found time to make a fairly accurate survey, with solar-compass and boat-log, of the north shore of Lake Athabasca. While travelling along by the north-west shore of the lake, we met Charlôt and a band of Indians travelling southward from their wintering ground on Charlôt River. We learned from them that there existed an excellent canoe-route up Charlôt River, across a height of land and down a stream into the south side of Great Slave Lake, or, instead of descending this latter stream to its mouth, a portage could be made to another stream that flows into unknown country towards the north, probably into the west branch of Doobaunt River, the mouth of which was found two months later.

Two days were lost on the shore of this lake on account of high winds, but on the morning of June 29th, we reached the now abandoned trading post of Fond du Lac. Here Moberly was to leave his family with some of his friends who were camped on the south shore. As soon as he reached their camp he, however, began to object to proceeding further, and it was only after long persuasion, and after we had agreed to hire, at extravagant wages, a friend of his to go along with him, that we were able to induce him to accompany us. But he positively refused to do any more work at the paddle that day. Accordingly we went a couple of miles, and camped for the night. The next day Moberly, and his friend Beauvais, caught up to us just before noon, and came slowly after us until evening, when we camped on a point nine miles west of the east end of the lake. Fond du Lac.

On the following morning we paddled to the east end of Lake Athabasca, where a couple of families of Indians were camped. Here Moberly and Beauvais, who had all along taken the post of rear-guard, rather than that of guides, went ashore, and lying on the beach, refused to go further until we should make a feast, distribute flour to the Indians here, and also leave some to be sent back to their families. With our limited supply of provisions, it was of course quite impossible to accede to these demands, and we, therefore, left them, and proceeded up Stone River, glad to be rid of the miserable fellows who had already caused us so much delay, and had done nothing for us but devour our provisions. Our guides leave us.

July the 3rd and 4th were occupied in crossing Woodcock portage, and on the evening of the latter day we camped on the beach of Middle Lake, at the north end of Elizabeth portage. July 5th and 6th, and the morning of the 7th, were spent carrying the canoes and cargo across Elizabeth portage, and at the same time, I made an examination of the heavy rapid north of the portage. On the afternoon of the 7th we paddled against a stiff head wind to the south end of the portage on the north shore of Black Lake, where we were to leave the country that we had explored in 1892, and to strike northward into the unknown territory between Stone River and the Arctic Ocean, guided only by a rude Indian map of the country as far as the head-waters of a stream that flowed northward into the land of the Eskimos and the musk-oxen. Portages west of Black Lake. Leave the explored country.

On July 8th, most of the things were carried across this portage, which is two miles and a third in length, and on Sunday, the 9th, the men remained in camp on a hill overlooking a lovely little lake at the north end of the portage.

A day and a half at the beginning of the succeeding week, were spent travelling through a chain of small narrow lakes, lying in a valley be- Ascent of Chipman River.

tween steep rocky ridges. On Tuesday afternoon we entered Chipman Lake, and the time until the following afternoon was chiefly spent looking for Chipman River, which was found to flow into its north-eastern side. The remainder of the week was spent ascending this river to its source in Selwyn Lake.

On the evening of Monday, July 17th, we came on a small band of Chippewyan Indians camped near the north end of Selwyn Lake, at the foot of a hill, on the side of which birch bark could be obtained sufficiently large for canoes. These Indians did all in their power to dissuade our men from proceeding further, by describing the river ahead of us as being full of impassable rapids, and the country as swarming with cannibal Eskimos. However, on the following day they conducted us to the north end of the lake, where there is a portage, a mile and a quarter in length, across the height-of-land to Daly Lake, from which the river that we were destined to follow flows northward. The Indians would not accompany us north of the height-of-land, and most of the remainder of this week was occupied in following the shores of Daly Lake, though for one day we were prevented by high winds from launching our canoes. Shortly before noon, on Saturday, 22nd July, the Telzoa River, flowing from the lake, was discovered.

Cross the height-of-land.

Descent of Telzoa River.

Thence we continued down this stream, running most of the rapids. In searching our way through the irregular lakes we were obliged to climb most of the hills from which extensive views might be obtained, and to explore many deep bays which were found to have no other outlet than the one by which we had entered them. In this way a considerable tract of country came under observation, but progress was correspondingly slow. On July 27th, while crossing Boyd Lake, we passed from the wooded country into the Barren Lands, and on the 29th we met a vast herd of Barren-ground Caribou collected on a good feeding-ground on the eastern shore of Carey Lake. A number of these deer were shot, and the next few days were spent partially drying as much of the meat as we were able to carry with us.

Last grove of spruce.

On the 6th of August what proved to be the last grove of timber on the river was passed, and on the 7th we entered Doobaunt Lake, which was found to be almost entirely covered with ice, although in most places there was a lane of water between the ice and the shore.

Detention in Doobaunt Lake.

Eleven days were spent in this lake, during five of which we were detained in camp by heavy storms. During the remaining six days the north-western and northern shores were carefully examined in the search for the outlet. The length of the shore-line measured was 117 miles, while the direct distance across the lake from the point where the river enters it, to the point where it leaves it, is only 57 miles, or about two or three days' journey.

On the morning of the 18th of August the river was again entered as it flowed from the north end of Doobaunt Lake. After travelling swiftly down the stream for a few miles, we came to the wildest and most picturesque rapid on the river, where the water rushes for more than two miles through a deep crooked gorge, with a width of not more than twenty-five or thirty yards. Points of black pitchstone or red conglomerate project into the gorge, and as the water dashes against them it is hurled back in a mass of curling ever-moving spray. On the south-east side of this rapid the canoes and cargo were carried for rather more than two miles and a half, over an open prairie country, which, at the time, was very wet from the recent rains.

Outlet of the lake found.

On the evening of the 19th of August, about half way between Grant and Wharton lakes, we came to an Eskimo tent, occupied by a man, his two wives and five children. At first these people were in great consternation at seeing three canoes descending the river from the land of their hereditary enemies, the Chippewyans, but a present of a few trifles and a little tobacco put them fairly at their ease. The man informed us that it was still a long way to the sea, but that there were many Eskimos camped beside the river lower down, and that from them we should receive direction and assistance from time to time. He also said, that while there were still many heavy rapids on the river, the worst of all, and the one that would give us by far the most trouble, was near its mouth. This information proved to be very misleading, for we did not see any more Eskimos for two weeks, and the great rapid, that we were expecting to find at the mouth of the river, turned out to be simply a long stretch of swift current down which the canoes were run easily and without danger, into the west end of Baker Lake. It is quite possible that the information, as given, was not intended to be misleading, but my brother, who acted as our interpreter, and who speaks the language of the Eskimos of Savage Islands with fluency, found it very difficult to understand the dialect spoken by these inland deer-hunting Eskimos, and so may have somewhat misconstrued the man's meaning. Our cook, who was said to have acted as Eskimo interpreter at one of the Hudson's Bay Company's trading stores near the mouth of Mackenzie River for eight years, could not understand this dialect at all.

Meet with Eskimos.

Report of many bad rapids ahead.

Difficulty in understanding this Eskimo dialect.

The direct course across Wharton Lake, from the point where the river enters it to where it leaves it again, is only twelve miles, but contrary winds obliged us to keep to the wrong shore, and detained

Contrary winds.

us in the lake for two days. Lady Marjorie Lake was also crossed in the teeth of a strong head wind, which constantly dashed the spray from the ice-cold water into our canoes and over us. As we descended the stream north-westward from Lady Marjorie Lake, the north-west wind continued to make travel very slow and wearisome. More than two days were spent on this portion of the river, and though all laboured manfully at the paddles, we were unable to travel as fast as the current was flowing in the middle of the stream.

Mouth of Thelew River.

On the evening of the 25th of August, nineteen days after we had left the last grove of timber on the river above Doobaunt Lake, we reached the sandy plains at the mouth of a branch coming in from the west. Probably this stream is the Thelew River of Sir George Back, or the river described to me by Charlôt, a Chippewyan Indian, as being easily reached by ascending the Charlôt River from the north side of Lake Athabasca. On parts of these sandy plains was quite a rank growth of willow, and among the willows were scattered some large drifted tree-trunks. At our camp some of this wood was collected, and we not only enjoyed the luxury of a fire, but some bread was baked, and a large pot of meat was well boiled. Deer were fairly plentiful in the vicinity, and were shot from time to time in order to supply the party with fresh meat, but hunting was not allowed to interfere with the greatest possible expedition in travel. It had become evident that it would be possible to reach Churchill before winter only by travelling with the utmost speed. In order to gain this speed, and avoid the delay from the long portages which we expected still to reach, very little fresh meat was taken into the canoes at a time, and thus we assumed the risk of a shortness of provisions.

Some large driftwood.

Necessity of rapid travel.

From the mouth of Thelew River we turned eastward and travelled through Aberdeen and Schultz lakes, one day being lost in the former lake searching for the outlet. On August 30th, when on the river a short distance below Schultz Lake, we were overtaken by a heavy storm, and, until the morning of the 2nd September, we were unable to launch the canoes. On the latter date we ran down the river to the west end of Baker Lake, which had previously been visited by white men, and which we recognized with great pleasure, for it put an end to our uncertainty as to whether we were travelling towards the Arctic Ocean or towards Hudson Bay, and we had not encountered the long dangerous rapid that we had been looking for. We now wished, if possible, to obtain a supply of caribou-meat, but unfortunately the caribou had become very scarce, having probably withdrawn from the shore into the interior.

Reach a point previously visited by white men.

The survey with compass and boat-log was continued eastward along the north shore of Baker Lake, though for two days we were detained by a storm at the mouth of Prince River. On September 7th we reached the head of Chesterfield Inlet, a long narrow fiord stretching into the very heart of the Barren Lands from the west coast of Hudson Bay. Thereafter in the tidal water of the inlet and along the west coast of the bay, the boat-log was of little or no service, and the distances were, therefore, estimated from the rate of travel. The mouth of the inlet was reached on the 12th of September, and the day being clear, excellent observations were obtained, both for latitude and longitude.

Chesterfield Inlet.

The next three days were beautifully fine and mild, and we made good progress southward down the shore, passing Marble Island, which rose as a vast white dome out of the smooth blue-green water. Towards evening of September 15th, a wind sprang up from the south-east, and drove us ashore on a small sandy island on the north side of Corbett's Inlet, in latitude 62° 30′ 00″, where we were detained for two days.

Pass Marble Island.

On the 17th of September, the south-west wind went down, and we crossed the mouth of Corbett's Inlet, but before we had reached the southern shore a heavy gale sprang up from the north-west, and our little canoes were almost swamped as we approached the shore. All the coolness and dexterity of our good canoemen were called into play in guiding the canoes through and between the breakers into the quiet water behind the rocky reefs. The storm continued to rage, and we were obliged to remain for three days on the point south of Corbett's Inlet, by which time the fresh-water ponds were covered with ice more than three-quarters of an inch thick.

Dangerous crossing of Corbett's Inlet.

The 20th and 21st of September were sufficiently fine to allow us to paddle across Pistol and Mistake bays, at times keeping close to the rocky shore, and at times being miles from land out in the middle of the bays or inlets. The existing maps or charts were of little or no service in guiding us, so that we were obliged to follow the curvings of the shore, or shape our course from headland to headland, being quite unable to take advantage of inside channels, if any such exist.

Previous maps of no service.

On the evening of the 21st we camped on the north side of Neville's Bay. During the night a north-east gale set in, and on the following morning it was driving before it a heavy fall of snow. The barometer dropped about an inch that day, and the storm continued to rage for four days, accompanied by snow, sleet and rain. On the fourth day we walked over the hard crusted snow to the mouth of Ferguson River, which was afterwards descended in 1894. The provisions that we had brought with us were now exhausted, and henceforward we were obliged to depend on our guns for food.

Winter

On September 26th, although the weather was still rough and cold, and the thermometer was constantly below freezing point, the canoes were again launched, and we paddled across the mouth of Neville's Bay, around the rocky point to the south of it, and across Dawson Inlet, to a low sandy shore near the mouth of Wallace River, where we were again detained for a day by heavy seas. During that day five ground squirrels were shot.

On 28th September, after having made a breakfast of the ground squirrels shot the day before, we again started southward, and travelled a few miles. Some caribou were then seen on the shore, and we immediately landed to hunt them, and though unsuccessful in this, one of the men shot a polar bear, and thus furnished us with a considerable supply of food. Another storm now set in and continued to rage for five days, accompanied by a heavy fall of snow, so that the lichens, or dwarf birch, on which we had depended for fuel, were buried out of sight, and the shore, above high-tide mark, was covered with eighteen inches of snow and ice.

Polar bear shot.

Want of fuel.

Flat ice-covered shore.

On October 4th the canoes were again launched, by carrying them out half a mile over the flat ice-covered shore to meet the tide. During the day we paddled about ten miles against a south-west wind, which all the time drove a light snow in our faces, and camped on a very low shore in latitude 61° 31′ 10″, having been obliged to carry everything half a mile over the flat shore to the land above high-water mark. October 5th was cold and clear, the thermometer at noon standing 26° F. We travelled two miles and were then driven ashore by rough weather.

Impossibility of reaching Churchill with loaded canoes.

It had now become evident that we should be quite unable to reach Churchill, which was still 260 miles distant, on open water with our three canoes and their cargo of collections made during the summer. It was, therefore, decided to leave everything behind which was not absolutely necessary for the safety of the party, and thus lightened, to push forward with all possible speed. The land was a vast snow-covered treeless plain, but a slight gravelly eminence was chosen, half a mile from high-tide mark, and on it one canoe, all our rock specimens, instruments, and whatever else was not necessary for our existence, were carefully piled in a heap, covered with tarpaulins, and weighted down with heavy stones. The note-books, photographs, and collection of plants, with axes, guns, ammunition, blankets and two tents, were placed in the remaining two canoes. Thus lightened, with four men paddling in each canoe, we again started southward, determined to travel as far as possible by water.

Collections, instruments, &c., câched on the shore.

The shore was flat, with a tide of from twelve to fourteen feet, and at ebb tide the water was usually several miles distant from the line reached by it at flood tide, so that we were unable to land or launch the canoes more than once in twelve hours—at the time of flood tide.

Wide tidal shore.

For ten days we struggled onward in the canoes, living on what sea ducks could be shot over the open water. The weather was cold, and the spray that was dashed over us by the wind froze on our clothes and beards. It was necessary to constantly knock the ice from the paddles, or otherwise they would soon become too heavy to swing. In places a bordage of ice had formed in front of the beach, so that it was impossible to reach the land with the canoes. The floating ice, through which it was often necessary to push the canoes, had cut them badly and rendered them very leaky. By this time one of the men was suffering severely from an attack of dysentery, and was unable to take his place at the paddle.

Canoe journey continued.

Canoes cut by floating ice.

At nightfall, on October 14th, the tide was at its ebb, and the canoes were several miles from land, off the mouth of Paukathakuskow River, in the midst of heavy drifting ice. The night was spent in the canoes, and one of the men had both his feet badly frozen. At flood tide, shortly after noon on the following day, the edge of the solid ice was reached, and the canoes were drawn over it to the shore. It was impossible to put them again into the water, as that night the shore became covered with compact ice for a long distance out. It was afterwards learned that the Hudson's Bay Company's officer at Churchill had left a boat on the shore between York and Churchill, several weeks before, considering it too late to continue the journey to Churchill that season.

End of canoe journey of 1893.

From the mouth of Paukathakuskow River two men were sent on foot along the shore to Churchill, where they were able to obtain four sledges and teams of dogs, and with the assistance of these dog-teams the canoes and party were hauled over the snow to Churchill, where we arrived on October 19th.

Churchill reached with dogs and sledges.

On the 6th of November, the Churchill River was frozen over, and having obtained a sledge and team of dogs, to haul the provisions as well as the man whose feet had been frozen, the overland journey to Winnipeg, a distance of about 900 miles by the proposed line of travel, was begun.

Start from Churchill for Winnipeg.

On arriving at Nelson River, the stream was found to be full of running ice, so that it was impossible to cross it, either in a boat or on the ice. Our party, augmented by three local Indians, was therefore obliged to remain on its banks for ten days, subsisting on the few

Delay at Nelson River.

rabbits, ptarmigan, foxes, &c., that we were able to catch or shoot. During this time the weather was very cold, the temperature often falling at night to -20° F. On November 24th, however, we arrived at York Factory, and on the 28th of the same month we left the inhospitable shore of Hudson Bay, and travelled by way of Oxford House and Norway House to West Selkirk, Manitoba, where we arrived on the evening of January 1st, 1894.

Arrive at Selkirk.

Work of 1894.

On the 28th of May, 1894, the writer was instructed to further explore the Barren Lands west of Hudson Bay. Information had been received during the two previous years, that a passable canoe-route existed from Reindeer Lake northward up Cochrane River, across a height-of-land to Kasba or White Partridge Lake, and thence north-eastward down the Kazan or White Partridge River to Hudson Bay; and it was certain that as the river was south and east of the Telzoa or Doobaunt River, its mouth must be somewhere between the head of Chesterfield Inlet and Churchill. What little information had been received had led to the belief that it was the river which we had seen flowing into the bottom of Neville's Bay. This proved to be an error, and it is now reasonably certain that the Kazan River discharges into the south side of Baker Lake.

Mr. R. Munro-Ferguson.

On this occasion, the writer was accompanied by Mr. R. Munro-Ferguson, A.D.C. to His Excellency the Governor General of Canada, with his own canoe and men, and entirely at his own expense. Mr. Ferguson also supplied the party with several instruments, and throughout the whole season did everything in his power to advance the interests of the expedition. Its complete success is largely due to his constant and enthusiastic energy and assistance.

Preparation and assistance.

Two cedar canoes, built specially at Peterborough, Ontario, were provided, and with the kind assistance of Mr. Wm. Clark, of Winnipeg, and Mr. McLean, of St. Peter's, three canoemen, Roderick Thomas, John Harper and John James Flett, were employed at Selkirk, Manitoba, while a fourth man was engaged as cook and canoeman in Winnipeg. Sir John Schultz, Lieutenant Governor of Manitoba, also kindly loaned us a large birch-bark canoe to assist us in carrying provisions during the earlier part of the trip. Arrangements were also made with Mr. C. C. Chipman, Commissioner of the Hudson's Bay Company, for obtaining any additional supplies that might be needed from the trading stores of the company if the articles were not wanted for their own use. A supply of provisions was also purchased and sent up to Fort Churchill, on Hudson's Bay, by the Hudson's Bay Company's steamer "Erik," to serve on the return trip, or in the event of being delayed at Churchill.

With these arrangements made, and with ten weeks' provisions, the party started from Selkirk on June 16th, but it was the 22nd of June before it reached Grand Rapids, at the mouth of the Saskatchewan River. Here the canoes were put in the water for the first time, and two additional men were employed to man the birch-bark canoe, and accompany us up the river as far as Cumberland House, which was reached on July 2nd. On the way we were delayed for two days by a heavy storm, and our progress was greatly retarded by the rapid current of the river, which at that season of the year was at extreme high water. Leave Selkirk.

Unfortunately some of our provisions had been lost by the upsetting of one of our canoes in the Calico Rapids below Cedar Lake, but we were able to replace most of them at Cumberland House. David Crane, a Cree Indian, was engaged as canoeman to replace the cook employed in Winnipeg who had proved inefficient; and two other Indians were engaged to accompany us in the birch-bark canoe as far as Du Brochet post at the north end of Reindeer Lake, from which place they were to return. The two men employed at Grand Rapids returned from here. Arrive at Cumberland.

On July 4th, the party left the Saskatchewan River at Cumberland, and turned northward up Sturgeon-weir River to Churchill River at Frog Portage, thence down the Churchill River a few miles to where it is joined by Reindeer River, up this stream to Reindeer Lake and along the eastern shore of Reindeer Lake to its northern end, where the Hudson's Bay Company have their most northerly trading post in that district, and the Roman Catholic Church has a mission. Here the Chippewyan Indians resort from the surrounding country two or three times a year to barter their fur and deer meat for ammunition and clothing, and to perform their devotional exercises. About Christmas time a few Eskimos come in from the far north bringing robes and furs to trade for ammunition and tobacco, but throughout the remainder of the year the trader and the missionary are almost alone. Du Brochet Post.

At this place, which is usually called Du Brochet post, the two Indians whom we had engaged at Cumberland were sent back in the bark canoe, and two Chippewyan Indians were persuaded to accompany us northward in their own canoe as far as Ennadai Lake on the Kazan River, as guides, and to help us to carry our provisions. Engage two Indian guides.

Up to the time of our arrival at Du Brochet post, we had been travelling through country which was already to some extent known, at least geographically, and we had therefore hurried on, devoting all Extent of previous surveys.

the time caused by necessary delays to an inspection of the adjoining rocks and not to the making of any regular geographical survey. The position of Du Brochet post had been moderately well determined by the surveys of Mr. A. C. Cochrane in 1881 and Mr. D. B. Dowling in 1892. The first-named gentleman had ascended Cochrane River, following the route we were about to travel, for one hundred and fifteen miles, but his distances were all estimated, and on this river he took no astronomical observations for either latitude or the variations of the compass, so that it was necessary to commence the survey from this trading post.

Surveys begun.

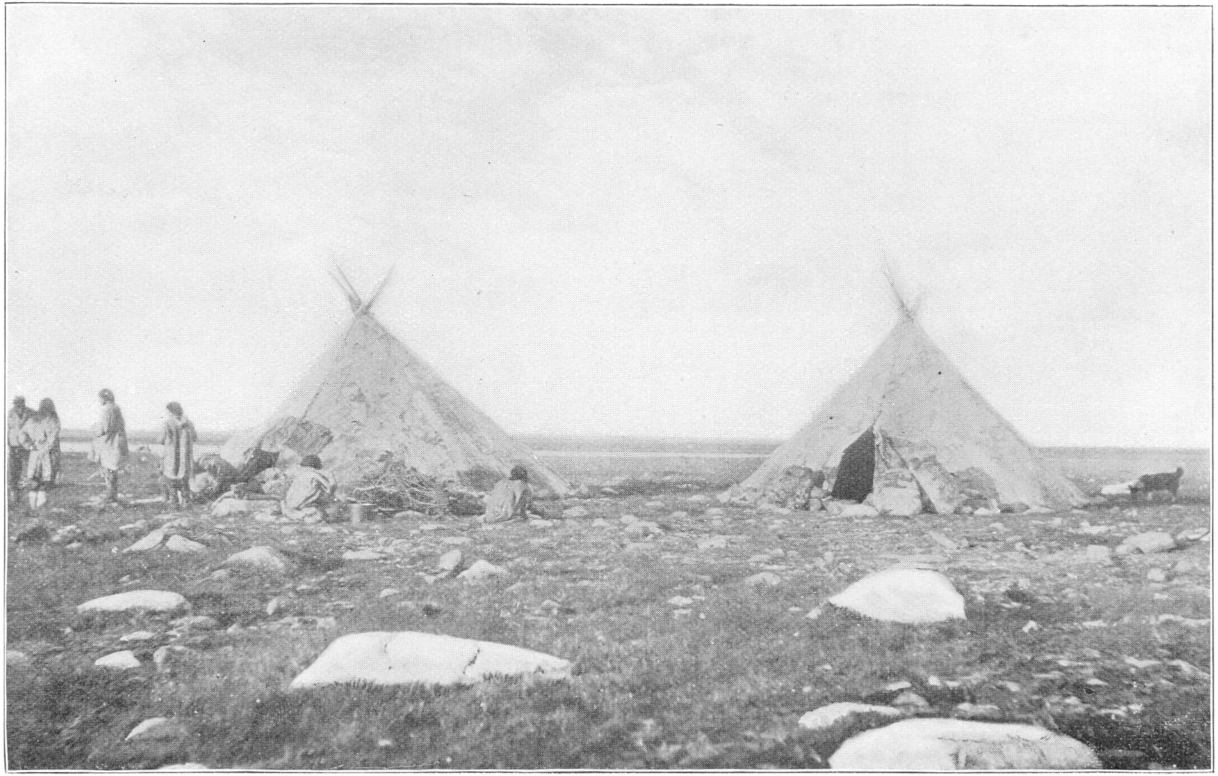
Observations were, therefore, taken for latitude and the variation of the compass, and on the afternoon of July 20th we left this last abode of civilized man and began the ascent of Cochrane River, measuring the quiet stretches with a boat-log and estimating the stretches of running water, taking the bearings with a prismatic compass, using a solar compass occasionally to correct the variations, and taking the latitude daily, when possible, with the sextant. The river was ascended in a general northerly direction for a hundred and twenty-one miles, in which distance there were nine portages, to a point on its east bank, where the Indians usually leave the stream and carry their canoes over a steep-sided sandy ridge for a third of a mile to a small lake.

Long chain of portages.

On the afternoon July 27th, we left Cochrane River and carried our canoes, provisions and supplies across this portage, which proved to be the first of a long chain of portages, forty-four in number, with an aggregate length of about thirteen miles. The trails were usually very bad, being often over irregular masses of broken rock, and, as a rule, it was necessary to make four trips over each portage to carry the canoes and their loads. This route passes through many lakelets and down and up small streams tributary to Thlewiaza River, till it finally reaches Kasba Lake, on the sandy shore of which we had the pleasure of camping on the evening of August 5th.

Begin the descent of Kazan River.

A storm now delayed us for a day and a half, but on the 7th of August, we were able to launch our canoes on this lovely sheet of clear water, and begin the survey of its eastern shore. With considerable difficulty we induced our Chippewyan guides to accompany us through this lake, and down the Kazan River, which flows from it, for thirty miles to the south end of Ennadai Lake. These Indians had now done all that they had originally agreed to do in taking us down the Kazan River as far as they had any knowledge of the country, either from their own experience, or from the accounts of their friends. We had reached the



J. B. TYRRELL.—Photo. Aug. 18, 1894.

ESKIMO CAMP ON THE BARREN LANDS.

northern confines of their hunting grounds, and the unknown country to the north was supposed to be thickly peopled with unfriendly Eskimos.

Indian guides return south.

On the morning of August 10th, therefore, we paid them for their services, and continued northward over Ennadai Lake without them.

The party now consisted of Mr. Munro-Ferguson and the writer, with four canoe-men, in the two cedar canoes. An unknown river, with many broad lakes, lay between us and some point on the west side of Hudson Bay, beyond which was the canoe journey in autumn down the inhospitable, treeless shore, of the bay itself.

Storm on Ennadai Lake.

After paddling thirty miles down this lake, we were delayed for two days by a heavy storm with snow and rain, where the tents had been pitched in the second camp beyond the northern edge of the woods. Up to this time we had not seen any caribou, and had not been able to shoot anything with which to replenish our rapidly diminishing stock of provisions.

Barren-ground caribou.

On August 14th, we crossed to the west side of Ennadai Lake, and then, for the first time that season, fell in with the Barren-ground caribou, travelling southward in large numbers. The country was open and treeless, and the deer were rather difficult to approach, but twelve were shot and cut up, and their meat was spread out to dry in the sun and wind.

An Indian wanderer.

Here a Chippewyan Indian came into our camp and gave us to understand that many Eskimos were camped farther down the river. After considerable persuasion, he consented to guide us down to where the Eskimos were living, but the next day he left us, and we saw nothing more of him. We, therefore, continued down the river without any guide until the afternoon of August 17th, when we reached the Eskimo camp of Kopanuak, so called after its chief man. On our approach, the inhabitants fled away over the hills, but after a while they became convinced of our friendly intentions, and slowly returned. We now felt very keenly the need of an interpreter, for none of us could speak their language, and they could not understand a word of ours. However, after considerable difficulty, one of the Eskimos was induced to draw a rough map of the lower part of the river, which appeared to show that it flowed through several large lakes and then emptied into the west side of Hudson Bay, south of Marble Island. Delighted with this information, and accompanied by three Eskimos in their deer-skin kyacks, we continued down the river to the tent of a bald old man named Hikuatuak, where we camped for the night, drenched to the skin by a drizzling rain which had been falling during the afternoon.

Meet with Eskimos.

Companions.

The next day the Eskimos accompanied us, attracted by the small presents of needles, tobacco, &c., that we were able to make to them, and by the novel sight of white men journeying through their country. Two camps were passed, and towards evening we reached a third, consisting of two tents, inhabited by four families or about sixteen persons. Hallo was the chief man, but two others were Ah-yout and his son Kakkuk.

An Eskimo guide secured.

We had still to descend about a thousand feet before reaching sea-level, and it was therefore probable that many rapids or falls lay between us and Hudson Bay, while much time might be lost in searching our way through the irregular lakes. It was therefore necessary, if the journey was to be continued, that a guide should be secured. At length, after a long parley, the promise of a gun to himself, and tobacco, beads and knives to many of his relatives, induced Kakkuk to accompany us, while his father, Ah-yout, said that he would go a short distance with his son. The next night Ah-yout volunteered the pleasing intelligence that he would go with us all the way to the sea. We continued down the river, almost every day passing two or three small Eskimo camps, where we were always welcomed kindly, and our presents of tobacco, &c., were received with shouts of joy. With needles, thimbles, &c., we purchased deer-skin clothing to protect ourselves against the severity of the autumn weather which was now so nearly upon us.

Unwelcome news about the river.

On August 26th we reached Passamut's camp, where it was learned for the first time that the river that we were descending emptied into Chesterfield Inlet. To follow the river there would be out of the question, for we would probably reach the Inlet even later than in the previous year, and on the trip down the shore of Hudson Bay, we should be exposed to the same dangers and privations that we had then suffered. After making diligent inquiries, however, we learned that it was possible to leave the Kazan River some distance below, and by a chain of long portages to reach a lake at the head of another stream which empties into Hudson Bay opposite the Walrus Islands. We determined to try this route.

Another route.

On the 30th and 31st of August we crossed Hicoliguah Lake, doubtless the Yath-kyed Lake of Samuel Hearne, and reached an Eskimo camp below it, near the point where we were to leave the river. Six more Eskimos were hired to help us across the portages, one of them agreeing to accompany us to the sea, for our two guides did not know the way any further. The first of September was beautifully fine, giving us the opportunity of obtaining good observations for latitude and

Leave Kazan River.

variation, the former being 63° 7′ 48″, and the latter 20° 45′ east. After this rainy and stormy weather set in. For most of five days the men worked ankle-deep in the water on the wet portages. On the 5th of September we reached Ferguson Lake, five of the Eskimos were paid off, and from that time until September 18th, when we reached Hudson Bay, the weather was constantly stormy, with showers of rain and snow. The Eskimos shot reindeer and supplied us with meat, but very little fuel was to be had to cook it with. At Hudson Bay our Eskimo guides were paid off and we parted with them with great regret, for in the month that they had been with us we had all become excellent friends.

Reach Hudson Bay.

On reaching the mouth of the river we at once recognized it as a place to which we had walked through the deep snow on September 25th, 1893, when storm-bound on a point a few miles distant, at the mouth of Neville's Bay. From the time of our arrival at that camp it had then taken us twenty-eight days to reach Churchill. Should the weather prove similar to that of last year, and cause us similar delays, many and great hardships were undoubtedly again in store for us. But the day was calm, and while our three Eskimo friends turned back up the river, we paddled out with the tide over the salt water of Hudson Bay, camping for the night on a bold rocky point a few miles south of Sir Bibby Island.

Canoe journey along the shore.

The next day a stiff south wind with a heavy fall of snow, rendered our progress very slow, but at length we succeeded in crossing Dawson Inlet and reaching the point near the mouth of Wallace River where we had camped on the26th of September the previous year. After cutting a hole through the ice of the small lake in the vicinity, the water was found to be now quite blackish, and we were, therefore, obliged to melt some snow over the alcohol lamp for tea. The next day, 20th September, the south wind was still blowing, causing heavy breakers on the low sandy shore, but we carried our canoes and cargo a few hundred yards along the shore and managed to launch the canoes behind a bar of sand. The ebbing tide, and low shore with its very long points of boulders, obliged us to keep far out from land. When the tide rose again we landed, probably a short distance north of our *câche* of last year, but it was now after dark and we could see nothing of the adjoining country. The next morning was cold and cloudy, with a south-east wind. Leaving Mr. Munro-Ferguson to launch the canoes and bring them on as soon as the tide should rise sufficiently high, the writer walked along the shore to look for the *câche*. The small ponds were all frozen over, but the brooks were still open except along their edges. After walking for a couple of hours, without seeing any signs of the *câche*, the canoes came up. The tide was now ebbing fast, and it was necessary to join the canoes at once and travel on, leaving the shore altogether, or to land the canoes for the day.

Delay inadvisable.

For the past three weeks the sky had been constantly overcast, so that no astronomical observations could be taken to determine our position, and for five days out of the past seven, it had been snowing more or less every day. As the subarctic winter was rapidly closing round us, and we were still two hundred and sixty miles from Fort Churchill, the nearest base of supplies, on an uninhabited barren coast, with no fuel but three pints of alcohol, it seemed very unwise to lose even a day's travel in a search for the *câche ;* more especially so, as we should have been able to take very little, if any, of the stuff with us, for our collections and necessary provisions furnished our two canoes with nearly all the loads that they could carry. We, therefore, continued our journey, camping at high tide, long after dark, on a sandy flat below spring-tide level, about seven miles north north-west from Cape Esquimaux.

The next day we travelled about eleven miles, being finally driven ashore in a storm on a small sandy island on which there was no water. On the day following we travelled about sixteen miles. The tide was at its height shortly before noon, but we continued in our canoes till after two o'clock, when finding that the tide was ebbing very fast, we turned towards shore, but were unable to come within a mile and a quarter of land when we went aground on the sand and boulders. The canoes and stuff were then portaged for the above distance to a small island, where the camp was pitched, trusting that an east wind would not arise in the night and drive the rising tide over us. The water around us was found to be fresh, and further investigation proved that we were camped in the mouth of a river, probably of considerable size. The night was starry and cold, and an observation showed us to be in latitude 60° 49′ 45″. At low tide the sea could not be seen from our camp.

Left aground by the ebbing tide.

The next morning the water was frozen all around the tents. The canoes were carried a third of a mile to meet the incoming tide, and we were afloat an hour and a half before the tide was at its height. That day, in spite of a snow storm, we made eight miles along a low shore, often through thin floating ice, going ashore, as the tide went out, on a sand spit in front of the mouth of a small brook.

Water frozen around the tents.

The next day, 25th September, the canoes and stuff were carried out on the flat shore, and the tide was met nearly three hours before it was at flood, and in spite of a stiff south-west wind right in our faces, we travelled ten miles to a rocky knoll, where we camped about a foot and a half above the last flood tide, separated from the low shore by a quarter of a mile of sandy tidal flat. Opposite us was the mouth of a small brook, from which we obtained water. Our object in camping on this little rock was to be able to catch the tide in the morning, for it would be up about four o'clock, long before the first streak of dawn appeared at that time of year. The next morning was perfectly calm, and we had launched our canoes by half past four, but at six o'clock a dense fog set in, and continued almost all morning, covering the canoes and everything in them thickly with frost crystals. Many times the canoes were in danger of destruction from cakes of floating ice, or from being carried over boulders by the swiftly ebbing tide. Lunch was eaten in the canoes, and a long day's travel of about thirty-five miles was made, camp being pitched for the night in the bottom of a bay full of boulders. The next day was clear, cold and windy, the thermometer standing at 26° Fahrenheit at noon, when an observation was obtained showing the latitude to be 60° 3′ 30″. On a light rise a short distance back from the shore the men found some drifted tree-trunks, being the first large driftwood that we had seen this autumn on the west coast of the bay. Towards evening the wind went down a little and we travelled southward for four miles to a stony hill, where two large drifted logs gave us the promise of a good warm fire, a luxury that we had not enjoyed for many a day.

Camp on rocky knoll.

Travel in the fog.

First driftwood.

The next morning we launched our canoes at high tide and shoved through the thin ice among the boulders by the shore. The weather was cold throughout the day, the ice forming constantly on our paddles, but we carried some firewood in our canoes, and at noon, when the tide was down, we came to a rock where we were able to build a fire and have a hot lunch, and at night our camp was pitched on a point in latitude 59° 28′ 8″, where driftwood was very abundant, and we had a splendid fire. On September 29th the wind prevented us from going past Hubbart Point, having travelled only eight miles, and our camp was pitched on the stony hill at the point. In the afternoon the men paddled to the shore, about a mile to the west, and procured some water.

Difficult navigation.

Reach Hubbart Point.

September 30th was dull and either calm or with a light breeze from the north, and good progress was made. At night-fall we were opposite the mouth of Paukathakuskow River, where we went ashore for the last time last year. The tide was not yet up, and we experienced considerable difficulty getting to land through and over the thick ice, finally reaching a willow-covered flat, where our tents were pitched in the snow. The next morning we continued to follow the shore for about five miles and then, as the Churchill rocks began to appear on the horizon, we struck across the mouth of Button's Bay and rounded the outer Churchill beacon at noon. The tide was rushing out of the gap at the mouth of the harbour, and we were, therefore, unable to enter it until the tide had turned. About four o'clock we passed old Fort Prince of Wales and entered the harbour, and just as night settled down on us we landed on the rocky point below the mission at Churchill. Here we were met by Reverend Mr. Lofthouse, Capt. Hawes and Mr. Alston and given a hearty welcome. It was impossible to proceed further with canoes, and, as the rivers were not yet frozen, it was equally impossible to travel overland. We, therefore, accepted the very kind invitation of Mr. and Mrs. Lofthouse to stay with them during our necessary detention at Churchill, while Capt. Hawes provided a room for the men in one of the houses at the trading post. During our detention here, which was protracted through nearly two months, the rocks of the vicinity were examined as closely as possible, the surveys already made were plotted on a scale of two miles to an inch, considerable information was collected as to the dates of opening and closing of Churchill harbour during the past seventy years. Sketches and descriptions of the country lying west of Hudson Bay and east of Reindeer Lake and Kazan River were also obtained from an Eskimo named Powow who was spending the winter at Churchill, and from Jimmy Anderson and Curly Head, two Chippewyan Indians who came in to trade.

Arrive at Churchill.

Work at Churchill.

Preparations for overland journey.

In 1893 we had returned southward from Churchill by following the route used by the Hudson's Bay Company to York Factory, and thence to Oxford and Norway House. This year we decided to explore a new route, going direct from Churchill to Split Lake on the Nelson River, and thence by Cross Lake to Norway House, a route especially interesting as being near the proposed line of the Hudson Bay railway; but there was no trail across the country from Churchill to Split Lake, for the route had never been travelled, and the Hudson's Bay Company's officer at Churchill was unwilling to risk the starvation of his men and dogs by sending them that way. On November 10th the Churchill River froze over, but we were obliged to wait until the 22nd, when eight Chippewyans came in to trade, before we could obtain dogs. From these Indians we bought five dogs and a dog-sled. Two Cree Indians, named James Wastascot and David Dick, were at that time camping in the vicinity, and as food was very scarce, we induced them to accompany us to Split Lake with their dog-sled and team of three dogs. The Hudson's Bay Company also agreed to send a dog-team and two men with us for the first six days of our journey. The Geological

Survey canoe was stored at Churchill and most of the collections and heavy stuff were left to be brought out of Hudson Bay the following year by the annual ship of the Hudson's Bay Company.

Provisions, &c.

Being now provided with means of transport, the loads, consisting almost entirely of provisions, bedding, guns and ammunition, were made up and packed on the sleds. Fourteen days' rations were taken for the men and twelve for the dogs, the latter consisting of refuse meat from the white whales or belugas that had been caught in the harbour during the summer. The total weight of the provisions was a thousand pounds, four hundred being for the men and six hundred for the dogs.

Start for Split Lake.

At day-break, on the morning of Wednesday, the 28th of November, we bade goodbye to our kind friends and started up the Churchill River on our long tramp homeward. That day we walked without snow-shoes on the ice of the river, but early the next day we left the river to the west of us, and, tying on our snow-shoes, started across an almost treeless snow-covered plain, through which Deer River winds in a very sinuous channel. On the fifth day the edge of the woods was reached, and from that time the snow was very soft and deep. On the night of the 3rd of December camp was pitched on the brow of a high ridge, which was said to extend a long way both to the north and south. Here the Hudson's Bay Company's dog team and two men left us and returned to Churchill, while we continued southward with our own team and that of our two Indians, chopping our way through the forest. Our course led us across the head-waters of Owl River, which flows into Hudson Bay a short distance north of Nelson River. On December 9th we reached Wapinihik'iskow or White Spruce Lake, at the head of the Kisse'-mitiskun or Old Fish-weir River, a tributary of Nelson River, and the same evening we reached Namaco Lake, at the head of Mittitto or Limestone River, where we found a small band of Indians camped for the winter. Our dog food was almost exhausted, and here we not only obtained a supply of fish for our dogs, but we induced one of the Indians to accompany us with his dog-team to Split Lake, where he was accustomed to trade his furs. The rest of our route was therefore comparatively easy, for we had the assistance of a guide, a fresh team of dogs and a well cleared trail, though the trail was now covered deep with soft snow. On the evening of 13th December we reached the bank of Nelson River, a short distance from Gull Rapids, and ascending the river we reached the Hudson's Bay Company's trading post on Split Lake on the morning of the 15th of December, the eighteenth day out from Churchill.

General course.

Reach Nelson River.

Here we paid off our Indian companions, who were to return to Churchill and Namaco Lake, and hired another man and dog-team to accompany us to Norway House, which place we reached on Christmas Eve, after an eight days' walk. There four days were spent under Mr. Macdonald's hospitable roof, giving both men and dogs a much needed rest. David Crane, one of our steersmen, who had accompanied us throughout the summer, was here paid off, and sent home to Cumberland by Grand Rapids and up the Saskatchewan River. Then, after hiring a fresh dog team, we again started southward on the 29th of December, and walking on the shore of Lake Winnipeg, reached Dog Head on the evening of the January 4th. The dogs from Norway House had already returned, and here the dog-team purchased at Churchill was disposed of. At length, leaving aside our snowshoes, we obtained two carioles and one sled, with three teams of dogs, to take us to Drunken Point, where we hired horse-teams to take us to Selkirk. That town was reached on the evening of January 7th, after an absence of six months and twenty-two days, during which time we had travelled 2900 miles, 1750 of which was in canoes and 725 on snowshoes.

ReachSelkirk.

HISTORICAL SKETCH.

Reasons for former want of knowledge about this country.

The country here reported on has up to the present remained essentially unexplored, for in it valuable fur-bearing animals are scarce or in most places almost entirely wanting, and fur-traders have, therefore, not penetrated into it, become familiar with its waterways, or marked out its portages. Its lakes, streams, and mountains have remained unknown except from the vague stories that have been brought into the Hudson's Bay Company's trading posts on Churchill River, or on Great Slave, Athabasca or Reindeer lakes. No trading posts had ever been established in it, and its beauties and dangers were wrapped in the deepest mystery. North of the limit of the woods it had never been crossed by civilized man, and only once had any attempt been made to penetrate into it.

Copper reported.

During the last century many reports were brought to Churchill, on Hudson Bay, of the existence of great quantities of native copper on the banks of a stream far to the north, and about the same time the Hudson's Bay Company was subjected to severe criticism and violent censure in England on account of the constant assertions, and growing belief, that the Company was strongly opposed to any investigation or exploration of the interior country, back from the shores of Hudson Bay.

Hudson's Bay Co. censured.

Samuel Hearne.

Accordingly Samuel Hearne, a clerk at Fort Prince of Wales, the stone fortress at the mouth of Churchill River, was sent with some

Indians on foot, in the autumn of 1769, to look for the Coppermine River, and the deposit of ore on its banks.* He went but a short distance up Seal River, when the Indians deserted him and he was obliged to return, having been absent thirty-six days. 1st Journey, 1769.

On the 23rd of February, 1770, he again started from Fort Prince of Wales, and travelled westward to Lake Sheth-than-nee, or Sheth-nanei (the high hill) where he remained for the winter. In the spring he began his journey northward, and reached Baralzone, near the edge of the woods, on June 1st. Continuing onward he crossed some lakes and streams at the head of the Tha-anné and Maguse rivers, and on June 30th arrived on the banks of the Kazan River above Yath-kyed Lake, at a place which he calls Cathawhachaga, only a short day's journey south of a bay of Yath-kyed Lake. Since a number of Indians were collected at this point to kill caribou as they attemped to cross the river, it was probably the regular deer-crossing place above Yath kyed Lake, known to the Eskimos as Pal-lel'-lue. Hearne's astronomical observations are here seen to be very inaccurate for he states "I made several observations for the latitude, and found it to be 63° 4′ north," whereas the river flows into Yath-kyed Lake from the southwest about latitude 62° 38′, and the crossing-place is a couple of minutes further south, leaving the mean of his "several observations" about 28′ too far north. 2nd Journey, 1770. Cathawhachaga.

From Yath-kyed Lake he accompanied a large band of Indians as they wandered backward and forward in search of caribou, working very slowly towards the north-west, around the north side of Doobaunt Lake, until the season became so far advanced that his guide refused to go through to the Coppermine River that year. The Indians with whom he was travelling also plundered him of almost all that he had in his possession, and to complete his discomfiture his sextant had been blown over by the wind and shattered. He, therefore, decided to return to Churchill. Keeping to the west of Doobaunt Lake, he appears to have crossed the Telzoa River a short distance above it, perhaps at the bluff of small black spruce where we camped on the 6th of August, 1893, and the Kazan River a short distance above Angikuni Lake. On 25th October he reached the edge of the woods. The day before he reached Seal River he crossed an exceedingly stony piece of ground, possibly of a morainic character. On November 25th, he arrived at Fort Prince of Wales, "after having been absent eight months and twenty-two days, on a fruitless or at least unsuccessful journey." Plundered by his Indian guides. His return.

* A journey from Prince of Wales Fort, in Hudson Bay, to the Northern Ocean, by Samuel Hearne, Dublin, 1796.

3rd Journey. 1770-1772.

Twelve days afterwards, having obtained new guides, he again set out for the Coppermine River, but on this occasion he avoided the Barren Lands as much as possible. Starting from the fort, over the snow, with dogs and sledges, he reached Seal River on December 13th, and on the 30th of the same month arrived at Island Lake. In the beginning of February, 1771, he crossed Kasba or White Partridge Lake near its northern end, and a month later Whooldyah'd Lake, which is possibly the one here called Daly Lake, though it is almost equally likely to be one of the many adjoining lakes. He continued westward to a place called Thelewey-aza-yeth, or Little Fish Hill, somewhere north of Lake Athabasca. Here he turned northward, and, passing near the east end of Great Slave Lake, reached Coppermine River on the 15th of July. On his return journey, he followed much the same course from Thelewey-aza-yeth to Churchill.

Remarks on Hearne's work.

Of the recent state of our knowledge of this country, Dr. G. M. Dawson, Director of the Geological Survey, speaks as follows:—"The lakes and rivers shown in this great region depend entirely on the results of the three journeys made by Hearne in 1769-1772. Hearne really wandered through parts of this region in company with Indians whom he was unable to control, his ultimate object (which he at length accomplished) being to reach the Coppermine River, in order to ascertain, for the Hudson's Bay Company, whether it was possible to utilize the native copper found there. Not even roughly approximate accuracy can be assigned to his geographical work. Referring to the position of the mouth of the Coppermine, he writes: 'The latitude may be depended on to within 20 miles at the utmost.' In reality it afterwards proved to be 200 miles too far north."*

Hearne's book gives an exceedingly interesting account of life among the Indians at that time, and of the animals and birds found in the vicinity of Churchill, but it contains very little information about the character of the country over which he passed, and nothing about its geology.

West coast of Hudson Bay.

The west coast of Hudson Bay, north of Fort Churchill, along the eastern edge of the Barren Lands, has been seen by several explorers, but as all have travelled in large boats, or ships, which necessarily kept out long distances from land, or touched it at but very few of the more prominent points, the details of the shore have remained quite uncertain. It is believed that previous to 1893 no white man attempted to travel along this coast in canoes or small boats.

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* On some of the Larger Unexplored regions of Canada, by G. M. Dawson. Ottawa Naturalist, vol. IX., No. 2, May, 1890.

Sir Thomas Button.

About the middle of April, 1612, Captain (afterwards Admiral Sir) Thomas Button* sailed from Gravesend in two small ships, the *Resolution* and the *Discovery*, (the latter the same ship from which Henry Hudson had been set adrift by his mutinous crew in Hudson Bay the year before), in search of a north-west passage to China and the Indies, and also probably to try to find some trace of Hudson. After passing through Hudson Strait, Button crossed Hudson Bay and sighted its western shore in north latitude 60° 40′ which he named "Hopes-checked." Here encountering a heavy storm he turned southward, and on the 15th of August ran into Nelson River, so called after the master of the *Resolution*, who died here, where he laid up his ships for the winter. The next summer he left Nelson River, possibly only in the *Discovery*, and sailed northward, rounding Cape Churchill, passing "Hubbart's-Hope" in latitude 60°, and then kept in sight of the shore as far as "Hopes-Checked." He then stood north-eastward past the east end of Marble Island, which he called "Hope's-Advance," and onward into the Welcome as far north as latitude 65°, after which he turned southward and eastward back to England.

Jens Munck.

The next to reach the north-west coast of Hudson Bay was Captain Jens Munck†, who, in 1619, sailed with two ships from Elsineur through Hudson Straits into Hudson Bay, reaching its west shore in latitude 63° 20′, when he was forced by ice to turn south. He is said to have established winter quarters in Churchill Harbour, where he caught black foxes and sables (martens) which are not found far north of the edge of the woods. During the winter he lost most of his men through scurvy, and next spring, abandoning one of his ships, he returned to Denmark.

Luke Fox.

On May 5th, 1631, Captain Luke Fox‡ set sail from Deptford in the *Charles*, a pinnace of seventy tons burden, to continue the search for the North-west Passage. On July 27th he reached the west shore of Hudson Bay in latitude 64° 10′, going ashore on an island which he called Sir Thomas Roe's Welcome, a name since applied to the strait between Southampton Island and the mainland. His description of the west shore of the Bay, which he examined with some care, is exceedingly quaint and interesting, and shows that the shore had the same character two centuries and a half ago as it has at present.

* North-west Fox, London, 1635 Republished by Hakluyt Society, London, 1894, vol. I., pp. 162-179.

† History of the Voyages and Discoveries made in the North, by John Reinold Forster, Dublin, 1786, pp. 470 and 471, and a Chronological History of Voyages into the Arctic Regions, by John Barrow, London, 1818, pp. 230–234.

‡ North-west Fox, London, 1635. Reprint by the Hakluyt Society. London 1894.

Reaches Marble Island.

From Roe's Welcome he turned south-westward until he raised a white island bearing south-west. He stood around the outside of this island and sent a boat ashore near its south-west point. He named the island "Brooke-Cobham," after Sir John Brooke, afterwards Lord Cobham, one of the patrons of the expedition, not recognizing it as Button's Hope's-Advance, and he says that "it is all of a white marble."

On July 30th, he writes:—"When I had stood about W.S.W. from this island twelve leagues I haled in again W. by N., as I see the ridges and broken land stretch, and, keeping the west main always in sight, many ridges did appear, which to go to the seaward of I stood S.W. and by W. I anchored athwart a little island twelve leagues from Brooke-Cobham. The master, with the boat, went on land when it was low water," and behind this island he saw other islands and ledges at low water, so that he thought he could have gone on foot to the main. As the men here caught a dun fox (probably the blue variety of the white fox) alive, the island was facetiously called Dunn Fox Island. It would appear to be one of the small islands lying off the cape south of Corbett's Inlet. Next day he continued south-westward to latitude 62° 5′, when, standing in between W. and N.W., he anchored among a group of islands, apparently in Mistake Bay, in seven fathoms of water. In his account he says:—"I named those islands Brigges his Mathematickes," the rocks and shoals probably putting him in mind of the intricate calculations of his patron, Mr. Henry Briggs. On August 1st, he again stood to sea and when clear, took up a course S.W. by S., but losing sight of land turned W.—"The land met me again, stretching more to south, and many humlocks therein. Stood to within seven miles, and had by six, seven and ten fathoms. I run off a long way before I came into twenty fathoms, passing by two dry ridges that had been far without me." "August 2nd, stood W.S.W. seven leagues to an island (Sentry Island?) and three or four more within it, all lying almost without sight of the maine. I stood within them to seven fathoms. I went to seaward off the said island, which is said to have a long reef off its N.E. end." Its position is given as in latitude 61° or 61° 10′. "I turned S.W. and anchored at twenty fathoms." August 3rd, he travelled along the shore, which was "low, but now and then a sandy knowle or downe would appear," S.W. by W. for ten leagues to latitude 60° 22′, where he anchored three miles from shore in seven fathoms and sent a boat ashore, which found remains of a birch canoe, arrows, etc. On the evening of August 4th, he reached Hubbart Point, of which he says: "It is all stones. Upon it were many corpses, and there were carved toys in the graves." They got fourteen days' firewood from this stony

Dunn Fox Island.

Hubbart Point.

point, bringing back a boat load to the ship. On the 5th, he writes: "I made way south three leagues to latitude 59° 5′, and then I discerned the land to meet upon my weather bough and ahead, so I taked and lay N.W. by N. two leagues. It seemed to be higher land than I had lately seen. I stood thus to northward until daylight, and then I see my land I was upon yesterday morning, and the land within it, which I see yesternight, stretching into Hubbert's Hope. I stood about to the northward, the land looking more pleasant than before, and bolder shore, higher and full of wood, and the daylight being come on I could see the bottom of 'Vainly Hoapt Hubbert.'"

Pass Churchill River.

August 6. "Standing along, while this land trented E. and W., we see the entrance of a large river (Churchill River). At the S. entrance of a river was a cliff, like unto Balsea Cliff, near Harwich, and on the south again another great bay, whose bottom was easier to be seen. The S. part of this bay lyeth E. and W., and at the E. end thereof lyeth an island S. and N., about three miles long." Since 1831 this island seems to have been almost entirely swept away.

Capt. Fox continued to examine the shore south-eastward as far as Cape Henrietta Maria, whence he returned to England.

Fort Churchill built.

About 1715, the Hudson's Bay Company built a trading post at the mouth of Churchill River.

Messrs. Knight and Barlow

In 1719, this Company sent Messrs. Knight, Barlow and Vaughan, from Gravesend, in two small ships to look for gold, copper, &c., but they all miserably perished on the east end of Marble Island.*

John Scroggs.

On the 22nd of June, 1722, John Scroggs was sent north from Churchill, in the sloop *Whalebone*, to look for his lost countrymen, and to continue the search for the deposit of copper.† He went as far north as Whalebone Point, in latitude "64° 56′," and about the end of July he returned to Churchill. Among the names given by him are "Pistol Bay," which was applied to one of the inlets north of Whale Cove; "Pits Mount," on Marble Island; and "Whalebone Bluff," at the east end of that island.‡

Joseph Robson.

Between 1733 and 1747 Joseph Robson§, a Civil Engineer, spent six years on the west coast of Hudson Bay, either at Churchill or

*Hearne's Journey, Dublin, 1796, pp. xxxviii.

†Hearne's Journey, p. xxxiii, and Dobb's, An account of the countries adjoining to Hudson's Bay, p. 80.

‡A description of the coast, lakes, and currents, in Button's Bay. London, Anon—n. d. (Probably 1745.)

§An Account of Six Years' Residence in Hudson's Bay, from 1733 to 1736, and 1744 to 1747, by Joseph Robson, London, 12mo, 1752.

York. During this time he evidently made a survey of the tidal lagoon at the mouth of the Churchill River, showing the character of the shore and the high and low water mark in considerable detail. His published plan covers an area of eighty-two square miles, on a scale of one nautical mile to an inch.

Crow and Napier.

In the beginning of July, 1737, Messrs. Crow and Napier sailed from Churchill on a voyage of discovery, but they merely went direct to Whale Cove, where they traded with the Eskimos. Whale Cove is said to have been so called, "from a whale's having carried one of the Company's sloops to sea, by its tail getting foul of the anchor and cable." They sent a boat north into Pistol Bay to look for a harbour, but found none. Napier died during the voyage, and Crow returned to Churchill.*

Middleton and Moore in the *Furnace* and *Discovery*.

In the year 1741, Captain Christopher Middleton, in the *Furnace*, a sloop or bomb-ketch, and Mr. William Moore in the *Discovery*, a pink, sailed from England in search of the North-west Passage, which they hoped to find near the north-west angle of Hudson Bay. On the 10th of August, they arrived at Churchill River, where, at the time, the Hudson's Bay Company was building a massive stone fort, and though it was still so early in the season, they decided to remain for the winter, probably using the little harbour at Sloop's Cove as their winter quarters. On June 1st, 1742 (old style), the ice broke up in the river, and at spring tide, on the 9th and 10th of the same month they "got the ship (*Furnace*) out of her dock and moored her." On July 1st, the two ships left Churchill, and sailed northward. Keeping well out from the land, they passed "Brooke-Cobham" (Marble Island) on the 4th, and on the 13th entered Wager Inlet, which Captain Middleton named after Sir Charles Wager. Shortly afterwards they discovered Repulse Bay, whence they turned southward to "Brooke-Cobham."

Marble Island harbour.

On August 12th, John Rankin, the Lieutenant of the *Furnace*, discovered and explored the harbour on the south side of Marble Island, and in his log of that date the name Marble Island first appears as an alternative for Brooke-Cobham. On the same date he also observed an opening in the land to the westward, but was unable to examine it. This opening is since known as Rankin Inlet. On August 15th, the ships bore away for England. †

Moore and Smith in the *Dobbs* and *California*.

As the results obtained on this expedition were not considered at all satisfactory, two ships were again fitted out, the *Dobbs*, of 180 tons, and the *California*, of 140 tons.‡ The former was put in

* A description, etc., of Button's Bay.

† An account of the countries adjoining to Hudson's Bay, by Arthur Dobbs, Esq., London, 1744.

‡ A voyage to Hudson's Bay by Henry Ellis, London, 1748. Another account of the same voyage was written by Mr. Drage, the clerk of the *California*, but I have been unable to see a copy of his book.

charge of Captain William Moore, who had been in charge of the *Discovery* on the previous expedition, and the latter in charge of Captain Francis Smith. On the 20th of May, 1746, they sailed from England, and on the 11th of August made the land on the west side of the Welcome, in latitude 64°. On the 19th they reached Marble Island, and after establishing the port they bore southward to their winter quarters in the mouth of Haye's River, near York factory. In June of the following year they sailed northward, determined, if possible, to find the North-west Passage to the South Sea through the mythical Straits of Anian. The long boat of the *Dobbs* had been enlarged and christened the *Resolution*, and on 1st July, in latitude 61° 40′, Captain Moore, Mr. Ellis and eight hands "went on board, in order to examine the coast," instructing the mate to wait for them in the *Dobbs* at Marble Island. They continued northward to Knight's Island, which is said to be in latitude 62° 2′, and would therefore seem to be one of the islands off the mouth of Ferguson River. From here they had several islands in view, such as Sir Biby's, Merry's, Jones's, etc., "all rocky and barren." From here they sailed into Neville's Bay, at the bottom of which there is said to be a "pretty large river running westward." This is said to be north-west some distance from latitude 62° 12′, but not only this but many of the other latitudes given in the account are very inaccurate. On the 9th of July they directed their course to the eastward and anchored at Sea-horse Island, the most eastward of these islands. "On the 10th we weighed, and stood along shore among many small islands and pieces of floating ice, till we arrived at Whale Cove in the latitude of 62° 30′ north." Its true latitude is about 62°.

Winter in Haye's River.

Explore the coast north of Cape Esquimaux.

"We sailed again on the 11th, and arrived the same day at a point in the latitude of 62° 47′ north, from whence we discovered a large opening, running to the westward, to which I gave the name of Corbet's Inlet." On the 13th they rejoined the *Dobbs* and *California*, which were anchored between Marble Island and the main land. In their absence Captain Smith, of the *California*, had attempted to enter Rankin Inlet with his ship, but finding himself among shoals, he desisted, and sent his chief and second mates to examine it, who found it to terminate in a bay.

Corbett's Inlet.

On the morning of the 13th, before their arrival, Captain Smith had sent Mr. Westoll, his second mate, in the long boat to search the coasts between Capes Jalabert and Fullerton. On the 14th the chief mate of the *Dobbs* was sent in the *Resolution* to explore the same piece of coast. The two ships sailed northward along the coast.

Discovery of Chesterfield Inlet.

About July 26th, they were again joined by the two boats.—"The officers aboard then reported, that they found an inlet, in the latitude of 64° north, and in the longitude of 32′ east from Marble Island, which was three or four leagues wide at the entrance, but upon their sailing eight leagues up it, increased to six or seven leagues wide. That their course so far was N.N.W. by compass, but then it began to turn more to the westward; that sailing ten leagues higher, it grew narrower by degrees, till it became but four leagues wide; that notwithstanding they could perceive the shores open again, they were discouraged from proceeding further, because the water from being salt, transparent, and deep, with steep shores, and strong currents, grew fresher, thicker and shallower at that height." On Ellis's map, this inlet is called Chesterfield Inlet, but it is said to have been also called Bowden's Inlet, after the mate of the *California*. After obtaining this information about Chesterfield Inlet, the two ships sailed northward and re-explored Wager Inlet, and then returned to England.

The explorations of Fox, Moore and Smith, had shown that there was no hope of a North-west Passage from the west side of Hudson Bay south of Repulse Bay, except possibly by Chesterfield or by Corbett Inlets, the bottoms of which had not been visited.

Captain Christopher.

Accordingly, in the year 1761, Captain Christopher * was sent from Churchill, in the sloop *Churchill*, to examine Chesterfield Inlet more fully. He ascended it for about a hundred miles, when, finding that the water had become almost fresh, he turned back. In the following year he returned to the inlet in the same sloop, while Mr. Norton accompanied him in a cutter. They ascended the inlet in the sloop to a large fresh-water lake, which they called Baker Lake, at the west end of which they saw the mouth of a river. On Christopher's chart, opposite the mouth of this river, these words are written:—"A small river, full of falls and shoals, not water for a boat."

Mr. Johnson explores Rankin Inlet.

In 1764, Rankin Inlet was explored by Mr. Johnson. His map shows it to be fifty-five miles deep; and thirty-five miles from its mouth he anchored in seventeen fathoms of water. The information given on the face of the manuscript chart received from the Admiralty Office, is all that I have been able to learn about his journey.

Corbett's Inlet still remained unexplored, and the journey made by Samuel Hearne into the interior had shown the existence of a large

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* Introduction to Cook's Third Voyage.

Observations on the Passage between the Atlantic and Pacific Oceans, by Wm. Goldson, 4to., Portsea Town, 1793, pp. 45 and 46.

I have also received, through the kindness of Admiral Wharton of the Admiralty Office, London, a copy of the manuscript chart of Bowden (Chesterfield) and Rankin Inlets, made by Captains Christopher and Johnson.

river flowing from Doobaunt Lake, which it was thought might be the river discharging into the head of Chesterfield Inlet.

Charles Duncan.

To decide these two questions, and also to continue the search for the North-west Passage northward from the Welcome, Captain Charles Duncan was sent out to Churchill in 1790, to take command of the sloop *Churchill.* But being unable to obtain a crew willing to sail in her, he returned to England the same year.*

In the following year he was given charge of the brig *Beaver*, a ship of 84 tons, and on the 2nd of May he sailed from the Thames. He examined Corbett's Inlet, which he found to terminate at the mouth of a river navigable only for canoes. He then turned southward and spent the winter at Churchill.

Corbett's Inlet explored.

In the following year he entered Chesterfield Inlet. He left the brig in Lake's Harbour, while he went in the boat to the head of Baker Lake. Thence "he followed the course of the river, by land, until he found it came from the northward, in which direction he traced it near thirty miles, when, being convinced that it must be the drain of some lake in that line, and not an outlet from the Doobaunt, he returned, being satisfied that his following it further could not lead to any useful discovery. Had its course been from the westward, he would not have left it, he says, until he had seen its source."†

Chesterfield Inlet and Baker Lake explored.

Dr. Rae.

In June, 1846, Dr. John Rae started with two boats from York Factory, for Repulse Bay. ‡ On the 5th of July he left Churchill, and on the 13th passed the mouth of Chesterfield Inlet, having kept within sight of the shore through part of the distance. On his return in 1847 he passed the mouth of Chesterfield Inlet on August 18th, and on the 31st reached Churchill. He was the first to give us any information about the character of the rocks along this coast, stating that the shore as far north as Cape Esquimaux is low, beyond which it is "lined with bare primitive rocks." Specimens collected by him from Rankin's Inlet are described by Professor Tennant as hornblende-slate, mica-slate, chlorite-slate, talcose-slate, quartz with copper-pyrites, &c.

In 1853, Dr. Rae, while on his expedition in search of Sir John Franklin, entered Chesterfield Inlet, and ascended the Quoich River, which empties into its north side, in the hope of being able to cross to Back or Great Fish River, but finding it too much obstructed by rapids, he turned back. No account of this journey has been seen by the writer.

* History of Arctic Voyages, by John Barrow, 8 vo., London, 1818, pp. 345-348.

† Observations on the Passage between the Atlantic and Pacific Oceans, by Wm. Goldson. 4to., Portsea Town, 1793, pp. 52-54.

‡ Narrative of an Expedition to the Shores of the Arctic Sea, by John Rae, London, 1850.

Dr. R. Bell.

In 1879 Dr. R. Bell, of this Survey, descended the lower portion of Churchill River to the Bay. He described the "Churchill quartzites," recorded the occurrence of some of the glacial striæ, and concluded that the sea-level there is now lowering (land is rising) at the rate of seven feet in a century.*

In 1884 Dr. Bell, while on board the *Neptune*, visited Marble Island, and in his report he has described the white quartzite of which the island is composed, and the mica-schists of Deadman's Island, at the mouth of the harbour.†

From what was seen at Churchill and Marble Island, and from the examination of a number of specimens, collected on the coast by a friend, some clearly from loose masses, he gives a note on the geology of the west coast of Hudson Bay. He concludes that the shore from Seal River to Esquimaux Point is underlain by "flat-lying limestones," and that "Huronian rocks prevail all along the north-west coast of Hudson Bay, from Esquimaux Point to ChesterfieldInlet." ‡

DESCRIPTION OF ROUTES.

A description of the shore of Lake Athabasca, with the survey made of it in 1893, has already appeared in my Report on the Country between Lake Athabasca and the Churchill River.§

A short distance east of the mouth of Wolverene or Chipman River, on the north shore of Black Lake, there is a portage leading northward to the hunting ground of the Chippewyan Indians. On the evening of the 7th July we camped on the beach at the beginning of the portage. Northward the country was entirely unknown to either ourselves or any of our men, and our only guide was a rude map of the route as far north as Daly Lake, obtained from an Indian during the preceding year.

Black Lake to Height of Land.

Wolverene Portage.

The Wolverene portage is two miles and a quarter long, and rises in this distance 210 feet, the height of Black Lake being 1000 feet, and the level of the small lake at the north end of the portage 1210 feet above sea-level. The country through which the portage passes is

*Report of Progress, Geol. Surv. Can., 1878-89, pp. 19-22 C.

†Report of Progress, Geol. Surv. Can., 1882-84, pp. 34-36 D D.

‡Annual Report Geol. Sur. Can., Vol. I. (N.S.) 1885, pp. 18-20 D D.

§ Annual Report, Geol. Surv. Can., vol. VIII. (N.S.) part D.

generally thickly wooded with small black spruce, Banksian pine, and larch. There are two or three sandy stretches, but for most of the way the land is composed of light-gray clay, doubtless a glacial wash deposited in the bottom of Hyper-Black Lake, the enlarged post-glacial representative of Black Lake. Through this clay rise morainic ridges of rough, irregular boulders. The following is a paced survey of the portage. Two thousand paces equal one geographical mile :— Portage route.

N. 25° W. 300	paces.	Over morainic hill seventy feet high, composed of small stones and boulders.
N. 25° W. 300	"	Across a black spruce swamp and over a low ridge of large irregular boulders.
N. 10° W. 45	"	Over a low ridge of sand and boulders, to an old Indian camping ground.
N. 45° W. 24	"	
N. 20° W. 60	"	
N. 25° W. 150	"	Through swamp to ridge of thinly foliated highly biotitic, dark-gray gneiss, striking N. 60° E. and dipping N. 30° W. < 40°.
N. 20° W. 267	"	Through swamp to a ridge of similar gneiss, wooded with Banksian pines.
N. 25° W. 350	"	Down a gentle sandy slope wooded with small Banksian pines to a little weedy creek.
N. 10° W. 170	"	
N. 30° W. 50	"	Through swamp.
N. 60° W. 90	"	Up a hill of similar reddish gneiss striking as before.
N. 35° W. 250	"	Through swamp.
N. 50° W. 45	"	Up a slope of red gneiss to the top of a sandy hill, wooded with small Banksian pines
N. 5° E. 100	"	
N. 35° W. 200	"	Down sandy slope to the edge of a little sandy terrace.
N. 25° W. 35	"	Through swamp.
N. 20° E. 100	"	Over a low hill of sand and boulders wooded with spruce and larch.
N. 10° W. 200	"	
N. 20° W. 130	"	Through swamp.
N. 10° E. 410	"	Over a dry sandy and mossy plain wooded with small spruce, to a brook.
N. 30° E. 96	"	Open Banksian pine woods.
N. 15° E. 400	"	Up the east side of the valley of a creek, over rising land studded with boulders, and wooded with spruce and birch.
N. 5° W. 240	"	Over similar country to the south end of a small narrow lake lying among rocky wooded hills.
4,012	"	

Camp was pitched at the south end of this little lake, from which a noisy, interrupted brook ran past our tents towards Black Lake, which lay glittering in the sun a few miles to the south. To the west is a rocky ridge 150 feet high, composed of a dark-gray highly hornblendic gneiss, varying to a coarse red augen-gneiss, which strikes N. 60° E., and has an almost vertical dip. Glacial striæ were seen on its summit trending S. 45° W. The south-eastern side of the ridge is steep and thickly covered with boulders, imbedded in a matrix of fine red sand or silt, which supports a thick growth of small black spruce.

Chain of small lakes and portages.

The little lake is clear and shallow, with a bottom of rude stones. It is from one to two hundred yards wide and nearly half a mile long. A creek flows into its northern end through boulders. The portage track at this end is 1000 yards long, and runs along the bottom of the valley on the east side of the creek. It is hard and dry, being generally over the fine light-gray silt. It ascends about forty-five feet and ends on the shore of another similar lake in a pleasant grove of spruce, where the turf descends to the edge of the water, and the bottom of the lake, close to shore, is of small rounded stones. This second lake is very similar to the last, is a mile long, but has a long arm extending towards the west. It appears to be moderately deep and has mossy banks, while wooded rocky hills descend into it from all sides. Here and there salient points project into the water. A little stream flows into its northern end, descending five feet from another lake. The canoes were carried over the boulders for seventy-five yards, from one lake to the other. The third lake is similar to the last, with high wooded shores, and rounded islands and points of hornblende-gneiss. After following its east shore, the portage leading from it was found about the middle of its western side opposite some small islands.

This portage is 450 yards long, with a rise of fifteen feet, through woods of small black spruce, birch and a few balsam poplars. It is in a valley, over light-gray till thickly studded with sub-angular boulders of reddish granite and gneiss.

The fourth lake is a small shallow pond a third of a mile wide, with wooded shores. The fifth portage is fifty yards long, across a narrow ridge underlain by a reddish-gray medium-grained garnetiferous hornblende-gneiss striking N. 60° E., and with almost vertical dip. The path descends in all fifteen feet to the fifth lake, a pond which is not more than 200 yards across.

The landing at the sixth portage is beside a rocky cliff of reddish gray hornblende-biotite gneiss, with similar dip and strike to the last. The portage is 160 yards long, through spruce woods, across a swamp, and over moss-covered rock down to a lake. The rock is a reddish-gray, well foliated gneiss, striking N. 30° E., and dipping N. 60° W. $<$ 70°.

The sixth lake lies twenty feet below the last, and is nearly half a mile long. The seventh portage is 550 yards long, and like the others it is in a valley, over till holding irregular boulders of granite and gneiss, with hills of gneiss on each side. It has a descent of about fifteen feet to Chipman or Wolverene Lake. At the end of the portage nearest to Chipman Lake, the rock is a gray, well-foliated biotite-gneiss, highly quartzose, striking N. 40° E., and dipping N. 50° W. < 65°.

Chipman Lake.

Chipman Lake is a very irregular body of water lying on the course of Chipman River at an approximate elevation of 1210 feet above the sea. The course followed by the Indians in their journeyings to and from the north, passes through this lake for four miles and a half, but we spent more than a day in the lake, and surveyed its shores for twenty-one miles, before we found the river flowing into it.

The shores are unusually high and sparsely wooded. They consist for the most part of dark-gray or reddish hornblende-gneiss, striking N. 45° E., and with a dip approaching more or less closely to vertical. There are a number of islands. Some are high and rocky, others are long ridges of sand and boulders. At the north end of the lake is an even terrace of stratified sand, twenty-five feet above the present water-level, probably formed at the mouth of a stream when the Keewatin glacier retired to the north. The river flows out of the south end of the lake as a swift stream 120 feet wide, and flows into its north-east side in a channel two feet deep between rocks thirty-five yards apart.

River above Chipman Lake.

The rock on the west side of the river, above Chipman Lake, consists of a fine-grained dark hornblende-granite, intimately folded in with a red felspathic gneiss, without definite strike or dip.

For six miles N. 40° E. from the lake, the river takes the form of a long lake, divided by a low sandy point, past which there is a swift current. In the middle of this lake are many high, rounded, rocky, wooded islands, composed of fine dark garnetiferous granite, interbanded with light-reddish gneiss, striking N. 40° E. and dipping N. 50° W. at an angle of 60°. The shores are also high, the rock rising in rounded bosses gives the skyline a rudely wavy contour. Boulders and rock-fragments are thickly scattered in the low places, and perched boulders were constantly to be seen on the high bare points.

Three rapids.

Above this lake the river flows for four miles from N. 25° W. Beside it, in some places, is a low sandy flat scantily wooded with small Banksian pines, while behind, or in places descending to the edge of the water, are dark craggy cliffs of hornblende-gneiss. Three rapids obstruct the upper portion of this reach, and past them portages were made, respectively 80, 1100 and 300 yards long. The middle portage is over very stony hills, having the appearance of a moraine that blocked up the valley. The boulders are for the most part irregular and of local rock, and are imbedded in a gray rock-flour. At the foot of the upper portage is a good exposure of evenly foliated hornblende-gneiss interstratified with thin layers of light-red felspathic gneiss, striking N. 20° E. and dipping N. 70° W. at an angle of 40°. Behind this portage is a hill, 170 feet high, of dark-gray gneiss, the sides of which are covered with clayey and gravelly till mixed with boulders.

Birch Lake.

At this rapid the river flows from Birch Lake, which is thirteen miles long and two miles in greatest width, lying N. 25° E., in the direction of the strike of the underlying and surrounding gneiss. The shores generally descend in wooded slopes, in some places steep, and in others broken by a sandy terrace from fifteen to twenty feet above the water.

Grove of spruce.

The river flows into the north end of Birch Lake in a heavy rapid with a descent of fifty feet, over a bed of thinly foliated light-gray hornblende-gneiss. Growing among the stones near the foot of the rapid is a grove of large white spruce. A portage half a mile long runs along the east bank of the river past this rapid, over a ridge of stony morainic hills composed chiefly of subangular masses of gneiss. The north end of the portage opens on the shore of Selwyn Lake, just at the top of the rapid.

Selwyn Lake.

Selwyn Lake is fifty miles long in a direction N. 40° E. It lies at an elevation of 1340 feet above the sea, and the temperature of the water in the open lake on July 15th was 58° F. In its south-western portion it averages a mile in width, but in its north-eastern extension it extends an unknown distance towards the east. As we have already seen, it is drained by Chipman River south-westward to Black Lake, but the Indians state that Porcupine River, which empties into Stone River above Black Lake, also takes its rise in this lake.

The shores and islands are usually composed of boulders or bouldery till. The surrounding surface rises and falls in rather gentle undulations, with here and there a higher elongated hill or drumlin. Occasionally low cliffs of brown peat overhang the water. Many of the islands are drumlins, or low elongated ridges of till and boulders, while a few are of waterworn sand and gravel and are evidently kames or eskers.

In the south-western arm of the lake there are comparatively few rock-exposures, those seen being chiefly composed of coarse white massive granite. At a point about the middle of the west side of the lake, the rock is a yellowish-gray highly garnetiferous micaceous gneiss, striking N. 55° E., and dipping N. 35° W. at an angle of 25°. It is cut by a vein of coarse white pegmatitic granite, containing large crystals of white and black mica. Towards the bottom of the north-western bay are sandy terraces, associated with hills of boulders. At the northern end of the lake the shores are generally more rocky than farther south, and its north-western arm is flanked by hills of gneiss from 200 to 300 feet in height.

The country is more or less generally wooded with small black spruce, but on some of the sandy tracts are orchard-like groves of birch.

Height-of-Land.

The height-of-land is a belt of low stony morainic hills, lying in a rather wide valley between rocky ridges several hundred feet in height. It is a mile and a quarter wide, extending from the shore of Selwyn Lake to a shallow bay at the southern end of Daly Lake. A good dry portage, 2400 yards long, runs through small spruce, from one lake to the other.

Daly Lake.

General character.

Daly Lake lies just north of the height-of-land separating the waters flowing to Lake Athabasca, and thence to the Arctic Ocean, and those flowing to Hudson Bay. It has an elevation of 1290 feet above the sea, or fifty feet less than Selwyn Lake. The temperature of the water in the open lake on July 21st was 58° F. It consists of two portions respectively twenty-three and thirty miles long, lying north-east and south-west, joined by a transverse portion six miles long. At the south end of the lake high hills of gneiss rise on both sides. These soon draw apart or decline, and the banks become low and strewn with boulders. The few hills that remain are composed of till and boulders. Then long low sandy points project from the shore, extending into a chain of sandy islands.

Large island.

A large island, ten miles from the south-west end of the lake, is composed of light-green massive and sheared diorite, in which the hornblende is largely altered to chlorite; while some of the points to the south of it are composed of red and green hornblende-gneiss, with a general easterly strike.

Peninsula.

Eight miles north of the above large island we crossed a neck of land on a portage 500 yards in length, apparently at the base of a long peninsula extending from the western shore. The portage is over a gentle hill of clay and boulders, rising to a height of twenty feet above the lake. To the east is a rugged rocky hill, while to the west the land rises with a light slope.

A mile north of this portage is a long point, near which is a moderately well foliated light-gray, highly garnetiferous gneiss, striking N. 20° W., and with nearly vertical dip. The surrounding country is characterized by low drumlins, or ridges of till and boulders. The point is of

Esker. boulders, and from it an open sandy ridge, or esker, extends S. 38° W., winding slightly, and gradually rising over some rocky hills seventy feet above this lake. On the side of this ridge some small dwarfed aspens *(Populus tremuloides)* grow, marking the extreme northern limit of the tree in this vicinity.

Northern limit of poplar.

Rocky shore. A point four miles to the west, on the north shore, is composed of biotite-gneiss striking N. 30° E., and dipping S. 60° E., at an angle of 45°. Its summit and eastern slope are well rounded, while its western side is much more broken. On the weathered surface are some rough grooves, probably glacial, trending S. 80° W., while in a slight depression is a beautifully polished surface with minute glacial striæ trending S. 60° W.

From this point northward the east shore is generally low and strewn with angular fragments of rock. A point in latitude 60° 39′ 30″, is composed of biotite-gneiss, just behind which is a knoll of a compact medium grained greenstone (diabase?), cut by many anastomosing veins of white granite which cut the greenstone into large eye-like masses or even give it the appearance of a conglomerate. The surface is generally rough and weathered, but some quartz veins have preserved their fine polish, and show many distinct parallel glacial striæ trending S. 85° W.

Eight miles further towards the north-east, is the bare rounded point of an island of reddish, white-weathering, massive granite, containing irregular inclusions of gray foliated gneiss. Its surface is smooth and polished, and is marked with glacial striæ and small grooves trending S. 70° W. The eastern side of the hill, facing the direction from which the glacier moved, is rounded, while the west, or lee side is rough and broken. In depressions protected from the eastern glacier, five occurrences were found of distinct older glacial striæ trending S. 25° W. Two miles and a-half further east, the rock is a reddish biotite-gneiss, containing large phenocrysts of orthoclase, striking N. 15° E., and dipping N. 75° W., at an angle of 60°. For the remaining thirteen miles, to the bottom of the lake, the rock, wherever seen, was a gray biotite gneiss, with a general northerly strike, and its surface was everywhere strongly marked by glacial striæ trending S. 70° to 75° W.

Low shores. The shores are generally low, and are strewn with loose angular masses of rock. These stones did not seem to be anywhere piled in definite boulder-walls. The nearest approach to boulder-walls was at some of the points, where an unassorted mass of clay and boulders had been shoved up to a height of two or three feet. Points or bars of gravel or sand of any considerable size are also conspicuously absent, and the whole shore is new, and but little modified by either wave or ice action.

Tundras or mossy plains. Around the shore of Daly Lake, and extending northward to the northern limit of the wooded country, are more or less extensive mossy or tundra areas, usually on gentle slopes that extend from the woods down to the edge of the water. Seen from a distance, these have the appearance of open green meadows. On closer inspection the surface is found to be even, moderately dry and firm, and to be covered with a growth of a light green papery lichen, probably a species of *Peltagera*, cranberry, trailing raspberry, Indian tea (*Ledum palustre*), &c. Beneath the surface is a thickness of eight or ten feet or more of moss, apparently some of the forms of *Sphagnum cymbilium* or *acutifolium*, which is quite dead. In July, at a depth of a foot, the moss was found to be frozen, or rather imbedded in a solid mass of ice. On the upper side of the slope was a scattered grove of spruce and larch, overshadowing a wet mossy swamp, in which the *Sphagnum* was in full growth, while on its lower side the mossy slope usually ended on the shore of the lake in a vertical or overhanging cliff of peat, from which masses of peat were falling on the sandy beach. Several of these cliffs were closely examined, and when the thin outer portion of unfrozen moss was cleared away they were found to consist of a wall of frozen moss, through which were many streaks of clear ice.

Mode of formation. These gently-sloping mossy plains would seemed to have been formed somewhat in the following manner. The drainage from the higher land accumulated at the bases of the hills on soil which was either impervious in itself or was rendered impervious by being permanently frozen. Moss, small spruce and larch, began to grow on this wet ground, and each winter the moss froze to the bottom, thawing again with the return of summer. It increased in thickness year by year, until it had reached such a depth that the lower part remained permanently frozen, the heat of the summer not being sufficient to thaw it. Many of the swamps in the more northern parts of Canada would seem to be thus permanently frozen, but every summer they thaw to a sufficient depth to permit of the continuous growth of the upper layer of moss and the overshadowing forest of stunted conifers. But in this region the summer heat is not sufficient to thaw the moss to such a depth as to allow trees to grow over the frozen substratum. The trees therefore die, and the moss, having the ice close beneath it and deprived of its overshadowing screen of trees, also dies, and the surface of this dead and dry peat bog soon becomes covered with such small plants as the country will produce.

During the summer, the water continues to drain from the higher lands, but is retained along the upper side of the frozen mossy plain. Here the mossy swamp is still growing, and is constantly but slowly adding to the upper side of the slope and thus increasing its area. This growth in area does not, however, go on indefinitely. The frozen mass seems to descend slowly, like a glacier. At the foot of the slope, in most places, is a cliff of peat which is constantly breaking away, and is kept in its place on the lake shore or river bank only by the gradual descent of the moss and ice from the higher ground behind.

In some few places these mossy plains cover level, or almost level, tracts of country. These level bogs have been formed very much in the same way as those on the slopes, by the gradual thickening of the moss and retirement of the line of living mossy swamp to a narrow strip on the edge of the bog. The masses of clear ice that were seen in the faces of the cliffs of frozen moss have been formed in the living swamps as frozen pools, or in the dead bog as little frozen streams over which the moss has gradually closed.

Possibly the explanation here given for the formation of these "tundras" may also apply to many of those in Alaska and Northern Siberia.

Telzoa River.

Telzoa River flows from Daly Lake in two channels, the more easterly and smaller of which was the one followed. After a course of two miles and a half it opens into a small irregular lake, with low sandy or stony shores, the underlying gneiss showing at but few places. At the bottom of the most north-easterly bay of this little lake is an esker extending N. 77° E. an unknown distance. It is from forty to seventy feet high, and is composed of sand and gravel. In many places it is divided, and a small lake may lie in the hollow between its two portions. Looking from the summit of the esker, the country may be seen to be low and sandy, with many irregular lakes lying in the shallow depressions, and with the intervening land thinly wooded with small black spruce.

Esker.

From the north-western side of the little lake, the river flows as a rapid stream 250 yards wide, with an even bed of boulders, but so shallow that on the 24th of July there was not water enough for the canoes. On the south-west side of the rapid is a level mossy plain extending back to some low hills a mile or more to the south, a cliff of moss and ice eight feet high forming the south-west bank of the river, the channel having here no other confining wall. On the north-east side of

Rapid.

the stream is a wide, mossy flat, or gentle slope, the lower part of which is underlain by an irregular mass of rounded transported boulders. The surface is wet, and the moss is growing, thus differing from the "fossil" swamp on the opposite bank.

Stunted spruce and larch.

Groves of stunted black spruce occur here and there, the trees being from six to fifteen feet high, and usually much expanded at the base. Larches are scattered through the spruce, being much the tallest and largest trees in the groves. Their trunks, from eight to ten inches in diameter, are all spirally twisted in the grain.

Under one of the groves is a rounded boss of green and red hornblende-gneiss, striking N. 30° E. and dipping N. 60° W. at an angle of 70°.

Below these rapids is another small lake, with low unwooded grassy shores and occasional sandy beaches, below which again is a long crooked rapid with a descent of about twelve feet, where the stream is crossed by a ridge of light-gray biotite-gneiss, striking S. 85° E. and dipping N. 5° E. at an angle of 70°. At the foot of the rapid is a little stretch of quiet water. For five miles below this quiet water the river is very rapid. The banks are everywhere low and grassy, and the country is flat and sandy or boggy, hills being rarely seen, and the underlying rock being nowhere exposed.

The river next opens into an oval lake three miles long, below which is a long rapid terminating in a swift chûte over a rocky barrier, the total descent being about twenty feet. At the foot of the rapid is another small irregular lake, lying among rounded morainic hills of till and boulders. A long point, extending into the western side of this lake, is composed of biotite-gneiss, striking N. 20° W. and dipping N. 70° E. at an angle of 60°. The surface is rounded towards the east, and broken towards the west, but no glacial markings could be detected.

Hinde Lake.

Three miles and a half farther north, on a long low point of similar gneiss in another lake, the surface is well rounded and shows strong glacial grooves trending S. 80° W. For this lake the name Hinde Lake is here proposed, after Dr. George Jennings Hinde.

Red Hill.

Near the north-west shore of Hinde Lake, Red Hill rises to a height of 120 feet, forming the most conspicuous elevation in this part of the country. It is the termination of a long esker, and is composed chiefly of small, somewhat angular pebbles, of red granite, mixed with which are larger rounded pebbles, cobbles and boulders. Several large angular boulders, or blocks of gneiss, are lying half buried in the summit. Its general trend is N. 70° E. It rises more or less gradually from the east-north-east in a series of parallel elongated overlapping hills, between which are deep depressions without outlet. Low sandy ridges also skirt the sides of the higher ridges.

Lake terraces. Towards the west-south-west, the esker terminates in two terraces, one above the other, of well-rounded gravel, the faces of which are as steep as the gravel will lie. The brow of the upper terrace looks as if the coarse gravel forming it had been dropped there but yesterday, for it is very loose, and does not seem to have been disturbed at all by atmospheric agencies since the terrace was formed.

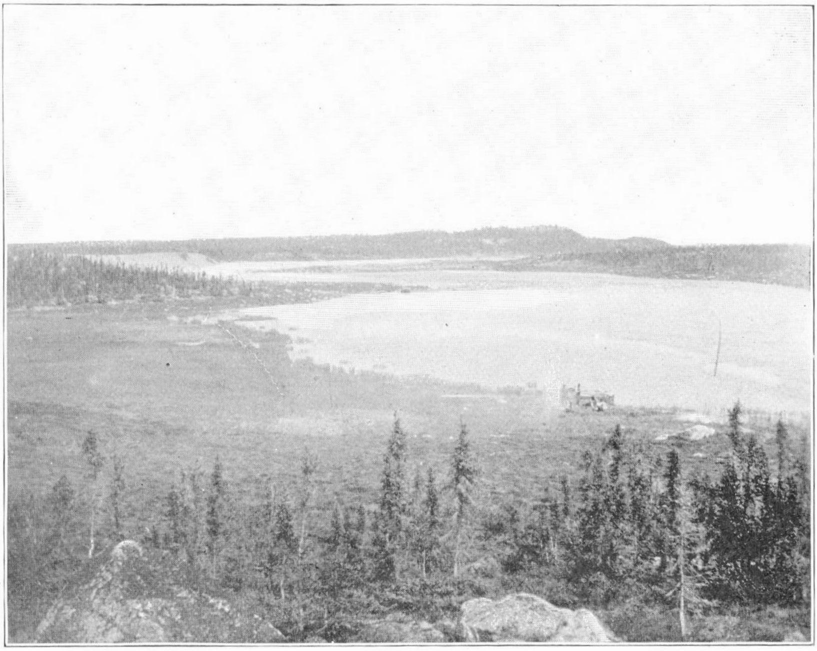
Red Hill would, therefore, seem to have been formed at the mouth of a glacial river, at the very face of the Keewatin Glacier, when the foot of the glacier was bounded by a shallow lake into which the river discharged its sediment. From the eastern end of Red Hill, the esker, here somewhat lower, extends as a long sand-ridge along the north-west shore of Hinde Lake, reaching the river a short distance below Ptarmigan Rapid, and afterwards extending an unknown distance into the country to the east, marking the line of the old glacial river, wooded with white spruce up to forty feet or more in height, which was the first good timber seen north of Black Lake. One fine even trunk, on Red Hill, measured five feet six inches in circumference two feet above the but. The surrounding low country is covered with moss or grass, or is wooded with small black spruce.

Ptarmigan Rapid. Ptarmigan Rapid is a long swift chûte at the outlet of Hinde Lake, down which the canoes were run one at a time, for but one of our steersmen was capable of handling a canoe successfully in such rough rapid water. Beside the rapid the rock is a well-foliated yellowish-gray garnetiferous gneiss, containing, in places, a considerable quantity of magnetite. Here, on the 26th of July, among some small willows, ptarmigan were seen for the first time, hence the above name for the rapid.

Below the gap where the river cuts through the Red Hill esker, the stream enters a region of typical drumlins, or elongated-oval, hogs-back hills parallel to the esker, from twenty to fifty feet high, and composed of reddish-gray till and boulders.

Esker. Ten miles below Ptarmigan Rapid, measured in a straight line, the river cuts through another esker, trending S. 60° W. and N. 60° E. It can be traced by the eye for a considerable distance, rising over the hills and descending into the depressions, being rendered very conspicuous by its covering of tall white spruce.

Moraine. A short distance south of this esker is a wide ridge of boulders of granite, gneiss, &c., imbedded in a matrix of gray pebbly clay. The



July 26, 1893.

TELZOA RIVER, BELOW PTARMIGAN RAPID.
Esker in the distance.

J. B. TYRRELL.—Photo. Aug. 14, 1893.

SNOW ON THE SHORE OF DOOBAUNT LAKE.
At the foot of a cliff of Cambrian Conglomerate.

ridge, which is eighty feet high, is prolonged into two ridges in a direction S. 20° E. It undoubtedly forms part of the moraine that extends north-westward of the esker for several miles, the general trend of the morainic hills being transverse to the direction of the esker. Just below the esker, the river flows in a heavy rapid between these morainic hills, and the sides of the channel are formed of walls of angular fragments of rock, piled up and shoved back by the ice of the spring.

At the foot of the rapid the river opens into a lake twenty-one miles long and of undetermined width, here called Boyd Lake, in memory of the late Honourable John Boyd, Lieutenant-Governor of New Brunswick. Boyd Lake.

The moraine extends northward into Boyd Lake, forming a number of low stony islands and shallow stony shores which are very difficult to approach with a canoe. The stones are for the most part angular, and seem to be all of Laurentian granite and gneiss. Another esker crosses the lake through this moraine, forming a chain of sandy islands among the stony ones, and extending in a long sandy ridge on both sides of the lake.

We had now reached the northern edge of the forest, and hence forward any timber seen on this river was in the form of scattered and often widely separated groves. With the disappearance of this stunted forest, mossy plains and bogs also almost entirely disappeared, and they were nowhere found to extend beyond the extreme northern limit of trees. Northern edge of forest.

The shores of the southern portion of Boyd Lake rise in long slopes to heights of from a hundred to a hundred and fifty feet, and the beach is composed largely of more or less angular fragments of rock. Further north the shores rise to low elevations or stony hills, with a matrix of gray pebbly clay. Islands are numerous, and are composed largely of boulders, more or less rounded, usually arranged in ridges parallel to the long axis of the lake. The boulders are of whitish or red granite, or gray or red gneiss, but among them was found one pebble of stratified Palæozoic limestone. Shores of Boyd Lake.

No rock in place was seen around the lake, or for some distance north or south of it, but doubtless the country is underlain by Laurentian rocks. No rock seen.

Two miles below Boyd Lake, camp was pitched on the Barren Lands for the first time, and we were obliged to search the shores for pieces of drift-wood for fuel. Among the boulders at this camp were a few small ones of white quartzite and fine red and white unaltered sand- Camp on Barren Lands.

stone. For seven miles below Boyd Lake, measured in a straight line, the river winds around hills of boulders, with a rapid at every bend, and then, in the bottom of the valley, is the first exposure of rock seen for many miles. It consists of a red, well-foliated hornblende-biotite-gneiss, striking N. 47° E., and dipping N. 43° W. at an angle of 25°. The surface is well smoothed and strongly scored with parallel glacial grooves trending S. 5° E., the direction of motion being clearly indicated by the rounded northern and broken southern surfaces, the latter pointing up the river.

Gneiss.

Three miles and a half further down the stream, through a low-lying country, diversified by little hills of sand, boulders and broken rock, is another exposure of the underlying rock, consisting of a gray evenly foliated hornblende-gneiss, striking N. 20° W., and with almost vertical dip. Its surface is smooth, and well marked with glacial grooves trending S. 80° W.

A few small groves of black and white spruce and larch grow beside the river in this vicinity.

For the next five miles the river flows in devious channels, usually with a swift current, at one place breaking into a swift rapid, down which it was necessary to run the canoes one at a time. The banks are gently rounded stony slopes, partly green with grass and moss.

Barlow Lake.

In north latitude 61° 53′ the river enters Barlow Lake, so called in memory of Mr. Scott Barlow, formerly chief draughtsman to the Geological Survey of Canada. It seems to be shallow, is sixteen miles long, from two to four miles wide, and, like most of the other lakes on this river, is dotted with islands. On one of the islands, five miles from the south end of the lake, is a low rounded boss of coarse white biotite-granite. Its surface is well smoothed, and shows strong glacial grooves running S. 50° W. Two miles further north, on some other islands, are ridges of boulders extending southward from highest points at their northern ends.

Stony hills.

The country around the southern portion of the lake is a gently undulating prairie, while farther north a marshy border extends along the western shore stretching back to a ridge of stony hills from 100 to 200 feet in height. One of these hills near the north end of the lake, was found to be 130 feet high, and to trend S. 60° W. Its sides and summit are covered with sub-angular boulders, often very large, sometimes imbedded in a reddish-gray clay, but sometimes tumbled together without any matrix. They are chiefly of reddish gneiss, coarse red porphyritic granite and white granite, but some are of green diabase and red quartz-porphyry. From the top of the hill several other similar ridges, some probably from 200 to 300 feet high, were seen, and between the ridges, stretching away to the north, are extensive low green plains, covered with grass or moss. The hills are probably part of a moraine of the Keewatin glacier which, in its latest stages, here flowed from the east.

Rapid at outlet of lake.

At the outlet of Barlow Lake is a heavy rapid, with a descent of about twelve feet, on each side of which are banks of large boulders of red gneiss. On a flat composed of these boulders, on the north-west side of the river, is a small grove of large white spruce trees. At the foot of the heaviest part of the rapid is a boss of coarse red pegmatitic granite, rounded on its eastern, and broken on its western side. Below this rapid a low country was entered, where the river flows with a current of from four to five miles an hour, in a well defined channel a hundred yards wide, with rounded grassy banks ten feet high, of a compact yellowish-gray clayey till with rounded boulders. Boulders are also piled around the points, having been pushed into an even wall by the ice.

Carey Lake.

Four miles below Barlow Lake, the river enters the south end of Carey Lake, so called in honour of the Rev. Dr. Carey, of St. John, N.B.

Barren-ground caribou.

After paddling up the lake for five miles, directing our course towards a high point with a large boulder on its summit, afterwards called Cairn Point, we saw an immense herd of caribou (*Rangifer Grœnlandicus*), moving along the east shore. We at once paddled towards the land, and found the deer standing on low wet grassy land near the water, at the foot of a long stony slope

It was now nearly six weeks since we had left our last base of supplies at Fort Chippewyan, and our provisions were rapidly diminishing, so that the question of how to add to our stock had begun to be a serious one, if we were to continue our journey into the wilderness. Here were deer in abundance, and near at hand was a grove of small black spruce and tamarack, which would furnish fuel to smoke and dry as much meat as we could carry.

The following extract from my daily journal, with the photographs in front of the report, will give a fairly clear idea of the number of deer seen :—

"July 30.—Yesterday was the first clear warm day that we had had for a long time, but to-day is also clear and warm, with a gentle breeze blowing from the west. We spent the day skinning and cutting up the fattest of the bucks that we had killed yesterday. Our camp is a

Extract from journal.

hundred yards from the lake, near the edge of a bog, with a scattered grove of larch and small black spruce just behind us. All day the caribou have been around us in vast numbers, many thousands being collected together in single herds. One herd collected on the hill behind our camp, and another remained for hours in the wet bog on the point in front of us. The little fawns were running about everywhere, often coming up to within a yard or two of us, uttering their sharp grunts as they stood and looked up at us, or as they turned and ran back to the does. About noon a large herd had collected on the sides and summit of the hill behind us. Taking the small hand-camera with which we were supplied, we walked quietly among them. As we approached to within a few yards of the dense herd, it opened to let us in and then formed a circle around us, so that we were able to stand for a couple of hours and watch the deer as they stood in the light breeze, or rubbed slowly past each other to keep off the black flies. The bucks, with their beautiful branching antlers, kept well to the background. We obtained a number of photographs, which show the animals in many positions. Later in the afternoon a herd of bucks trotted up to us, and stood at about forty yards distance. This was a most beautiful sight, for their horns are now full grown, though still soft at the tips, but unfortunately we had not the camera with us. We did not shoot any to-day.

"July 31.—To-day was again beautifully warm, with a breeze from the south, but we had a squall and heavy shower towards evening. We have been drying meat to-day. The work is very tedious and slow, but it is hardly likely that we shall have such another opportunity, with abundance of meat, wood, and fine warm weather combined. The deer did not come to this part of the shore to-day, but great numbers are over at Cairn Point. Ptarmigan are very plentiful in the vicinity.

"The hills are underlain by a coarse gray biotite-granite, which appears on a few of the higher points, but the slopes are thickly scattered with loose boulders of the same or similar rock, imbedded in a matrix of gray clay.

"A peculiar feature of the gentle slopes here (and throughout the Barren Lands generally) is the great number of little clay terraces, often somewhat circular, and from one to five or six yards in diameter, the clay being often studded with small stones and pebbles, and sometimes there is a cluster of larger stones in the middle. They are quite level, and usually have a little raised ring of grass around their rims. These little clay flats or discs may occur on hillsides, otherwise literally covered with boulders, or they may compose the greater part of more gentle slopes. In wet weather they are covered with shallow pools of water. The mode of their formation is not very apparent, but it is probably by a sliding of the upper clay over the frozen subsoil.

"A meridian observation of the sun to-day gave us a latitude 62° 9′ 24″.

"August 1st.—We are still obliged to remain in camp for the purpose of drying the meat we have on hand. The weather continues warm and dry, though mosquitoes are very troublesome.

"Immediately after dinner we went over to the point two miles north-west of camp. The point is a long sloping ridge 150 feet high, trending N. 75° E. Its sides and summit are scattered with boulders, chiefly of red granite, and on its very crest is a huge boulder of coarse red porphyritic granite nine feet high. On top of this boulder we erected a cairn, under which we put a bottle with a short record of our trip, and a map of our course so far, so that, should any mishap befall the party in the country farther north, our friends may learn of our safe arrival here. Over the cairn we planted a small Union Jack. Cairn Point.

"Although the surface of the hill is composed largely of boulders imbedded in a yellow sandy till, I found one outcrop of coarse red granite containing large crystals of pyrite. The surface of the granite showed distinct glacial striæ trending S. 85° W.

"No caribou have come near our camp to-day, but we saw a few when over on the point.

"Aug. 2nd.—The morning was gloomy, but the sun came out for a little while, so that we could pack our dried meat in bales, and by nine o'clock we were off."

Temperature of the water in the open lake 54° F.

Two miles north-east of Cairn Point is a shallow strait, with stiff current, connecting wider expansions of the lake. For four miles beyond this strait the north-east shore is marshy or grassy, and then, near the mouth of a small brook, it is broken by morainic boulder ridges a hundred feet in height, the edge of the grassy plain and the foot of the hills meeting in a fairly well-defined line running S. 85° E. The individual boulder-ridges lie in parallel lines extending S. 75° W. A few exposures of rock on the sides of the ridges show that some of them have cores of red granite similar to that of Cairn Hill. Morainic ridges.

At the mouth of the brook is a small grassy glade, wooded with white spruce, one tree of which was fifty feet high and thirty inches in diameter, two feet above the butt. Under the trees were ferns, raspberry bushes, etc., the last that we were destined to see that summer. Large spruce.

Bare rocky hill.

East of this brook is a hill of bare, red, whitish-weathering granite, the first hill of bare unbroken rock that we had seen for a long time. On its south side are several points on which boulders have been piled by the ice in walls from eight to ten feet high, the bases of the boulder-walls being beneath the water. Opposite to it, on the east shore, is a low point of red hornblende-gneiss, the surface of which is well scored by glacial grooves trending W. On the northern shore, the whole country is one great stretch of angular fragments of coarse red granite broken from the underlying rock, between which there is very seldom any matrix of clay, sand or pebbles.

Glacial striæ.

At the foot of Carey Lake is a rounded hill, ninety feet high, of coarse red granite, the summit of which is smoothed, and strongly marked by glacial grooves trending S. 20° E., while any vertical surfaces facing W.S.W. and trending S.S.E. are polished and fluted. The northern side of the hill is rounded, while the southern side is rough and broken. There is also another later set of grooves and striæ, showing well on the higher polished points, and trending S. 80° W., parallel to most of the others seen on this part of the river; but they have not affected the general shape of this rocky hill to the same extent as the earlier striæ.

Below Carey Lake is a heavy rapid three miles long with a descent of about fifty-five feet, the upper portion of which is divided by a low stony island. On the west bank, opposite the foot of the island, is a low hill of coarse augen-gneiss striking N. 40° E. Below the rapid the river continues to flow in a north-easterly direction for several miles, with stony grassy slopes to the south-east, while to the north-west is a glaciated rocky shore, underlain by a rather fine-grained greenish red-weathering epidotic hornblende-gneiss, striking N. 5° E. but strongly jointed S. 70° E. Its surface is well marked with glacial striæ running S. 85° W.

Diorite.

The red-weathered gneiss extends to a point eight miles below Carey Lake, where, at a hill ninety feet high, it is replaced by a massive dark greenish-gray medium-grained diorite, containing large crystals of plagioclase, a small amount of quartz, a large quantity of pyrite and a small amount of sphene. It is cut by several thick veins of white quartz and red rather fine pegmatite. The general surface and summit is covered with glacial grooves and striæ trending S. 87° W., but some lee surfaces near the summit show strong glacial grooves running south, and a beautifully polished surface of quartz was covered with fine striæ running in the same direction.

The diorite continues along the north-west shore for two miles, while the opposite south-east shore is also high, and the hills seemed to have cores of the same rock, but their sides are sloping and covered with verdure.

Biotite-gneiss

At the next rapid, the diorite is replaced by a medium-grained red biotite-gneiss. This gneiss continues to form the shore for two miles, to a point, where it strikes N. 70° E. and dips S. 20° E. at an angle of 40°.

Markham Lake.

North of this point the river opens into Markham Lake, so called after Admiral A. H. Markham, the well-known Arctic explorer, who has always taken such a lively interest in any explorations in Hudson Bay and the adjoining country.

The southern portion of its west shore, along which we coasted, is low and grassy, being at first sandy and afterwards strewn with boulders. It then becomes rocky, rising to low bare hills of dark-gray highly hornblendic gneiss, striking in an east-north-easterly direction, and dipping south-south-east at an angle of 15°, cut by many both wide and narrow anastomosing veins of white pegmatitic granite. The surface is scored by glacial grooves trending S. 85° W.

Continuing northward, the points are low, and are composed of similar hornblende-gneiss, cut by granite veins, but at some distance back the country rises to high bare rounded rocky hills, trenched by deep gorges, in some of which the snow of the previous winter was still lying. The east shore is an even grassy slope, without boulders, descending to a sandy beach.

Near the outlet of the lake, on its west shore, is a rounded hill 115 feet high, the summit of which is composed of rather coarse gneiss, with very irregular strike, while on a point near the water's edge is a finely foliated light greenish-gray biotite-granite-gneiss, the biotite, which is in small amount, being largely altered to chlorite.

Nicholson Lake.

The river flowing from Markham Lake is wide, and occasionally rather shallow, with a swift current. After a course of a mile and a half, it empties into the south-east side of Nicholson Lake, so called in honour of Professor H. A. Nicholson, formerly professor of Natural History in Toronto University, and now of the University of Aberdeen. The shores of this lake seemed to be almost everywhere sloping and grassy, though at its south end are several small groves of spruce and larch, and a few dead trunks are standing on the western shore. On a large island near the middle of the lake is a sandy ridge about 200 feet high, with steeply sloping grassy sides, without boulders

It is possible that this ridge is a kame, associated with one of the terminal moraines of the Keewatin glacier.

North-west of this large island are some smaller ones with steep walls of boulders piled up ten feet high around them. While paddling through these islands we were struck by the appearance of a small white island standing out distinctly among the surrounding reddish ones. This island shows at its south end a low outcrop, extending for 120 yards behind the beach, of fine and even grained well-bedded Cambro-Silurian (Trenton) limestone, striking south and dipping west at an angle of 20°. The lower beds are somewhat more argillaceous, and many fragments of a limestone conglomerate were lying about, but the parent bed of the conglomerate was not seen.

Cambro-Silurian outlier.

Fossils.

Fossils were scarce and rather difficult to extract, but Mr. L. M. Lambe, of this Survey, has kindly furnished the following notes on the few that were collected.

"*Columnaria alveolata*, Goldf. Three highly silicified specimens, and some fragments, with the structure of the corallites as seen in natural transverse sections well preserved. A comparison of the specimens with the type of this species as figured by Goldfuss in the *Petrefacta Germaniæ*, pl. xxiv., figs. 7*a*, *b*, *c*, leaves no doubt as to the identity of the Nicholson Lake fossil.

"*Streptelasma rusticum*, Bill. A poorly preserved specimen and two fragments, in which the structure is obscured by concretionary silicification. This coral is, on account of its poor state of preservation, referred with some hesitation to Billings's species, considered by its author as typical of the Hudson River group.

"*Calapœcia Canadensis*, Bill. One silicified specimen, of irregular shape, measuring about four and a half inches at its greatest breadth, and about an inch and a quarter in thickness; it is a portion of what was evidently a much larger mass. The numerous pores are shown well in longitudinal sections and the tabulæ are normal in shape and disposition, as is also the irregular tabulate structure between the corallites.

"*Orthis testudinaria*, Dalman. Two small single valves, a dorsal and a ventral, with rather strong plications; the larger of the two is 7·5 mm. high, and 8·5 mm. broad."

This interesting exposure, only a few acres in extent, is doubtless an outlier of the Arctic Palæozoic basin. It was the only Palæozoic limestone seen north of the tributaries of the Saskatchewan River during the summer of 1893, but probably the same or similar beds occur in the vicinity or further north, for limestone boulders were frequently found scattered among those of granite and gneiss.

From the north end of Nicholson Lake, the river flows northward for two miles and a half down a heavy rapid, with a descent of about forty feet, towards the bottom of which the bank is formed by abrupt cliffs of reddish sandy till filled with boulders, and steep walls of reddish-gray horizontally foliated gneiss. Near the foot of the rapid the stream turns eastward, and for about six miles flows in the bottom of a valley from 150 to 200 feet deep, the banks being composed of horizontal reddish-gray gneiss, while several narrow esker-like ridges of sand and boulders run down the valley parallel to the sides. On the steep hillsides were some small groves of white spruce, the last that we were to see that summer, while the little patches of snow here and there in every direction would have kept us reminded that we had reached a sub-arctic climate, if the almost constant cold rain and wind had not made us thoroughly alive to the fact. On the hillsides Arctic hares were seen for the first time. Heavy rapid.

The river then becomes more diffuse and irregular, and after flowing for several miles, breaks up into a number of channels, just as it enters an oblong lake. This lake lies north-and-south, and is four and a half miles long. The temperature of its water on August 5th, was 47° F. At its south end the shores are moderately high, but they gradually decline towards the north, until at its north end is an extensive level green plain with no hills in sight. The points on the west shore are composed of reddish-gray gneiss. At one point this gneiss is cut by a dyke, about 140 feet wide, running S. 60° E., of medium-grained dark-gray diabase, much of the augite in which is altered to hornblende, and containing also a considerable quantity of magnetite. Small lake.

The Telzoa River flows from the east side of the oblong lake, in a well defined channel from 100 to 200 yards wide. Its banks of red till and boulders, are low and sloping, and rise to a wide grassy plain.

On the north bank of the river, half way between the above lake and Doobaunt Lake, is the last grove of black spruce on the river, where the trees are so stunted that they are not as high as one's head. Behind the grove is a low hill of massive red hornblende-granite, the surface of which is moderately well smoothed and rounded, but neither here, nor for some distance back up the river, was I able to detect any glacial striæ. Last grove of timber.

From the top of this hill Doobaunt Lake could be seen lying to the east of us, apparently covered with a solid sheet of ice. Back from the river is a stony plain, parts of which were whitened by the flowers of the Labrador tea *(Ledum palustre)* or the white tassels of the anemone *(Anemone parviflora)*, while many of the knolls were pink with the beautiful little flowers of *Rhododendron Laponicum.* A mile north of this stunted grove, rising abruptly out of the plain, is a short sandy ridge or esker running S. 70° W.

Fish.

In the river opposite the grove some fine salmon-trout and white-fish were caught, the former weighing as much as ten and a half, and the latter as much as eight and a half pounds. Among the spruce bushes there was some very old chopping, doubtless done by the Chippewyan Indians when they used to descend the Telzoa River as far as Doobaunt Lake. Along the edge of the bank also stones were piled one on another, after the manner of the Eskimos. Probably it was near this grove of spruce that Samuel Hearne, our only white predecessor in this portion of the Barren Lands, had crossed the Doobaunt River in company with a large band of Indians a hundred and twenty-three years before.

Old signs of Indians and Eskimos.

For five miles below this last spruce grove, the banks are rather low, and consist chiefly of sloping pavements of boulders, but in two or three places there are cliffs from twenty to thirty feet high, of reddish sand, mixed with rounded pebbles and boulders. The stream is also obstructed by several short rapids over low ridges of gneiss.

DOOBAUNT LAKE.

Doobaunt Lake is a large body of clear, cold water of unknown extent, the southern and eastern shores, indicated by dotted lines on the map, having been laid down from rude sketches made by Eskimos. Its western and northern shores were surveyed for 117 miles, but from the summits of the highest hills the opposite shores were nowhere distinctly seen. Its approximate altitude above the sea is 500 feet. By the Chippewyan Indians it is called T'o-b'o^{n}-t'ua or Water-shore Lake, possibly from the fact that the main portion of the lake is always covered with ice, and that in summer there is a lane of water between this ice and the shore. Its Eskimo name is Tūlĕmălūgŭa. Judging from subsequent Eskimo reports, it has two principal affluents. One of them flows into its southern side, and has scattered groves of white spruce on its banks. The other is the Doobaunt or Telzoa River which we had descended.

Extent.

Name.

Survey.

Eleven days were spent on the lake, during five of which we were unable to move on account of heavy storms. The description here given is confined to those portions of the western and northern shores explored on the remaining six days, while engaged in the search for its outlet.

The Doobaunt River flows into the west side of the lake in north latitude 62° 55′, and near its mouth is a low island of medium-grained red gneiss striking north and dipping west at an angle of 40°. On some gently sloping surfaces the glacial grooves were well shown running S. 87° W. **Island of gneiss.**

The body of the lake was covered with ice and overhung with mist, so that we were unable to paddle out into it, but turning northward in a channel of open water, we found that the shore for a short distance was rather high and craggy, and then it and the many outlying islands were quite low and sloped gently to the water. The points were all composed of gray, or reddish gray, gneiss similar to that seen on the river. Those points facing eastward were constantly well rounded, while the western sides of hills were broken into angular blocks. On one boss glacial grooves were found trending N. 80° W. The surrounding country is a stony plain composed chiefly of angular blocks broken from the underlying rock, among which are scattered a few boulders of white Huronian sandstone, red Cambrian rocks and light-gray unaltered Cambro-Silurian limestone. The surface of the plain is sparsely covered with grass in bunches and with black and green hair-like lichen. (*Alectoria divergens* and *A. ochroleuca.*) **Ice.** **Points of gneiss.**

Teall Point, nine miles north of the river, is an irregular peninsula projecting several miles out into the lake. On this point is a rounded hill a hundred feet high, underlain by a fine-grained red altered felspathic sandstone or arkose. It is chiefly composed of more or less rounded grains of quartz cemented together by interstitial silica. With the quartz grains are many of orthoclase, a few of plagioclase, some flakes of mica altered to chlorite, pyrite in small cubical crystals, the edges of which are altered to limonite, and a few irregular grains of sphene. Running N. 80° E., and extending down the south side of the hill, is a wide ferruginous band cut by many narrow veins of quartz. This sandstone doubtless represents some of the basal beds of the Athabasca series of the Cambrian, which series was afterwards found to have such an extensive development towards the north and east, and Doobaunt Lake would seem to add one more to the number of large Canadian lakes that lie along the contact of the Archæan gneisses and schists, and the overlying Palæozoic beds. **Teall Point.** **Athabasca sandstone.**

The ice was found to be packed solid against Teall Point, so that it was necessary to endeavour to find some way of passing behind it. At length a place was found where two bays, one from the south and the other from the north, almost met behind the peninsula, being separated only by a narrow neck of land a hundred and fifty yards wide, over which the canoes were carried. **Ice packed against the point.**

Three miles west of the above-described quartzite hill, in the bottom of a shallow bay, is an outcrop of light-gray granular biotite-gneiss (Laurentian) striking N. 80° E. and dipping S. 10° E. at an angle of 60°. It is cut by a dyke, six feet wide, running along the strike of the gneiss, of a coarse dark-grained gray augite-minette, containing biotite in numerous large idiomorphic crystals, and malacolite, also in large idiomorphic crystals, imbedded in a matrix of coarsely crystalline orthoclase. Some small particles of serpentine are considered by Professor F. D. Adams to be an alteration product of the malacolite. Many fine large crystals of apatite and a small amount of pyrite are also present.

Dyke of augite-minette.

Sericitic schist.

On a point a short distance further west is an outcrop of thinly foliated light-green sericitic schist, very similar to many of the schists so common in the Huronian, but whether this schist is Laurentian or Huronian was not definitely determined.

North of the neck of the peninsula the shore, with the exception of some distant hills, is low and slopes gently to the water. A small island, lying about three miles north of the neck, consists of a fine-grained thin and evenly foliated light gray-muscovite gneiss, striking S. 80° E. and dipping N. 10° E. at an angle of 60°.

Ridge of diorite.

Seven miles north of the neck, we landed on the low north-western shore, and found it to be composed of red biotite-gneiss foliated N. 40° E. Behind the beach is a stony and mossy flat extending back to a rounded hill about 200 feet high, probably composed of dark green diorite. Thence north-westward a high ridge runs parallel to the lake, descending with a beautiful even green slope to a sandy beach at the edge of the water. The crest of the ridge alone seemed to be rough with boulders or fragments of rock.

The point south-east of the mouth of Sunset Creek is of a very coarse granite, with large phenocrysts of orthoclase, in contact with a dark-gray mica-diorite, showing rude ophitic structure, composed chiefly of plagioclase and biotite, the latter mostly altered to chlorite, with accessory pale green hornblende, quartz, apatite, epidote, zoisite, and ilmenite surrounded by leucoxene. The summit of the granite hill is well glaciated, the general direction of the grooves and striæ being S. 30° W., but some of the higher polished points showed later striæ running N. 80° W.

Sunset Creek.

The ice was pushed close around this point, and hearing the sound of a rapid in the bottom of the bay we turned towards it in the hope of finding some willows for fuel. Arriving at Sunset Creek, we found it to be a torrential brook, swollen by the recent rains, flowing from a wide green valley that extends towards the north-west. It was about thirty feet wide at the swiftest parts. No willows were found, but a smoky fire was made with green dwarf birch *(Betula glandulosa.)*

The next morning the ice had moved a short distance off the point, leaving a clear channel of water around it. The shore east of the point maintains much the same character as before, descending in a long green slope to a sandy beach. After following it for a short distance we left it and struck across to a large island, which was reached near the middle of its southern side. Here the Athabasca series was again encountered, in the form of a coarse and fine red conglomerate, interbedded with layers of hard red quartzitic shale, mottled with green streaks and blotches. The finer beds are constantly covered with ripple marks, and occasionally show sun-cracks. They consist of angular and sub-angular grains of quartz and felspar, with a few scales of biotite, imbedded in a fine-grained matrix stained brown with iron-oxide. The whole series is well bedded, striking S. 10° W. and dipping S. 80° E. at an angle of 25°.

Island of sandstone.

In the next mile and a quarter the conglomerate seems to turn round gradually and strike along the shore, but at the south-east point of the island it strikes S. 20° E. and dips N. 70° E. at an angle of 17°.

The centre of the island rises in a long rounded hill to a height of 100 feet, on the top of which is a clear even grassy prairie. On the shore of this and the adjoining islands the bases of the cliffs were often covered with an accumulation of old snow and ice.

On an island five miles farther towards the north-east, the conglomerate is very coarse, with pebbles a foot or more in diameter, and is cut by a dyke fifteen feet wide of dark-green fine-grained diabase running N. 30° E. Close to the contact the conglomerate is altered almost to the hardness of a granite. The diabase is very much decomposed. In a microscopic section it is seen to be an interlocking mass of crystals, or fine laths, of plagioclase, mixed with larger crystals, frequently much elongated, of augite, altered to chlorite. Besides there are long and large crystals of apatite, a large quantity of ilmenite, often in skeleton crystals, and a little quartz.

Dyke cutting the sandstone.

On the point of an island two miles farther north is an outcrop of a coarse light-gray typical and rather fresh diabase, composed of stout lath-shaped crystals of augite, some of which are altered to hornblende, and some large particles of iron ore.

Diabase.

From this point of diabase we ran six miles north-westward to the bottom of a bay, where camp was pitched on a grassy slope beside a

Hill of gabbro.

hill of gray massive gabbro. This hill is well rounded and shows three fairly distinct sets of glacial grooves and striæ. The earliest set, well shown in polished protected grooves, runs S. 20° W. Another set runs N. 50° W., while the north-west side of the hill is rounded and strongly scored with grooves and striæ running S. 20° E. On a granite island three miles farther east, the only striæ distinctly shown were those running S. 20° W.

The surrounding country is a well-grassed undulating sandy plain. Two miles south-west of camp is what would seem to be a modified kame or esker. It consists of two rounded knolls or hills of sand and gravel, a mile apart, connected by a low sandy ridge running N. 50° E. The north-eastern knoll is about 200 feet high, and the other 300 feet high, the latter rising as a rounded knoll sixty feet above a level terrace around it, which was probably formed in one of the earlier stages of Hyper-Doobaunt Lake.

Highly-altered conglomerate.

Three miles and a half north-east of camp, across the plain, is a group of hills about 300 feet high, more or less connected by the 240-foot sand terrace. The hill more particularly examined was found to be composed of highly altered red Cambrian conglomerate, with white quartzite pebbles, so hard that it breaks almost indifferently between or through the pebbles. A microscopic section of some of the finer portions showed it to be a loosely coherent rock composed of grains of quartz with a few of felspar, cemented by a large amount of chalcedonic quartz, which is stained red by iron oxide. Some of the quartz grains show secondary enlargement, the secondary silica showing the same orientation as the primary.

Quartz-porphyry.

The highly altered conglomerate outcrops on the shore of the lake at a point two miles farther east, where it is cut by a vertical dyke running east-and-west, of light-red quartz-porphyry, with microcrystalline groundmass, coloured red by minute particles of iron ore, and showing a distinct flow-structure. It contains phenocrysts of felspar which are largely decomposed, and are often replaced by calcite; and grains of quartz, showing uneven extinction, with very irregular rounded outlines. These quartz grains are broken by many minute cracks, and are usually corroded, the groundmass sending irregular tongues into the quartzes. The groundmass contains fewer ferrites, and consequently is lighter in colour, around the phenocrysts.

Sandy peninsula.

To the south of the quartz-porphyry is a peninsula underlain by red gneiss and coarse green gabbro, on which are hills of horizontally stratified loose sand, often around a core of sandy till.

From this outcrop the conglomerate, often showing a distinct horizontal bedding, extends eastward along the shore for three miles and then retires from the edge of the lake.

From the foot of the ridge of conglomerate the shore then turns south-eastward, for ten miles, to a long point. For the first two miles the land descends in a long grassy slope, south of which is a prominent point of rounded boulders, probably morainic. In the bottom of a bay east of this point, and on the bank of a small brook, is a rough morainic ridge, forty feet high, of boulders of red and gray gneiss, white quartzite, &c., piled together in the utmost confusion, and without any infilling matrix. Moraine.

From the brook southward to the point of the peninsula, the westward slope descends from a ridge, possibly of rock, to a low flat grassy shore, with low rocky points; while the eastern slope is composed of boulders or angular blocks of red and gray granite and gneiss, many of which are piled high around the salient points. The rock on the western shore is chiefly a gray medium-grained biotitic augen-gneiss striking N. 35° W. and dipping S. 55° W. at an angle of 70°, holding bands of epidote and schorl. At one point is an outcrop of white, well stratified Huronian quartzite, very like the pebbles of the Athabasca conglomerate. The quartzite is very much crushed, and the grains show uneven extinction. The edges of the grains are all very jagged and irregular, and between them are many smaller grains, apparently broken from the larger ones by the crushing. Huronian quartzite.

The surface of the quartzite is smoothed and scored by glacial grooves trending N. 50° W., while at a point of gneiss, more particularly examined, the surface was found to show three sets of striæ. The earliest run S. 23° W. The rounded surfaces on the north side of the knoll are deeply scored by this set alone, while they are also seen in protected grooves on the east side. The second set runs N. 60° W., while the last set runs N. 40° W. up the south-eastern slope, though they are not very strong or distinct.

At the bottom of the bay east of the peninsula are low exposures of red biotite-granite, while three-quarters of a mile inland, up a gentle sandy slope broken by a few granite knolls, is a conspicuous hill eighty feet high, composed, on the south side, of a massive red quartz-porphyry or rhyolite, consisting of a micro-crystalline granitoid groundmass, through which is scattered an abundance of ferrite particles, and a considerable quantity of chlorite. In the groundmass are phenocrysts of orthoclase and quartz, besides which are small crystals of apatite, zircon, rutile, &c. On the north side of the hill is a greenish, red-weathering quartz-andesite, very similar to the quartz-porphyry, Quartz-porphyry and quartz-andesite.

except that the felspar is here a plagioclase. Both these rocks are strongly jointed, and break down into mural cliffs. Through the middle of the hill, between the rhyolite and andesite, is a depression filled with débris, possibly marking the line of a basic dyke.

The eastern shore of the bay is a long sandy or grassy slope, rising from the edge of the water to a ridge of prominent hills.

At a point three miles south of the hill of quartz-porphyry is a low boss of gray gneiss, while off the point is a boss of fine-grained green diorite, consisting of crystals of hornblende, sometimes altered to chlorite, surrounded by very much decomposed plagioclase.

Basic granite.

On the north side of the channel east of the bay, is a long point of a massive basic granite, consisting of quartz, orthoclase and biotite. The orthoclase occurs in large irregular individuals, surrounded by a fine-grained groundmass of much shattered quartz. Some of the biotite is altered to chlorite, which shows a deep blue polarization colour. Ilmenite surrounded by leucoxene, epidote, apatite and zircon were also seen in the section.

The surface of this granite is well polished and shows glacial grooves running N. 35° W. The south-east side of the point is well rounded, while in the grooves are many curved cross-fractures opening north-westward.

Green diorite and gray gneiss.

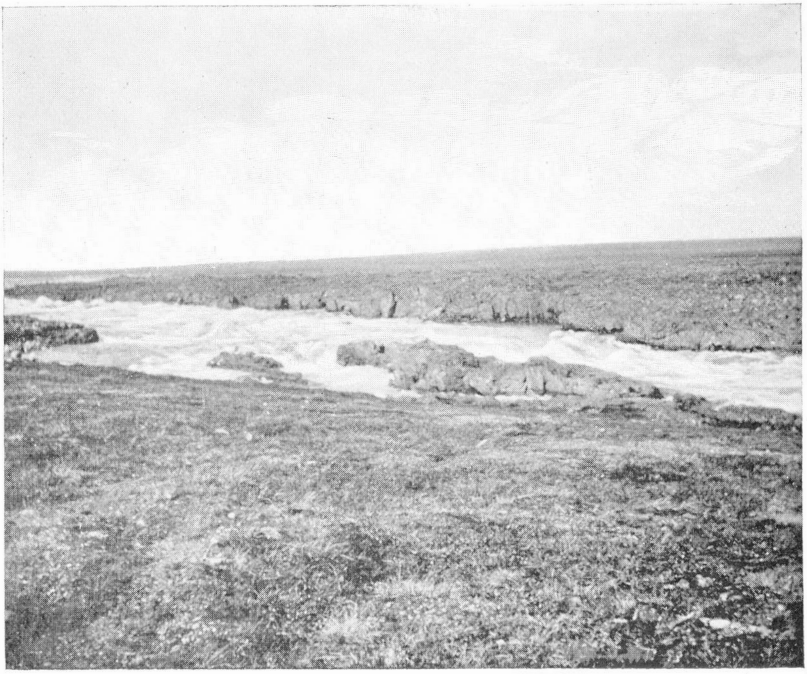
At a point half a mile further towards the north-east this basic granite is associated with green diorite, and with a rather fine-grained reddish-gray gneiss, composed of quartz, orthoclase, plagioclase and biotite. The latter is largely altered to chlorite, and much iron ore is separated out from it. Sphene is also fairly abundant.

From this point northward for nine miles, to the mouth of a small brook, the west shore is very low, and is composed of boulders and angular fragments of coarse red granite, sloping from low hills down to the shallow water.

Sandy shore.

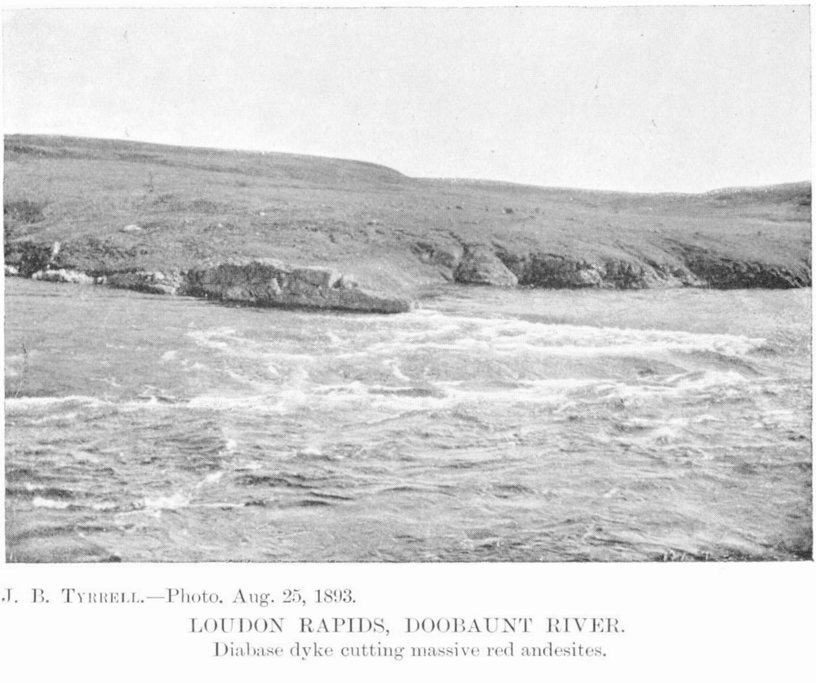
From the mouth of the brook the shore turns south-eastward for five miles. At first it is an even, probably sandy, slope, and then rocky knolls begin to appear, and continue to the point. At the point the rock is a very coarse massive red hornblende-granite, which in places seems to run into a decomposed highly ferruginous quartz-porphyry, cut by veins of white quartz. The surface of the granite is polished and scored by glacial grooves and striæ running N. 35° W.

Five miles east of the point, the river was found flowing out of the lake, where the beach is made up of boulders and large angular fragments of fine quartz-porphyry, red amygdaloidal trap, &c.



Aug. 18, 1893.

GORGE, BELOW DOOBAUNT LAKE.



J. B. TYRRELL.—Photo. Aug. 25, 1893.

LOUDON RAPIDS, DOOBAUNT RIVER.

Diabase dyke cutting massive red andesites.

Doobaunt River.

The river, where it leaves the lake, is about 200 yards wide. It almost immediately flows down two slight rapids, after which it has a current of four miles an hour, through a wide and almost level plain, underlain by reddish till, which holds small pebbles and boulders. Here and there are occasional knolls of sand and rounded gravel. The channel rapidly deepens, with steep green banks, and the stream rushes on in long swift rapids which required all the dexterity of our good canoemen to run.

Level plains of till.

Seven miles below Doobaunt Lake, the river flows over a ridge of coarse reddish hornblende-granite, and then suddenly contracts, and for two miles rushes as a foaming torrent down a narrow gorge about twenty-five yards wide, descending in the distance one hundred feet. The north-west bank is an almost continuous wall of rock, which, however, was not examined; the south-east bank is a steep sandy slope, with rocky points projecting into the gorge at frequent intervals. On this side the rocks seen were:—A fine-grained red quartz-augite-anderite or dacite, containing crystals of light green augite, plagioclase, and a few rounded corroded crystals of quartz in a finely crystalline groundmass, composed chiefly of minute crystals of plagioclase, coloured red by numerous inclusions of iron ore. A fine-grained dark-green pitchstone, consisting of glassy groundmass, filled with minute feathers of iron ore, which render the rock very opaque. This pitchstone is cut by veins of quartz with numerous cavities, lined with crystals of amethyst, etc. In contact with the pitchstone is highly altered red Athabasca conglomerate. This conglomerate forms the bank throughout the lower portion of the gorge. The gorge probably marks the line of a dyke of pitchstone or basalt, which has weathered away more rapidly than the surrounding granite and conglomerate.

Narrow gorge.

Past this heavy rapid, which is the most serious obstruction on the whole river, a portage two miles and a half in length was made on the south bank. Where we left the river the bank is thirty feet high, and is composed of reddish till with partially rounded pebbles. After ascending to the top of the bank the western half of the portage is over an almost level surface of till, holding pebbles but no boulders, east of which is a descent of sixty feet to a terrace or plain of gravel, some of which is quite loose and is not covered with grass or herbage. This plain undoubtedly represents one of the higher of the ancient beaches, or shores of Hudson Bay and the Arctic Ocean, when the land stood between 400 and 600 feet lower than at present. Whether the sea extended over the higher plain was not definitely determined, but the evidence at hand would seem to show that it did. The gravel terrace descends rather steeply to a low country strewn with well rounded boulders.

Grant Lake.

At the foot of the heavy rapid the river discharges into Grant Lake (so named for Sir James Grant, K.C.M.G., M.D). The lake is seven miles long, and on the 19th August was partly covered by an unbroken field of ice. Its western shore is sloping and grassy, while the beach is often strewn with angular fragments of red granite. Three miles and a half north of Doobaunt River, Chamberlin River, named in honour of Professor T. C. Chamberlin, discharges into the west side of the lake, bringing in about a quarter as much water as Doobaunt River. We subsequently learned from Eskimos that there are trees growing on its banks some distance up from its mouth, but where it flows into Grant Lake no wood, except a few very small willows, could be found. On its banks gravel terraces, marking old sea-shores, rise from seventy to eighty feet above the lake. North of this river is a narrow esker, eighty feet high and between one and two miles long, extending N. 20° W. and running down to a point at its south-eastern end. Its crest, which is chiefly composed of rounded pebbles and boulders, is very narrow, while the sides are as steep as the sand and gravel will lie.

Chamberlin River.

Esker.

Just north of Grant Lake, in north latitude 63° 44′ 30″, is a hill or esker, 270 feet high, composed of sand and rounded pebbles and cobbles. Around its base are deep kettle-holes, many of them containing ponds of water. The western side, facing the river, is moderately steep, and on it are three fairly distinct terraces or old beaches, the highest one being 120 feet above the lake, probably marking the highest ancient marine shore line. From this hill a long sandy ridge extends into the distance in a direction N. 80° E.

For eight miles below Grant Lake the river is from 200 to 400 yards in width, with a current of from three to six miles an hour. The banks are low, and at first are of stratified gravel, while afterwards they are of rude masses of red gneiss. At the end of the above distance is a heavy rapid full of large boulders, caused by the stream flowing over a band of fine gray micaceous gneiss striking N. 5° W. At the foot of this rapid the river expands into a small lake, which was choked with heavy ice. Its north shore is rocky, though not high, while the south shore is sloping and sandy.

Here we turned eastward, and just as we entered the river below the lake a solitary deer-skin tent was seen on the bank. On coming to this tent we found that it was occupied by an Eskimo, with his two wives and five children. From him we obtained some slight information about the river ahead of us, but we were also lead to believe that there were many more Eskimos camped on its banks from whom we would be able to obtain information from time to time. This proved to be misleading, as for the next thirteen days we did not see another Eskimo, although it was evident then they had been camped beside the river in many places.

Below the point on which the Eskimo was camped are a couple of small lakes, with sloping sandy shores. Below these, for three miles and a half, the river is very swift, and at one point there is a fall ten feet in height over a ledge of massive red and green epidotic quartz-diorite which contains large crystals of plagioclase, with smaller intermediate grains of quartz and plagioclase, biotite altered to chlorite, hornblende, epidote, apatite, and iron ore altered to leucoxene. Past this fall is a portage on the south side 250 yards in length.

Quartz-diorite.

Wharton Lake, so called in honour of Admiral W. J. L. Wharton, R.N., F.R.S., Hydrographer to the Admiralty, was entered a mile and a quarter below the above rapid. It is rather oval in shape, and lies in a north-and-south direction, having a greatest length of twenty-one miles, and a greatest width of about seven miles. The greater part of two days was spent in this lake, struggling against head winds, surveying its western and northern shores, and looking for its outlet, which was found about the middle of its eastern shore. The western shore is a grassy slope, rising to a terrace thirty feet above the water, or to rounded grassy hills sixty feet high. From the foot of the slope long points of boulders and masses of red quartz-porphyry and mottled red sandstone run out into the water, and the shore and hills are also largely composed of loose masses of red quartz-porphyry. The whole character of the country suggests a morainic area.

Wharton Lake.

At the north-west angle of the lake, behind a long island, Laurentian gneiss appears, its surface being marked by glacial grooves trending N. 60° W. The remainder of the northern, and the northern half of the eastern shore of the lake, consists of hills and ridges of boulders, imbedded in a sandy till, and overgrown with grass. On the point just north of the outlet of the lake is a rounded hill 230 feet high, of white Huronian quartzite, seamed by narrow veins of white chalcedonic quartz. It lies on a low anticline striking N. 35° E., the rock on the summit being horizontal. The top of the hill is beautifully polished, and is marked by two sets of glacial grooves and striæ, the later set trending N. 75° W., while the earlier set, seen on

Hill of Huronian quartzite.

Quartzite hill. lee surfaces, trends S. 28° W. On the southern side of the hill are three well marked gravel terraces, respectively 60, 105 and 130 feet above the lake. The lower two are of fine gravel and coarse red sand, and their brows are quite bare of vegetation, so that they form two conspicuous red lines on the side of the hill. The upper one is on a steeper part of the hill, and its face is almost vertical. It is composed of well-rounded coarse gravel and small cobbles, now all blackened with lichens. Around a little stone fire-place on the top of the hill were the remains of musk oxen which the Eskimos had recently killed.

Below Wharton Lake the river flows at first eastward, and then southward, for four miles to a small lake, in which distance it rushes down two rapids with descents respectively of 15 and 6 feet.

Small shallow lake.

The small lake seems to be everywhere shallow, though the water is very clear. On its south side is a sand ridge (or esker ?) about 300 feet high, trending east-and-west, on the side of which the three terraces seen at the quartzite hill are well shown. Towards the west end of the ridge are scarped banks of sand about eighty feet high. On the north side of the lake is a cluster of low islands, composed of boulders of red gneiss, covered with moss and grass. Low hills of boulders continue eastward, along the course of the river, for the next five miles. The stream has no well-defined channel, but flows around and between these hills with a current of from five to eight miles an hour. Five miles below the small lake is a rapid with a descent of twenty feet, past the lower part of which a portage 400 yards long was made over a hill of boulders, and we embarked from a sheet of ice that, on the 23rd of August, was still frozen to the bank. Above the rapid a gravel plain extends a long distance back from the river. At the foot of this rapid the river turns at right angles and flows northward for seven miles as a wide shallow rapid stream, through low country, composed of small morainic or drumlin-like hills of boulders of light-gray well foliated gneiss.

Rapid and portage.

Lady Marjorie Lake.

Lady Marjorie Lake, so named as a mark of respect to the daughter of Their Excellencies the Governor-General of Canada and Lady Aberdeen, was entered at the south end, in approximate latitude 64° 7′. Thence it extends northward for twelve miles, gradually expanding in width towards its northern end. The east shore is at first low, and then rises in a long high grassy ridge, probably an esker. The west shore, along which we coasted against a strong head wind, consists generally of low stony hills, forming a typical till-covered landscape. One low rounded boss of well-foliated biotite-gneiss, striking S. 77° E., was seen near the south end of this shore, its surface being marked by glacial grooves trending N. 67° W.

At the north-west angle of Lady Marjorie Lake the river leaves it, near the base of a high sandy hill. Thence the stream flows north-westward for two miles to the east side of a similar hill of sand and gravel, at the foot of which is a swift rapid over a ridge of rather coarse red epidotic and hornblendic granite, often containing inclusions of light-gray micaceous gneiss. The total fall in this rapid is about twenty feet. In descending it one of the canoes was badly broken on a stone.

Canot Cassé Rapid.

Below Canot Cassé Rapid the river continues in the same north-westerly direction, but the current moderates, and the banks are well-defined and sandy. Seven miles below, in latitude 64° 18′, is a group of hills from 200 to 400 feet in height, which had been conspicuous objects in the north for several days. One hill, 200 feet in height, was ascended. It is composed of mottled, light-greenish, coarse diabase, made up of large interlocking lath-shaped crystals of plagioclase, between which is augite, largely altered to a light-green hornblende. With these are crystals of apatite, and a number of particles of copper-pyrites. The hill is part of a dyke about 120 feet wide, running N. 35° W.; its sides are broken, and in many places abrupt and mural, or composed of tumbled angular fragments, giving it a very inaccessible appearance from a distance. Its summit is strongly marked by two distinct sets of glacial striæ, the later one running west, and the earlier one S. 20° W.

Conspicuous hills of trap.

The surrounding hills also seemed to be composed of the same green diabase. On one of those rising to the east, five distinct terraces, representing old beaches, are clearly marked. The uppermost one, doubtless the same shore-line as the upper terrace on the quartzite hill by Wharton Lake, is about 200 feet, and the lowest one is about 100 feet, above the river. The other three are between these. At the south point of the hill they appear as five well cut notches, from which gravel ridges extend along its sides.

Five terraces

From this point a ridge of hills, composed of similar diabase, continues north-westward, while the river flows with an easy current at the foot of the ridge. South-west of the river, a level plain extends into the distance.

Fifteen miles below Lady Marjorie Lake, the river suddenly narrows to a swift rapid, between walls of coarse red andesite, below which, for several miles, it flows in a well defined channel 200 yards wide, with steep banks of red bouldery till, gradually increasing from 50 to 100 feet in height.

Banks of andesite.

Loudon Rapids.

Twenty-six miles below Lady Marjorie Lake, in latitude 64° 27′ 12″, a narrow dyke of green diabase crosses the river, forming a heavy rapid, here called Loudon Rapid, after the President of Toronto University. The diabase dyke cuts through a coarse red massive andesite, composed of a fine-grained micro-felsitic groundmass, coloured by a number of rods and granules of iron ore, in which are imbedded large phenocrysts of plagioclase, very much decomposed. There are also a few crystals of light green chlorite, with dark borders of magnetite, and a few scattered crystals of apatite. The rock is very much jointed, and breaks easily when struck. Along the jointage-planes it is often considerably decomposed, with the formation of a green crust of copper-carbonate.

For five miles below Loudon Rapid, the river continues to flow in same north-westerly direction, with a current of four miles an hour.

Banks of red till.

The banks, from 50 to 100 feet in height, are often scarped, and are composed of light gray or red till, containing boulders, overlain by stratified deposits of similar composition. The river has all the appearance of a prairie stream, rolling prairie stretching out on both sides, and steep banks of till descending to the water.

Athabasca conglomerate.

At a point on the north-west shore of a small shallow lake, seven miles below Loudon Rapid, is a scarped bank showing thirty feet of light-gray sand, with boulders, at the foot of which is an outcrop, six feet in thickness, of light-gray rather fine Athabasca conglomerate, horizontally bedded, but much jointed, the pebbles in which are almost entirely of quartzite.

For three miles below this shallow lake, or a total distance of thirty-six miles from Lady Marjorie Lake, the river continues in the same north-westerly direction, on a direct course toward the Thlew-e-choh, Great fish or Back's River, and it seemed to us almost certain that we were travelling down a tributary of that stream, and not on any river flowing into Hudson Bay. We were now many miles north of the head of Chesterfield Inlet, and every mile travelled was taking us almost that much farther away from the inlet, and that much nearer to Back's River. That there was no large stream flowing into Hudson Bay north of Chesterfield Inlet, had been rendered reasonably certain by the exploration of Dr. Rae up Quoich River, and by the winter journeys of Lieutenant Schwatka from Daly Inlet to the mouth of Back's River. The spirits of the party sank as they thought of the long and toilsome return up this river, to be begun just a couple of weeks before the arctic winter should set it. But three miles below the small lake, the river broke up among sandy hills and islands, and through these a large stream seemed to join the Doobaunt River from the west. Clumps of willows were growing on the banks, and a considerable quantity of driftwood was scattered about, consisting of dead trunks of white spruce, a foot in diameter, limbs of balsam-poplar, etc. These had evidently been carried down by the tributary from the west, the banks of which must be fairly well wooded, and there can be no large lakes on its lower course to arrest the driftwood. Information subsequently obtained from Eskimos tended to confirm these conclusions. The river is almost certainly the Thelew River, of which Captain Back had been informed while journeying to the source of Back's River in 1833. One branch of this stream probably rises not far from Lake Athabasca and flows northward parallel to the Telzoa River, being reached by ascending either Charlot or Grease River.

Mouth of Thelew River.

From the first driftwood at the sand-hills the river turned towards the north-east. After continuing down the stream for five miles camp was pitched on a small island in latitude 64° 36′ 26″, behind a sandy beach, with a thick grove of willows three feet high behind the tents. The surrounding beaches were all sandy, quite different from the stony and gravelly shores higher up the river. Here we enjoyed the first good fire we had had for three weeks.

River turns eastward.

From this camp in the delta of the western river we descended a fine wide stream, with its low grassy and sandy banks, until, after a few miles, it turned directly eastward. A short distance below this bend is a small island, on which is a hill a hundred feet high of horizontally stratified white sand, on the summit of which are well-rounded pebbles. Hills of sand of similar character extend back from both sides of the river. They all probably represent a bar formed across the mouth of the bay to the west when the sea stood at the level of their summits.

Six miles and a half east of this sandy island is a low cliff of white till, the boulders in which are chiefly of white and light-red sandstone. A short distance farther east, the river flows into the west end of Aberdeen Lake.

Aberdeen Lake.

Aberdeen Lake—so called as a tribute of respect and esteem to His Excellency the Governor-General of Canada—is forty-four miles in length and about sixteen miles in greatest width, with an area of from two hundred to three hundred square miles. The temperature of the water on August 28th was 40° F. The south shore is a moderately high but gently sloping grassy ridge, while the western portion of the north shore consists chiefly of rather high drumlin-like ridges of sand and boulders, between which are often long gentle slopes descending to the water. The beach is usually sandy, but the more prominent points are closely packed walls of boulders, while pavements of rounded cobbles and boulders often extend out into the lake from the edge of the beach.

Terraced hill of sandstone.

Four miles west of the outlet of the lake, a gentle grassy slope rises a hundred feet to the foot of a ridge of coarse sandstone which is about 400 feet high. From the top of this slope the rocky hill is steep and rugged, with vertical cliffs of hard white or light-red sandstone which is thickly and horizontally bedded, and often contains so many pebbles of white quartzite as to change it into a conglomerate. The summit of the hill is well glaciated, the glacial grooves trending N. 35° W. Several gravel ridges, or old beach-lines, are well marked on its sides, with the following elevations in feet above the lake, viz.:—60, 90, 105, 150 and 180, the last being marked by a strongly cut terrace. Above these are one or two other beaches, the heights of which were not determined.

Still higher terraces.

Six miles further east, on the east side of the outlet of the river, is another hill 400 feet high, of coarse horizontal sandstone and conglomerate. On this hill the upper beaches can be clearly traced. The foot of the upper cliff, possibly an old beach-terrace, is 320 feet above the lake, but a very distinct old beach of rounded gravel and cobbles is clearly marked at a height of 290 feet. There is another beach at 220 feet, and a stony terrace at 170 feet, corresponding to the 180 feet beach on the other hill. On the side of this hill is a little valley down which a small glacier seems to have flowed, leaving little lateral and terminal moraines of boulders.

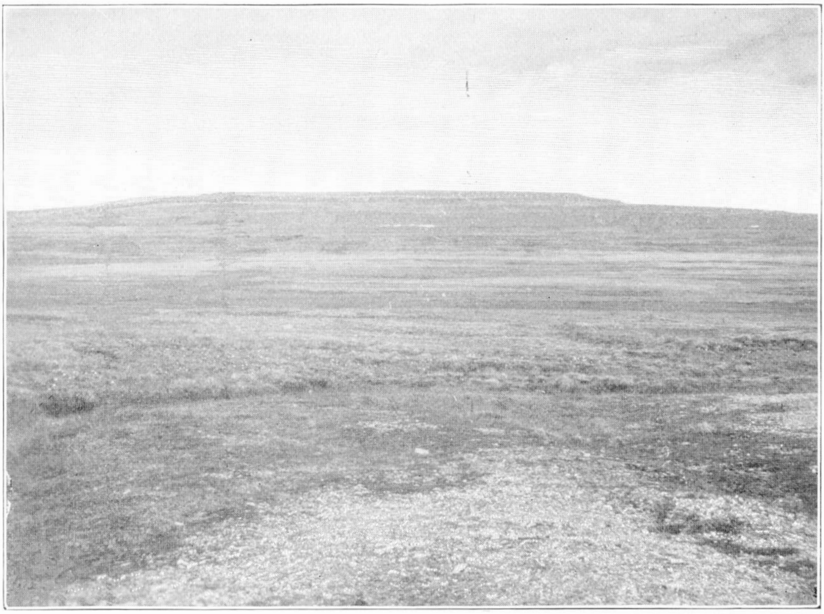
Outlet of Aberdeen Lake discovered.

The river flowing from Aberdeen Lake was discovered from the summit of this hill, previous to which most of a day had been spent in the south-eastern bay searching for it. As seen from here the country to the north, beyond the river, is low, grassy, and dotted with lakes, while to the east is a ridge of rough, stony hills.

From Aberdeen Lake we groped our way down the river for a couple of hours in a thick fog, and as the fog cleared away we were approaching a shallow rapid where the water spreads out over a bed of gravel, below which the river flows for several miles with a width of from a quarter to half a mile, with low gravel banks, to a small lake.

Hills of gneiss.

A stop was made on the north side of this small lake in latitude 64° 43′ 27″. A mile to the north rises a ridge of bare, smoothly rounded hills 300 to 400 feet high, composed of horizontally foliated gray micaceous gneiss, cut by many veins of red pegmatite. The summit is strongly scored by glacial grooves trending N. 30° W., the direction of glaciation being clearly indicated by the smoothed and rounded south-eastern slopes, and the jagged and broken hillsides facing north-westward. South of that portion of the hill just described is a depression filled with



Aug. 27, 1893.

HILL OF SANDSTONE, NORTH OF ABERDEEN LAKE.
Showing ancient marine terraces.

J. B. TYRRELL.—Photo. Sept. 2nd, 1893.

ESKIMOS, NEAR THE MOUTH OF DOOBAUNT RIVER.

débris, and across this is a lower hill of a red ferruginous rock intersected by quartz veins. Under the microscope this ferruginous rock is seen to consist of sharply angular grains of quartz imbedded in a crypto-crystalline matrix, which is deeply coloured by fine particles of ferruginous material, and shows very distinct flow structure. The quartz grains show uneven extinction, and many of them are composed of more than one individual. Occasionally their sides are broken and penetrated by tongues of the matrix. A short distance further east, on the line of the middle of the gap, is a red porcellaneous breccia, very similar to the last, but containing grains of felspar as well as quartz. Quartz-porphyry.

Between the hills and the shore is a fairly level grassy plain, strewn with boulders and angular fragments of unaltered sandstone, but none of the rocks from the hills to the north could be detected.

The small lake lies in the valley between the rounded hills of Laurentian gneiss to the north, and the hills of Cambrian sandstone to the south. Its shores are generally sloping and grassy, and there is a pebbly beach, but boulders are rare. The outlet of the lake is in the middle of a low level grassy plain. A high wall of boulders is piled on each side of the channel, which is between 300 and 400 yards wide.

At a point on the north bank of the river, a short distance below the lake, is a low outcrop of almost horizontal thin-bedded red sandstone.

Schultz Lake, so called in honour of the late Sir John Schultz, who did so much to promote exploration in northern Canada, receives the Doobaunt River at its western end. It lies in an east-and-west direction, is twenty-four miles long, and perhaps seven miles wide, but its northern shore was not closely explored. Schultz Lake.

At its western end, the northern shore seemed to be a continuation eastward of the ridge of Laurentian gneiss, while the south shore is low, with rounded hills in the distance, doubtless of sandstone. A point on this shore four miles east of the mouth of the river, is piled high with boulders, chiefly of white sandstone and conglomerate, but some are of green trap, green schist, and thinly foliated gneiss. Further east the south shore rises from the beach in a long grassy slope to the summit of a ridge of thickly and horizontally bedded sandstone or conglomerate. The beach is usually a pleasant strand of waterworn gravel, but in some places the gravel and boulders have been shoved by the ice into a high smooth wall. Character of shores.

At the south-east corner of the lake is a narrow channel into a deep bay, at the bottom of which is a ridge of high hills. On each side of he channel are similar high hills, the lower parts of which are sloping

High hills of sandstone.

and grassy. The hill to the south is composed of horizontal thick-bedded sandstone or conglomerate, while the hill to the north is very similar in appearance, and is probably composed of similar rocks, but dipping north-westward at an angle of 25°.

Four miles farther north is a rounded hill 400 feet high of white and red thick-bedded quartzitic sandstone, striking N. 25° W., and dipping S. 65° W., at an angle of 25°. Some of the beds of sandstone show distinct ripple-markings. Bands of conglomerate, with white quartzite pebbles, are interbedded with the sandstone. Specimens of the conglomerate from this place subsequently assayed for gold and silver proved to contain neither. On the sides of the hill and along the beach were a number of pebbles of green chloritic schist, indicating the presence of these rocks in the vicinity.

Glacial striæ.

The surface of the summit is strongly glaciated, the striæ trending N. 50° W. There is a well-marked terrace, or old beach, on the side of the hill, at a height of 260 feet above the lake.

Four miles north of this hill, the river leaves the north side of Schultz Lake in a channel a quarter of a mile wide, with low banks of horizontal white sandstone on both sides, behind which are rather high bare rounded hills of sandstone.

Rapid near outlet of Schultz Lake.

The river flows northward for a mile and a half, descending a swift but deep rapid with a fall of five feet, to the foot of a ridge of heavily jointed, red, medium-grained biotite-granite, which descends with a steep slope to the water. Here, at the extreme northern point of our journey, the river turns sharply, and flows south-eastward along the foot of the granite ridge, between the granite to the north, and a rounded grassy ridge of sandstone to the south. After flowing in this direction for four miles, it turns sharply north-eastward, and, at a rough heavy rapid, cuts through a ridge of the gray granite-gneiss, the strike of which is here north-eastward, while its dip is nearly vertical.

Huronian Schists.

Below this rapid the river enters a gradually deepening valley, and flows at the rate of six or seven miles an hour, between banks of light-gray, stony till. A heavy storm, with rain, now set in, and though the steep banks were soon seen to be composed of green Huronian schists, it was impossible to examine them, and we rushed on until we came to a stony flat in the valley, where we pitched our camp, and the men were able to collect some small, but green, dwarf birch for firewood.

The storm continued to rage for three days, during which time we were unable to launch our canoes.

The low hills behind camp were composed of thinly foliated light-green chloritic schist, striking S. 50° W. and dipping S. 40° E. at an angle of 55°. The schist, probably a crushed diabase, is composed of grains of plagioclase, orthoclase and quartz, in a fine holocrystalline matrix of similar material. With the above minerals are crystals of hornblende, some of augite, and a little titanic iron ore and leucoxene. In places the schist contains a large quantity of pyrite, and is cut by veins of white quartz, mixed with calcite. A short distance below camp was a hill of this green schist, cut by two dykes, respectively twenty-five and ten feet wide, of dark-green fine-grained basalt, almost vertical and running nearly with the strike of the schist, although occasionally spreading out a little, and breaking across its foliation. The rock is much coarser in the middle of the dykes than at the sides, and shows a strong transverse jointing. Under the microscope it is seen to be an interlocking mass of minute rod-like crystals, probably of felspar, imbedded in a fine-grained groundmass, blackened with minute rods and particles of iron ore. Here and there is a rather large crystal of augite. Close to the line of contact with this dyke, the schist is hardened, and there is often a narrow vein of white quartz, highly charged with pyrite.

Dykes of basalt.

The surface of the rock is well glaciated, the striæ trending N. 50° W., up the valley.

From camp, the river flows south-southeastward, across the strike of the schist, perhaps along the line of an eroded dyke, in a valley about 300 yards wide, and from 50 to 150 feet deep. The brows of the hills on both sides are bare and evenly rounded, and the banks slope steeply to the bottom of the valley. During, or at the close of, the glacial period, the valley has been filled with gray stony clay to a height of about thirty feet above the present level of the water, and the existing river is usually from thirty to fifty yards narrower than the rocky valley, so that on one side there is often a sloping bank of clay, while on the other side is a cliff of rock. Many broken shells of *Saxicava rugosa* were found on the top of this terrace of stony clay. At a hill on the west bank, 130 feet high, the green chloritic schist was found to have the same strike as at camp, but to dip N. 40° W. at an angle of 60°. The summit of this hill is scored by glacial grooves trending N. 70° W.

Old valley.

The river continued to flow with a swift current between sloping stony banks in a narrow deep valley, with high hills on each side, those to the east being much the more abrupt and precipitous, while those to the west descend in grassy slopes.

Ten miles above Baker Lake, we found a small band of Eskimos encamped in three tents on the west bank. We were received by them in a very kindly manner, and some of the men volunteered to accompany us down the river in their kyacks, or small canoes of deer-skins.

Chloritic gneiss.

Two miles below this camp is a hill, a hundred feet high, of green chloritic gneiss, striking S. 50° W., in the same direction as the schist. It is cut by some wide veins of red granite, and by several narrow dykes of red mica-trap, the latter composed of a groundmass of small interlocking crystals of very much decomposed felspar, coloured with particles of iron ore, in which are imbedded many phenocrysts of biotite, now largely altered to chlorite. Secondary particles of calcite are also scattered through the felspathic matrix.

The summit of the hill is strongly marked by glacial grooves trending N. 50° W.

About two miles above its mouth the river becomes wide and shallow, with a bed of rounded boulders, and with high ridges of boulders along each side. On the top of one of these ridges was a camp of ten or twelve tents of Eskimos, who received us kindly, but like the others, they were very much surprised to see white men descending the river.

Baker Lake reached.

On the evening of September 2nd, we reached the mouth of the river at the north-western angle of Baker Lake, and pitched our camp on a low flat, close to an exposure of coarse red horizontal sandstone. We had successfully crossed through the middle of the Barren Lands, and had now reached a point where Captains Christopher and Duncan had been before us in their search for the North-west Passage, though for more than a hundred years no white man had visited the spot or had entered Baker Lake. Seven hundred miles of travel had still to be accomplished before even the most remote trading post inhabited by white men could be reached.

General character

Baker Lake lies in a general east-and-west direction, with a total length of about forty-five miles, and a width which, though as yet undetermined, seems to be considerable. It is for the most of its extent free of islands. On September 6th the water in the open lake had a temperature of 41° F. Its southern shore was not examined, but at its western end it appears to be of sandstone. The north shore was surveyed with a compass and boat-log, and the following description applies to those portions of it on which we were obliged to land.

From the mouth of Doobaunt River we paddled out into the lake, being barely able to ride the heavy waves, and coasted eastward. Just east of the mouth of the river is a high hill, probably of sandstone, descending with long grassy slopes to the lake. Two miles from the river the shore drops back into a bay, and thence for nine miles it is bounded by a ridge of gneiss from 200 to 300 feet high. At Prince Point is a low exposure of red sandstone dipping southward at an angle of about 30°, and the beach is composed almost entirely of flattened pebbles of similar sandstone.

Prince River, so called after Professor E. E. Prince, Commissioner of Fisheries for Canada, is sixty feet wide at its mouth, and flows from a wide, gently sloping valley coming from N. 55° W. Three-quarters of a mile from the lake is a rapid with a descent of three feet, above which the stream appeared to be rapid and shallow, with an average width of about sixty yards. West of the mouth of this river is a hill of thinly foliated medium-grained gneiss, with red and gray bands, striking N. 65° W., and with vertical dip. On its south side, running almost with the strike of the gneiss, is a wide dyke of massive red augite-andesite, composed of a reddish fine-grained crypto-crystalline groundmass, through which are scattered a large number of particles of iron ore. It contains many large phenocrysts of biotite, which are almost entirely altered to chlorite and calcite, and many small crystals of light-green chlorite (?) surrounded by a black ferruginous border, probably altered from augite. Prince River. Augite-andesite.

At the rapid three-quarters of a mile up the river, the rock is a dark hornblende-schist, probably a crushed diorite or gabbro. It is cut by veins of granite, and includes irregular masses of fine-grained light-gray gneiss.

At this place the surface of the rock is beautifully smoothed and polished, and is generally scored by glacial striæ running S. 30° E., made by a glacier that descended the valley of the river. On some polished surfaces on the south side of the hill, other and older striæ were seen trending N. 75° W. On the hill at the mouth of the river the striæ of the local glacier were not seen, but the whole surface is strongly marked by glacial grooves trending N. 55° W., the direction of motion of the glacier being clearly shown by the rounded south-eastern slopes and the broken hillsides facing the north-west. Cross-striæ.

East of the mouth of Prince River is a terraced rocky hill about 400 feet high, the terraces, representing old sea-beaches, extending up almost to its summit. The central knoll, rising above the terraces, appeared from the distance to have a slightly columnar structure, but whether it is of andesite, red conglomerate, or of some other rock, was not determined.

Ponds frozen.

A heavy storm set in as we reached the mouth of Prince River and detained us on the shore for two days. On the morning of September 5th, before we left camp, all the small ponds were frozen over, and the wet sand of the beach was frozen sufficiently hard to permit a man to walk on it readily.

Absence of caribou.

For the past month the party had lived almost entirely on reindeer meat, for reindeer had been plentiful all along the banks of the river; but at Prince River we left the reindeer behind, and from there onward to Churchill none were shot. A fuller knowledge of the habits and distribution of these animals would have saved us much suffering, but that information was not then available.

Six miles and a half east of Prince River is a bold rocky point of well-foliated red and green gneiss, striking N. 40° W. and dipping S. 50° W. at an angle of 60°.

Calcareous conglomerate.

At a point three miles and a half further towards the north-east, the shore is composed of light-gray gneiss, behind which is a hill of coarse, red, calcareous conglomerate or arkose, composed of an allotriomorphic groundmass of calcite, in which are imbedded irregular grains of quartz showing uneven extinction and in many places fractured, a few flakes of mica, particles of hornblende, limonite and epidote. It strikes N. 80° W. and dips S. 10° W. at an angle of 25°.

Traces of small glacier.

For the next seven miles the land is rocky, and is largely composed of more or less thinly foliated gneiss, striking along the shore and with nearly vertical dip. At the end of the above distance is a valley a quarter of a mile long, on each side of which are hills, 150 feet high, of light-gray biotite-gneiss which strikes N. 77° E. and dips N. 13° W. at an angle of 60°. The valley runs S. 70° E. and descends seventy feet in its length. It has been comparatively recently occupied by a small glacier, a lateral moraine of boulders lying near the foot of each rocky wall. The summits of the hills are scored by glacial grooves running south.

For a short distance south-westward from this little valley, the shore is high and rugged, the points being composed of similar gneiss, which gradually swings round until it strikes southward out into the lake, and dips westward at an angle of about 45°. The land then becomes lower, and the beach is largely composed of boulders, with occasional outcrops of gneiss. At the point five miles north-east of the little valley the thinly foliated gneiss is cut by a greenstone dyke.

At the mouth of a brook, three miles north-east of this point, is a much fractured red and green, highly calcareous quartzose-schist, dipping westward at an angle of 15°, interbanded with layers of dark-green fine-grained diorite, the hornblende in which is largely altered to chlorite.

From the brook north-eastward for several miles, a ridge several hundred feet high, rises by a grassy slope from the edge of the water. At a point four miles from the brook is an outcrop of red sandstone and conglomerate striking S. 20° W., and dipping N. 70° W. at an angle of 45°. Red sandstone.

In the bottom of a bay, eight miles further east, a brook thirty yards wide flows over boulders and ridges of gneiss into the lake. Its banks are twenty feet high, and are of gray till filled with boulders. The rock, a well foliated red and gray gneiss, strikes N. 85° E., and dips S. 5° E. at an angle of 60°. The glacial grooves on its surface trend S. 15° W., the northern sides of the bosses being smoothly rounded, while the southern sides are rough and broken.

In the high rocky ridge south of the brook, the rock is a dark-green thinly foliated garnetiferous hornblende-gneiss, striking S. 80° W. and with almost vertical dip. This gneiss strikes along the northern shore; but at the foot of the steep hill, and extending downwards towards the edge of the water, there may be seen in places a band of red limestone, often brecciated, and including fragments of schist, &c. The width of this limestone band could not be determined, for its southern side was not seen. Limestone band.

The island opposite, about a mile and a half long, seemed to be composed chiefly of red stratified rock, probably sandstone, dipping at a low angle towards the south. At its eastern end is a high rounded hill composed of a massive red mica-trap, consisting of a small amount of a fine-grained groundmass reddened by minute particles of iron ore, through which are scattered many minute lath-shaped crystals of felspar (plagioclase?), many large phenocrysts of biotite, a few large phenocrysts of orthoclase, some long crystals of apatite, and some small masses of hæmatite. Red mica trap.

All the adjoining islands are of red rock, but as we were unable to visit most of them, on account of the shortness of time at our disposal, their exact character was not determined. A small island three miles and a half north-west of the head of the northern outlet of the lake, and the east end of the large island to the south of it, were found to consist of highly altered red sandstone and conglomerate, containing white quartz pebbles, and dipping at a low angle towards the rugged hills of gneiss on the north shore. Red sandstone and conglomerate.

At the head of the northern outlet of Baker Lake is a conspicuous rocky hill a hundred feet high, composed of well banded red and green gneiss, often highly garnetiferous, striking S. 65° E. and dipping S 25° W. at an angle of 70°. A dyke or band of fine-grained dark greenstone runs through the hill parallel with the strike of the gneiss.

Bowell Island.

Bowell Island, so called in honour of the Hon. Sir Mackenzie Bowell, lies to the south, with its high rocky shores which round down gently into the water.

Incoming tide.

On the evening of September 6th we entered the northern outlet of Baker Lake, but we had not proceeded far before we were met by an overfall or rapid, down which the water was flowing towards us. For a moment it seemed as if we must have taken the wrong course, but we soon recognized that we had met the incoming tide, though the water was quite fresh The tide therefore appears to ascend as far as Baker Lake, though it does not appreciably affect the level of the lake itself.

Rocky gorge.

The river flows in the bottom of a rocky gorge from 200 to 500 yards in width, on the north side of which are rugged broken cliffs, between 200 and 300 feet high, rising from the edge of the water. The rock is a hard, brittle, well banded, green gneiss, striking down the gorge, interlaminated with bands of dark greenstone, and also cut across the strike by narrow dykes of the same rock. The south shore is also high, but the hills are more evenly rounded, and the lower part of the slope is commonly grassy. A few willow bushes grow on the rocky slopes. The sides of the rock are well smoothed and glaciated, the grooves running straight down the valley. The movement of the glacier would seem to have been eastward, as the western sides of the knolls are rounded, while the eastern sides are rough and broken. On a small island near the mouth of the river the rock is a similar banded gneiss striking S. 85° E., and dipping N. 5° E., at an angle of 60°. It is very much crushed, the grains of quartz and felspar being all roughly angular, approximately equal in size, and showing fine foliation. It is cut by a dyke, about a hundred feet wide, running S. 63° E., of fine-grained dark-gray garnetiferous diorite.

Glacial striæ were apparent running S. 15° E.

Chesterfield Inlet.

Character.

Chesterfield Inlet was entered just below the above-mentioned island. It is a long, narrow fiord extending 125 miles westward from the north-west coast of Hudson Bay. Including Baker Lake it has a total length of 210 miles. On each side are bare, rocky slopes, usually from 100 to 200 feet high. No soundings were taken by the writer, but the greatest depth marked on Captain Christopher's chart, made in 1762, is forty fathoms. At its upper end, just east of Bowell Island, the tide was found to rise six feet, while at its mouth the rise of the spring tide is about eighteen feet.

Garnetiferous gneiss.

At a low point on the north shore, in latitude 63° 58′ 26″, and a mile and a half below the mouth of the river just descended, the rock is a coarse gray garnetiferous gneiss, striking N. 77° E., and dipping N. 13° W. at an angle of 70°, the garnets being often aggregated in large oval masses, around which the foliæ curve. We found, lying on the shore and probably derived from the rocks of the vicinity, a small boulder of granite containing a mass of copper-pyrites.

Three sets of glacial striæ.

The surface of the gneiss at this point was scored by three sets of glacial striæ. The earliest set, found in protected grooves on a sloping surfaces run S. 65° W. The surface generally is smoothed, and well marked by glacial grooves running S. 3° E., the direction of motion being quite evident. A still later set runs S. 43° E., but this glaciation has not been sufficiently severe to rub out the former, except on the very summits of the knolls.

Three miles further east, on the same shore, is a low point of thinly foliated green gneiss, cut across by a dyke of reddish granite or diorite, which is very much crushed and altered and in which a schistose character is developed. In thin sections the quartz and much of the felspar is seen to be broken into minute fragments, among which are scattered some rather large broken masses of felspar, chiefly plagioclase.

Flat Point

Four miles north-east, across the mouth of a bay that extends a long distance towards the north, we landed at an island lying off Flat Point. It was found to consist of rather coarse red and gray banded biotite-gneiss, striking N. 37° E., and dipping N. 53° W., at an angle of 45°, cut by anastomosing veins of coarse red pegmatite. Its surface is scored by glacial grooves bearing S. 17° W.

Two miles and a half further south-east, along the north shore, is a low island, the northern part of which consists of massive red granite, while its southern part is of a coarse gray gneiss, striking as before, but dipping south-eastward at a high angle. Two miles further down the shore the gneiss is again dipping north-westward at an angle of 60°.

Three miles and a half further east is a rounded point of typical reddish-gray biotite-gneiss, rather irregularly foliated, but seeming to have a general strike about N. 80° E. The surface is well glaciated, with grooves and striæ trending S. 23° E., the direction of motion being unmistakable.

Water slightly brackish.

The water in the inlet here begins to be slightly brackish.

From this point, for seventeen miles down the Inlet, as far as Ragged Point, the shores are composed of rather high rounded bare hills of light-gray gneiss, occasionally cut by dykes of dark greenstone. At Ragged Point the gneiss is intersected by veins of coarse white muscovite-granite. The surface is also strongly scored by glacial grooves and striæ bearing S. 17° E.

Coarse red granite.

On the north side of Promise Island is a rounded hill or ridge 300 feet high, of a somewhat coarse massive red granite, containing but a small amount of biotite. Just south of the granite is a hill of dark mica-schist, associated with gray gneiss, intersected by veins of coarse white granite. Narrow dykes of dark greenstone cut both the granite and the schist.

The shore north-east of Promise Island, and as far east as West Point, consists largely of the same granite, but some of the hills had the appearance of being composed of the light-gray gneiss. The south shore, possibly on the northern side of Farther-hope Island, seemed to be composed of gray gneiss.

Sterile rocky hills.

Below West Point we ran down with the tide, but against a stiff head wind, to a low point east of Dangerous Point. At the turn of the tide we put ashore, for it was useless to attempt to travel against both wind and current. The shore everywhere consisted of utterly sterile rocky hills of red granite or light-gray gneiss. At the place where we landed the rock is red granite, inclosing masses of gray gneiss. The glacial striæ run S. 20° E.

When the tide began to ebb we continued down the rock-bound inlet, and camped in a little cleft on a dark rocky island, three miles north-west of Merry Headland. The rock was dark- and light-gray biotite-gneiss, striking N. 55° E., and with almost vertical dip. The glacial striæ were here found to have turned towards the coast, running S. 50° E., down the inlet. The next day, September 10th, we travelled eleven miles against a stiff head wind, through the mist and drizzling rain, until the rising storm drove us ashore on a high rounded island of biotite-gneiss, cut by granite veins, and contained inclusions of dark hornblende-schist.

Seven miles south-east, on a high hill of light-gray biotite-gneiss cut by veins of coarse red pegmatite, an observation for longitude was taken. On the summit of this hill are distinct glacial grooves trending S. 86° E.

Sept. 9, 1893.

NORTH SHORE OF CHESTERFIELD INLET.
(Well glaciated gneiss.)

J. B. TYRRELL.—Photo. Sept. 20, 1893.

ROCKY SHORE OF HUDSON BAY, WEST OF TERM POINT.

At Peter's Cairn, three miles farther east, we were again storm-bound for most of a day, and during this time Mr. J. W. Tyrrell made a full collection of the plants of the vicinity. The hills are very similar to those farther up the inlet, being well rounded and almost utterly bare. The rock is a gray biotite-gneiss striking S. 10° W. and dipping S. 80° E. at an angle of 45°, cut by many veins of fine-grained red granite, and coarse red pegmatitic granite, so that the rock has often the appearance of fragments of gneiss, inclosed in a network of granite. On a point of similar gneiss, north of Spurrell Harbour, the surface is strongly scored by glacial grooves trending S. 45° E. Peter's Cairn.

At the rocky point south-east of Spurrell Harbour, which is at the southern entrance to Chesterfield Inlet, we were again delayed for most of a day by heavy winds, and observations were taken for variation of the compass, latitude and longitude, the latter to determine the distance that we had travelled eastward since leaving the forks of Doobaunt River. The latitude was found to be 63° 20′ 10″, and the variation of the compass 10° W. The point itself is a long gentle slope of smoothly glaciated biotite-gneiss, often with almost horizontal lamination. Like that previously described, it is cut by veins of fine-grained red granite and coarse pegmatite. Above high-water mark is a sandy terrace, on which is an old Eskimo camping ground, with the bases of igloos sunk a foot or two into the sand, and piled round with rings of stones, while around are many large slabs of stone in a vertical attitude, looking like gravestones in a cemetery. Spurrell Harbour.

Hudson Bay.

For six miles south of Chesterfield Inlet, the shore is rocky, and rises more or less gently back to hills of gray gneiss. Opposite Fairway Island is a low sloping point of light-gray gneiss, striking along the shore, cut by a boss of coarse dark-green hornblende-rock holding a large quantity of pyrite. Both rocks are cut by veins of coarse red granite. The glacial grooves here run S. 55° E. South of this point the character of the shore suddenly changes, and for eighteen miles it is composed almost entirely of rounded transported boulders of granite, gneiss, *etc.* These frequently extend south-eastward into long low points. In the bottoms of the bays the boulders are usually piled in even walls, behind which the land rises gradually to rounded terraced grassy hills. Rocky Shore.

The point north of Baker's Foreland is a long narrow bare ridge of gray gneiss, contrasting strongly with the surrounding shore of sand and boulders. The gneiss is cut by wide veins of coarse white pegmatitic granite. The surface of the rock is smooth and polished, but is not strongly scratched or grooved, though any grooves that were seen trend S. 35° E.

Baker's Foreland.

Baker's Foreland consists of high points of boulders extending into shallow water. From Baker's Foreland south-westward for fourteen miles, the shore is mostly low and composed of boulders of red and gray gneiss, which frequently extend as long low points into the sea. The land rises to a ridge of terraced grassy hills.

Huronian rocks commence.

At a point north-east of Rabbit Island the character of the shore changes, and dark-green Huronian schists crop out from beneath the boulders.

North of Rabbit Island is a high point, on which the Eskimos are accustomed to camp while waiting for the traders from Churchill. The point is composed of green calcareous chloritic schist, striking S. 55° W., and dipping N. 35° W. at an angle of 60°. The schist is cut by a dyke seventy-five feet wide, of massive green highly altered diabase, containing a large amount of mispickel. This diabase also outcrops along the shore, where it incloses many bands of the green schist. The glacial striæ here trend S. 20° E.

From this point south-westward for four miles and a half, to the mouth of Rankin Inlet, the shore is rocky, being composed of green chloritic schists, striking as before. The islands lying out towards Marble Island seemed to be composed of the same rock.

Long shoal.

At the point north-east of Rankin Inlet, a shoal covered with boulders extends a long distance out to sea, and obliged us to keep our canoes a mile from land. When we rounded this shoal, and again drew in to the land, we found it still composed of green chloritic schists, but they had turned and were striking N. 75° W., with dip S. 15° W., about 60°.

Rankin Inlet.

Thence westward for twenty miles, along the north shore of Rankin Inlet, the points and islands are composed of green schist, but the bays are shallow and lined with boulders. Behind the beach are low grassy hills, with bosses of rock projecting here and there through the turf.

Altered diabase.

Falstaff Island is high and rounded, and consists of a light-green rock, probably an altered diabase, showing very distinct concretionary structure, the face of the rock presenting the appearance of large oval masses piled together as closely as possible. Many veins of white quartz intersect the diabase.

A low bare island in the mouth of the inlet, on which we landed in crossing from shore to shore, is composed of light-green chloritic schist, probably an altered clastic rock, striking N. 65° W., with vertical dip, but also with a vertical slaty cleavage striking N. 25° W. Associated with this schist is a massive green altered diabase or gabbro. The surface of this island is strongly glaciated. The west side and the higher points are scored in a direction S. 70° E., but some of the depressions showed strong groovings S. 38° E. Well marked cross-fractures clearly indicated the direction of motion of the ice. Altered clasti rock.

The high rocky islands seemed to be confined to the north side of Rankin Inlet, one lying west of the course travelled being especially conspicuous. The south side of the inlet is also rocky, but the country farther south appeared to be composed of till and boulders.

The point, a mile and a half south of Cape Jones, consists of light-gray biotite-gneiss, heavily and almost horizontally foliated, traversed by occasional thin bands of mica-schist, and cut by many veins of red granite and quartz containing pyrite. The surface is strongly scored by glacial grooves, the last and general set bearing S. 65° E., while an earlier set bears S. 20° E. Cape Jones.

From a short distance south of Cape Jones the shore is low and composed of boulders, while grass-covered country, probably underlain by till, extends back to low hills. Through the rounded surfaces of these hills jagged knobs of rock, probably gray gneiss, occasionally project. Shoals, or low ridges of boulders, extend long distances out from shore, so that it was usually impossible to travel in our canoes within a mile of the high-water mark.

The rock at the point south of Corbett Inlet is a massive green fine or medium-grained diabase, which is now almost entirely altered into a mass of chlorite, epidote, zoisite and calcite. It has a clearly marked sphæroidal structure, being composed of ovoidal masses, from two to three feet in longest diameter, separated by narrow, lighter coloured bands of rock of very similar composition. Here and there bands of rounded nodules, from four to eight inches in diameter, traverse the rock quite independently of the ovoidal masses, two or three of the former often lying in one of the latter. This diabase is cut by many small veins of quartz and calcite, which contain large quantities of pyrite, arsenopyrite and chalcopyrite. Corbett Inlet

At one place the diabase was seen to inclose a band, 45 feet wide, of light-green clastic quartzose schist, striking N. 65° E., and with vertical dip; while other bands of similar, but more chloritic schist, were seen on the south side of the point. The surfaces of these rocks are almost everywhere smoothly rounded and polished. The harder Quartzose schist.

portions show clear glacial grooves and striæ trending S. 75° E., the direction of glacial motion being distinctly indicated by the rounded western sides, and the broken eastern sides of the knolls.

Rock-disintegration.

One of the most interesting styles of rock-disintegration in northern latitudes is here very well shown. The diabase is cut by jointage planes into large angular blocks. On or near the summits of the bare rocky hills many of these angular blocks, especially those which are smaller at the bottom than at the top, have been lifted straight up by the freezing and thawing of the water beneath them, and the subsequent contraction and expansion of the ice. They have then been supported by fragments of rock that have fallen between the sides of the blocks and the surrounding rock. Each winter the large angular blocks are raised higher, and the supporting stones fall into new positions, or are replaced by larger ones. Thus these blocks are often raised several feet above and out of the surrounding rock, and beneath them, in the hole from which they have been lifted, there is usually a pool of clear water.

Pistol Bay.

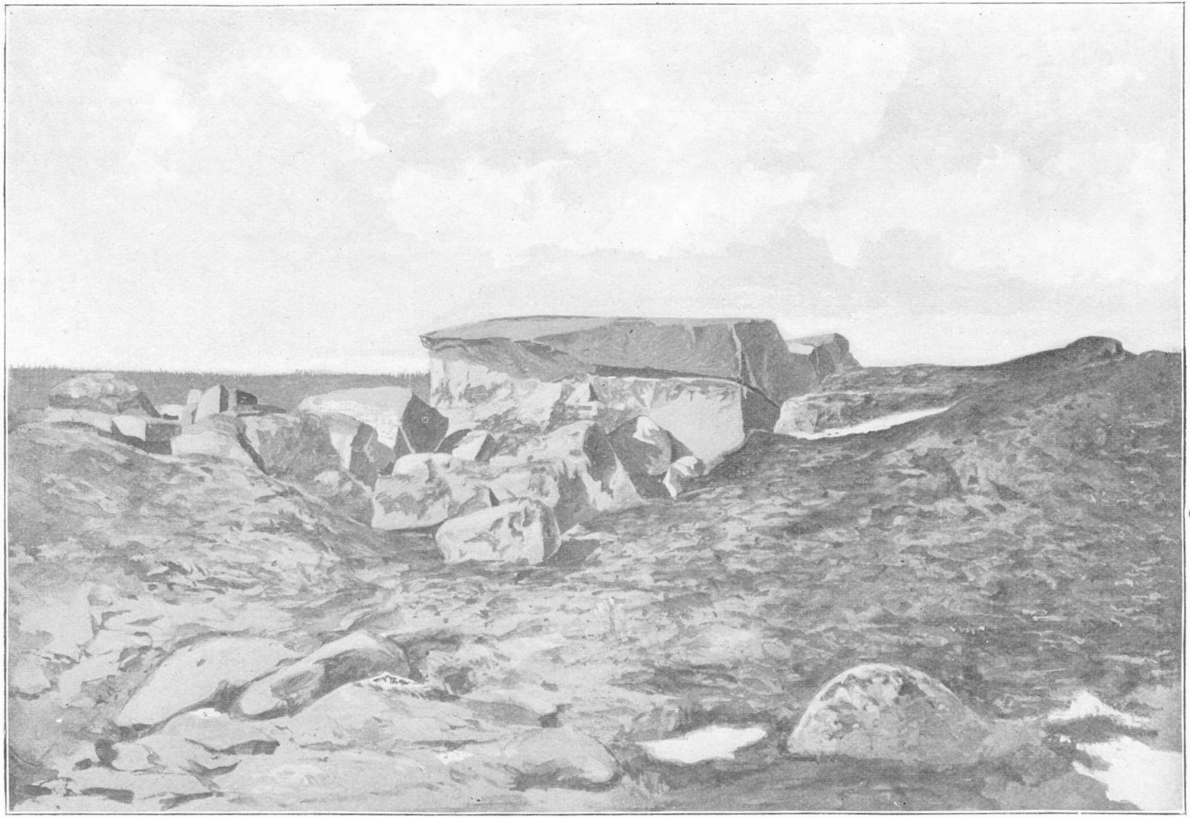
From the point south of Corbett Inlet around to the north side of Pistol Bay, the shore is composed of dark-green diabase or gabbro, intersected by bands of highly crystalline light-green quartzitic schist. At one point at which we were delayed, on the north side of Pistol Bay, this schist strikes S. 85° E., and dips N. 5° E., at an angle of 45°. The surface here shows strong glacial striæ trending S. 55° E.

Term Point.

Lying out in Pistol Bay, between two and three miles from its northern shore, are several islands of light-gray massive granite. From these islands an almost direct course was taken for fifteen miles across the mouth of the bay to Term Point, which was found to be composed of dark-gray mica-schist, probably of Huronian age, striking S. 25° E., and dipping S. 65° W., at an angle of 60°. It is cut by bands of light-gray gneissoid granite, and dark-green diabase.

From Term Point westward the shore is rocky, and the steep rocky cliffs descend into rather deep water. The rock is a dark-green diabase almost entirely altered to saussurite, and is cut by many veins of quartz and calcite, holding copper-pyrites.

In the bottoms of the bays the line of high tide is marked by sandy beaches, and fifteen feet above these are other similar beaches covered with shells which are still remarkably fresh, and still higher up the slope are other similar raised beaches which exhibit a freshness that is quite startling to one coming from a more southern country, where erosion and decay are very much more rapid.



J. B. TYRRELL.—Photo. Oct. 13, 1894.

SUMMIT OF RIDGE OF QUARTZITE, BEHIND CHURCHILL.

Large mass of rock heaved by the frost.

On the northern shore of Mistake Bay, nine miles west of Term Point, is a long point of similar green diabase. Seven miles further south-west, about the middle of the west shore of Mistake Bay, is a high point of similar dark-green diabase, containing, in many places, a large amount of copper-pyrites, and cut by small veins of quartz studded with iron-pyrites. Along the shore are many angular fragments of a dark-green, highly altered rock, now composed of chlorite, hornblende and magnetite, but the parent bed was not seen. The surface is everywhere well scored by glacial striæ trending S. 42° E. Mistake Bay

A mile farther south, on the south side of the last-named point, low hills of white, or light-pink Huronian quartzite, stretch away to the south. This quartzite is rather thinly and evenly bedded, and the bedding-planes frequently show ripple-markings, The strike is N. 88° E., and the dip S. 2° W., at an angle of 75°. The character of the contact of this quartzite with the adjoining highly altered diabase was not determined. Huronian quartzite.

Three miles south of the point is a remarkable flat-topped island, bounded by cliffs about forty or fifty feet high. It is composed of sand and coarse rounded gravel, and extends as a long, narrow, and almost horizontal ridge. As seen from the canoes it had the appearance of having been an esker which had subsequently been levelled off by wave action, at the time when some of the raised beaches around the bay were formed. Island of sand and gravel.

Opposite this island, and as far south as Neville Bay, the shore is low and shallow, and low points of boulders extend a long distance into the shallow water.

On the north side of the mouth of Neville Bay low glaciated bosses of reddish-gray gneiss crop out below high-water mark, while the low hills behind are morainic accumulations of boulders, that have been modified and slightly terraced by the subsequent action of the sea. These morainic hills extend for a couple of miles along the north shore of Neville Bay, north-west of which, for several miles, the shore of the bay consists of smooth, bare hills of greenish epidotic gneiss, between which are small till-covered areas covered with black lichen *(Alectoria divergens)*. Beyond these hills is an open sandy and gravelly country, rising in regular terraces to heights of about a hundred feet above the sea, beyond which, near the mouth of Ferguson River, the country is again characterized by bare rocky hills of gneiss. Gray gneiss.

From the mouth of Ferguson River to Churchill, we travelled along the shore both in 1893 and 1894, but on both occasions the journey was made with as few stops as possible, and these only at high tide, and in the former year the ground was thickly covered with snow, so that it was impossible to obtain more than a very general idea of the geology of the country.

[Nev]ille Bay. The south-west side of Neville Bay is usually rather low, with long points of boulders extending out from it into shallow water. Sir Bibby Island is a large, low island of till and boulders, and between it and the shore is a narrow shallow channel, probably dry at low tide, with a bottom of boulders. From this channel southward, for a short distance the shore is low and strewn with boulders, and then it becomes very bold and rocky.

Two miles south of Sir Bibby Island is a prominent rocky point, with a high rocky island lying a short distance off it. This point is composed of light- and dark-green diabase or gabbro, while the rock on the island shows a slaty cleavage and breaks into long thin slabs.

From this prominent point the shore turns westward and is bold and rocky, being composed of dark-green fine-grained diabase, studded with copper-pyrites.

Dawson Inlet. Dawson Inlet, lying to the west of this point, must be thirteen miles or more in depth, as we could not see to the bottom of it from the tops of the hills on the north shore. We crossed the mouth of this inlet to two islands, on which are long hills of sand and boulders. From these islands south-westward for several miles, the shore is low and thickly strewn with boulders. Here and there it becomes very flat and sandy. Behind this sandy plain is an old beach, fifteen feet above the present one. A short distance further inland are a number of narrow ispatinow-like ridges of gravel and boulders running S. 50° E., parallel to the direction followed by the Keewatin glacier towards Hudson Bay.

Point 6 miles S.W. of Wallace River. Six miles south-west of the point at the mouth of Wallace River, where we were delayed for five days in a storm, the tide runs out for a couple of miles, leaving behind it a wide sandy flat, studded with boulders, and partly covered with ropy seaweeds. Behind the beach is a wide grassy flat, dotted with small lakes, which extends back a couple of miles to the foot of an escarpment about thirty feet high, of sand and gravel. On top of this escarpment is a sandy plain without boulders. Near the shore are some low bosses of gray biotite-gneiss, rather irregularly foliated in a general north-east and south-west direction, and cut by many veins of red granite. Against the gneiss, though the exact contact was not observed, lies a band of rather thin-bedded white and pink Huronian quartzite striking N. 50° E., and with vertical dip. The surfaces of the beds are often strongly ripple-marked. Sixty feet of quartzite in all is exposed. North-west of the quartzite band is a low strip of land, about 200 yards wide, in which no rock exposures were seen, and beyond it is a band of green siliceous schist, probably also of Huronian age, dipping and striking the same as the quartzite. The schist is much jointed, and many angular blocks of it have been heaved out of their places by the frost.

From this place southward for many miles, no rock in place was seen, but the shore is very flat and strewn with boulders, and the tide at low water runs out several miles. In north latitude 61° 18′ is a prominent cape, consisting of two high morainic ridges of boulders, from which extensive shoals of boulders stretch seaward for several miles. South-west of this point is a group of hills, apparently morainic ridges and eskers. Low shore

Cape Esquimaux is a narrow esker-like ridge several miles long, trending S. 73° E., with a deep but narrow bay on each side. The scarped end of the point shows the cut face of a terrace twenty feet high, the lower part of which is of sandy till, full of boulders, while the upper part is of stratified sand. On the summit of the cape, near the point, are some small ponds of excellent fresh water, so that it is a convenient place for trading boats to stop as they travel between Churchill and Marble Island. Cape Esquimaux.

Sentry Island, lying off Esqimaux Point, appeared to be a long kame or drumlin, rising gently from both ends, and like so many of the ridges in the interior, with a large boulder on the summit. Sentry Island

The point five miles south of Esquimaux Point, is a similar long sandy ridge or esker, running S. 73° W., parallel to the last, quite narrow, and about twenty feet above high-water mark. Long bars of boulders extend seaward from the ends of both these points.

Seven miles south-westward from the latter point, in a rounding bay, we came to a low flat grassy shore, with a conspicuous drumlin-like hill half a mile inland.

On the shore, two miles south of this hill, is a low boss of red gneiss.

In north latitude 60° 50′, McConnell River discharges its waters in a series of little channels for a mile or two along the beach, and off the mouth of the river a very extensive shoal extends several miles out into the bay. On a level sandy plain, within the delta of the river, is a low rounded drumlin-like hill, which forms a very conspicuous feature on this portion of the shore. McConnell River.

For several miles south of McConnell River, a level well-grassed sandy plain extends along the shore, and then some low rounded Sandy plain.

hills make their appearance. Eight miles south of the river a brook thirty feet wide flows into the sea, at the mouth of which is a sandy spit, on which we found some drifted pieces of dry willow, which had doubtless been brought down by the brook. These were the first pieces of driftwood found while we were travelling southward down the shore of Hudson Bay. It would seem that there is a persistent current flowing southward down this shore, and any driftwood that may be brought down by streams into the sea is therefore carried in that direction, until it is thrown upon the beach out of the reach of the waves. Consequently no driftwood was found north of those rivers which had wood growing somewhere on their banks.

Absence of driftwood.

Four miles south of this brook, along a low flat shore, is a low boss of red granite.

Four miles further south is the mouth of a small river, which discharges a considerable quantity of brownish water over the stony beach. Two miles further south, in approximate latitude 60° 34′, is a low rounded hill of gray gneiss striking S. 60° E., and dipping S. 30° W., at an angle of about 40°, but the gneiss is so intersected by veins of red granite that it is impossible to determine the dip very closely. The surface is smooth and strongly glaciated, the grooves and striæ trending S. 73° W. The eastern sides of the knolls are rough and broken, while the western sides are smooth and rounded.

Gray gneiss.

For a long distance further southward the shore is all low, flat and sandy, with bars of boulders lying off, and parallel to it, and not projecting out from it as before.

In latitude 60° 7′ is a low rocky point of red gneiss, and three miles and a half south of this point, in observed latitude 60° 3′ 31″, some large driftwood was found on the higher points of the shore, about where it would be thrown by the heavy storms, so that it is probable that we were then in the vicinity of the most northerly stream that has heavy timber growing on its banks, though as yet there was no sign of any trees on the shore.

Four miles further south low ridges of sand and boulders began to appear along the shore, and three miles further on the country assumes a decidedly lumpy morainic appearance.

Egg Island.

Egg Island is a conical morainic knoll of boulders, lying in a gently rounded bay about a third of a mile from shore. The upper fifteen feet is covered with grass, while the rest, which is washed by the waves and tide, is a slope of naked boulders. The water between the island and the shore seems to be deep, and there is a moderately high morainic ridge of boulders on the shore opposite it.

For five miles south of Egg Island the country consists of low rough hills of boulders, and the beach is composed entirely of boulders. It was so steep that at half ebb we were able to pass in our canoes within one or two hundred yards of flood tide mark.

Here was a point that had been conspicuously marked by the Eskimos, for some of these people had raised a large drifted tree-trunk into an upright position on its summit, and had supported it there with heavy stones. The point is underlain with a coarse red granite, with a well rounded, roches moutonnées surface. It is scored by distinct glacial striæ trending S. 15° E. A few glacial grooves were also seen trending S. 30° E., but whether earlier or later was not determined. The boulders lying about are almost entirely of granite and gneiss, but a very few pebbles are of Palæozoic limestone.

Point of red granite.

The shore to the south continues to be strewn with boulders, though here and there the smooth granite or gneiss descends into the water. Six miles south of the Standing-stick Point is a knoll of medium-grained red biotite-granite, the surface of which is smoothly rounded on its western and broken and jagged on its eastern side. It shows many irregular glacial scratches, but one strongly marked set of parallel grooves trends S. 60° E.

In latitude 59° 28′ 8″ is a point of rather fine and even-grained rusty red granite. In places the rock descends steeply into the water, and the point is probably a good landing place for small boats at any stage of the tide. At extreme storm-tide mark, a large quantity of driftwood is scattered on the shore, some fine large trunks of white spruce among the other smaller fragments of wood.

Hubbart Point, several miles farther south, is the most easterly one of a number of stony morainic hills which extend southward for several miles, separated by tidal flats. The top of this hill, which is about forty feet above high-water mark, is moderately well grassed. On it are many stone mounds, evidently Eskimo graves, on and beside which are numerous spears, kettles and other articles that have belonged to the Eskimos while alive, and have been left here with the bodies by the surviving relatives. A large quantity of driftwood had also been collected and piled up by the Eskimos on this point.

Hubbart Point.

Here Captain Luke Foxe landed in 1631, 263 years before our first visit, and the description of it given by him would very well characterize the place as it appeared to us. In the distance towards the south-west is an escarpment or ridge of hills. With the field-glass this ridge was seen to be wooded with a coniferous forest, being the first trees that we had seen for many weeks.

Willows begin to appear.

South of Hubbart Point clumps of willows begin to appear on the shore. Some low, bare, rounded bosses of grey gneiss were seen near the edge of the water, but though the surfaces were smooth and polished, the snow made it impossible to determine the exact direction of glaciation.

Thence southward and eastward, to the bottom of Button Bay, the shore is low and flat, with a rather higher ridge in the background. At low tide a wide mud-flat, covered with boulders, extends seaward for several miles. Trees, chiefly small white spruce and larch, gradually approach the shore, until, at the bottom of Button Bay, the forest reaches to within a short distance of high-water mark.

Port Churchill.

Position.

The trading store and mission at Churchill are situated on the west side of the tidal lagoon at the mouth of the Churchill River, on an old sandy beach a few feet above high-tide level. Back of this old beach, which is between 100 and 200 yards in width, steep bare rounded hills rise to a height of 80 to 100 feet, forming part of the rocky ridge which extends along the west side of the river for several miles, out to the extreme end of Eskimo Point at the old fort, forming the bold promontory between the river and the east side of Button Bay. A similar rocky ridge also forms the east side of the mouth of the tidal lagoon, and thence extends eastward for a number of miles along the shore of Hudson Bay towards Cape Churchill.

Character of rock.

The rock is a greenish-gray even-grained, false-bedded, felspathic arkose sandstone, in places very massive, and in other places more thinly bedded, often cut by many irregular veins of dull white quartz, which contain a large quantity of magnetite. At the rocky point below the mission it strikes N. 45° E. and dips S. 45° E. $<$ 70°. In the hill south of Sloops Cove it strikes N. 55° E., and dips S. 35° E. $<$ 20°, with ripple-markings showing on the planes of bedding. At the mouth of the river, near old Fort Prince of Wales, it strikes N. 65° E., and dips S. 25° E., $<$ 70°. Its clastic character is everywhere apparent, and here and there, scattered very irregularly through the beds, it contains well rounded pebbles, some of which are as large as the fist, of white clastic quartzite similar to the Huronian quartzite of Marble Island. The occurrence of these quartzite pebbles appears to associate this Churchill arkose with the red Athabasca conglomerate, with its white quartzite pebbles, which has been correlated with the Keweenawan rocks of Lake Superior. The Churchill rock has been much more disturbed and altered than the Athabasca conglomerate, but that may be due to quite local conditions.

Cambro-Silurian limestone.

In a fissure, along the lines of bedding of this arkose, on the south-east side of the rocky point below the mission, protected from any of the three glaciations shortly to be described, is, or was, a small outlier of a unaltered Cambro-Silurian limestone containing a few cubic feet It is mainly composed of the following species of corals, which seemed to be in the same position in which they originally grew on the surface of the arkose, *Columnaria alveolata*, Goldfuss, *Favosites Gothlandicus*, Lam., and *Calapœcia Canadensis*, B. Scattered among the corals are fragments of the following shells: *Dinobolus magnificus* (?) B., *Rhynchonella*, probably *R. inequivalvis*, Castelneau, or *R. Anticostiensis*, B., *Orthoceras*, fragments of two or three small species, one marked with minute longitudinal ridges; *Actinoceras*, probably *Richardsoni*, Stokes, or *Bigsbyi*, Brown; *Cyrtoceras* sp., apparently the same as one from Little Black Island, Lake Winnipeg; *Illaenus* sp. Scattered along the shore in the vicinity are many boulders of thin-bedded white limestone of about the same age, containing the following fossils, viz.: *Calapœcia Canadensis*, B., *Columnaria alveolata*, Goldfuss, *Streptelasma robustum* (?), W., *Halysites catenularius* var. *gracilis*, Hall. *Dinobolus parvus*, Whitfield, *Rhynchonella*, sp. *Lophospira bicincta*, Hall, *Pleurotomaria* or *Trochonema* sp., *Maclurea Manitobensis*, W., *Orthoceras* or *Actinoceras* sp. *Pterygometopus callicephalus*, Hall.

Fragments of Silurian limestone.

With the above are associated some fragments of white Silurian limestone like that of the Grand Rapids on the Saskatchewan River, holding *Pentamerus decussatus*, W., in abundance, with *Pterinea* sp., the same as the species from Grand Rapids, *Pleurotomaria* sp., *Gomphoceras parvulum*, W., and an Ostracod which Professor T. Rupert Jones has determined as being probably identical with *Leperditia Selwynii*, Jones, from the Silurian of Anticosti, but also as being very similar to *Leperditia cœca*, Jones, from Grand Rapids.

In and around the old fort at the mouth of the river, are many boulders of heavier-bedded Trenton limestone containing large Orthoceratites very like some of those from the Trenton of Manitoba. These latter boulders have probably been transported along the shore from some outcrop of limestone farther towards the east.

Well-glaciated surfaces.

The bare quartzite hills have rounded roches moutonnées surfaces, but unlike the hills further north along the shore of Hudson Bay, they are planed and scored on every side, instead of being on one side smoothly rounded and on the opposite side jagged and broken. This evenly rounded character is caused by the rock having been travelled over by two or three different glaciers coming from different directions, each planing down the surface which faced it. Two of these glaciers have left markings which are very distinct and unmistakable.

Three glaciations.

Last glaciation.

The last glacier came from the north, and left grooves and striæ varying from S. 5° E. to S. 5° W. All the summits and rocky hillsides sloping towards the north are smoothed and scored by this glaciation and all traces of previous glaciation are there obliterated. Salient points on eastern and western slopes are also scored by glacial markings trending south, overrunning and rubbing out the other earlier markings, which, however, have been left in the depressions. A short distance behind Coccle Point there is an almost vertical face of rock, running north-and-south and looking westward over a low wide grassy flat, which is strongly grooved horizontally by this glaciation, to the exclusion of any other glacial markings. The direction of flow of this last glacier is clearly shown by the absence of this set of grooves on southern slopes, and by the presence in the grooves of numerous cross-fractures opening southward.

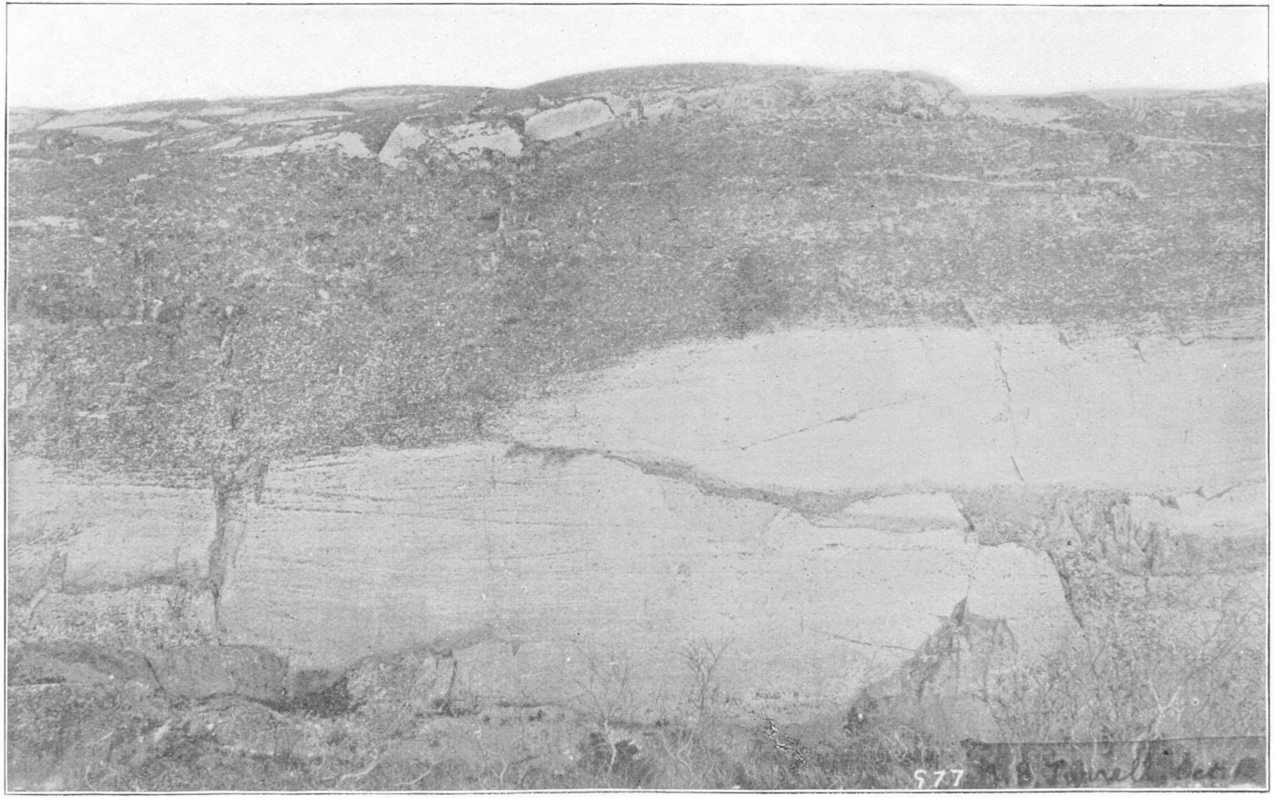
This glacier was evidently a southern continuation of the one which farther northward flows south-eastward and south-southeastward to the west coast of Hudson Bay from its névé ground in the vicinity of Doobaunt and Yath-kyed lakes.

Second glaciation.

The evidence of another glacier earlier than the one just described is also very distinct. Southern slopes, and those portions of the summits and western slopes protected by projecting bosses of rock from abrasion by the glacier from the north, are beautifully planed and strongly scored by glacial markings running N. 45°-55° E. The direction of flow of this glacier is clearly shown by the strong glacial markings on the protected south-western slopes, the grooves being constantly crossed by curved fractures opening towards the north-east, and the absence of this set of grooves on eastern slopes, however favourable these slopes might otherwise be for their preservation. The glacier that made these markings flowed north-eastward from the higher ground down into Hudson Bay, being perhaps a local glacier following the general course of the Churchill River, at the beginning of the last glacial period.

First glaciation.

The evidences of a still earlier glaciation are much less distinct, for all traces of it have been swept from northern, western and southern slopes, and from every rocky projection. But on protected parts of hillsides looking eastward towards the river, are many well planed surfaces strongly scored by a parallel set of glacial groovings trending



J. B. TYRRELL.—Photo Oct. 13, 1894.

CHURCHILL QUARTZITE, VERTICAL SURFACE FACING WESTWARD.

Showing grooves and striæ made by the glacier from the north.

S. 80° W. This glaciation is shown to be older than that moving towards the north-east at a number of places where surfaces scored by both sets of grooves come in contact with each other, but especially at some well protected spots on the summit of the ridge west of the trading store, where depressions, in the surface that is generally scored by glacial grooves running north-westward, are scored by the earlier set of grooves and striæ pointing S. 80° W. The direction of motion of this, the earliest of the three glaciers, could not be as certainly determined as that of the other two, but pits rounded on their western and broken on their eastern sides indicate that the direction here given is correct, and besides this many of the strongly scored surfaces would almost certainly be untouched by a glacier moving in the opposite direction.

Churchill is the most northerly point on the west shore of Hudson Bay where any signs of a westward glaciation could be detected, and the groovings here were probably caused by a more or less local glacier moving westward from a névé near the shore, when the land stood somewhat higher than it does at present, possibly centring in the vicinity of Cape Churchill, thirty miles east of the mouth of Churchill River.

Transported boulders.

The transported boulders on the flats and along the shore in the vicinity of Churchill, consist chiefly of local arkose rock or of white unaltered Palæozoic limestone, but a considerable number are of red and gray gneiss and fine-grained red granite, while a few small ones are of red quartz-porphyry. All are very probably derived from the country west of Hudson Bay.

Gravel terraces.

Gravel terraces, on the sides of the hills and up to their summits, mark old shore-lines, indicating the gradual rise of the land in post-glacial times, since it has been unburdened from its load of snow and ice.

Rising or stability of the land.

Whether the land is still rising, or whether it has now reached a condition of stability are interesting questions, and since Churchill has been occupied as a trading post of the Hudson's Bay Company for nearly two hundred years, it is reasonable to expect to find here some evidence of the relative positions of land and sea a comparatively long time ago.

Building of Fort Prince of Wales.

In 1733, the Hudson's Bay Company began building the massive stone fortification, which they called Fort Prince of Wales, on the summit of the low point west of the entrance to Churchill Harbour. This fort is surrounded by a gravel-covered plain or terrace, and the base of its walls is now seventeen feet above ordinary spring tide, and the top of the shingle beach, that is now regularly washed by the storm-waves at ordinary spring tides, is only six feet below the base of the walls. If the land had been eight or ten feet lower in 1733 than it is at present, the storm-waves with high spring tides would have regularly washed over the point, and it is not likely that a structure of any kind would have been built there, for the place would have been a disagreeable and dangerous one.

In his account of Hudson Bay, published in 1744, Sir Arthur Dobbs, a man who had made himself very well acquainted with the geography of the bay, states that Fort Prince of Wales is built "upon an eminence forty feet high," * a perfectly natural exaggeration for a man looking at the fort in its present position, twenty-five feet above mean tide level, but hardly intelligible if the land was ten or twelve feet lower than at present, and if the fort was but fourteen feet above mean tide, and less than eight feet above the top of spring tide.

Robson's map.

For several years between 1733 and 1747, Joseph Robson, an engineer, was stationed at Churchill to superintend the building of this fort. About 1746, he made a survey of the harbour and river for ten miles up from its mouth and drafted a map which was published by him in 1752.† This map shows the river at high and low water, and the rocks and low marshy ground around it just about as it is at present. A narrow neck of land, above high-water mark, connects the point on which Fort Prince of Wales is built with the main shore, a neck, the rocky portion of which, is still very little above high-water mark. The low-water mark is a quarter of a mile out from the mouth of Sloops Cove, and stony flats extend for a mile between high and low water opposite the position of the present trading post of the Hudson's Bay Company. The high-water mark was much the same then as now, and marshy ground but a few feet above the water, well shown on the old map, still extends south-west from the lagoon. A rise or fall of the land of a very few feet would change the shore-line considerably, and this old map shows clearly that no great change in the elevation of the land has taken place since it was made, about the middle of the last century

Sloops Cove.

Sloops Cove is a little bay on the west side of the river, two miles above old Fort Prince of Wales, so called from having been the wintering dock of the small sloops kept here during the eighteenth century for the purpose of carrying on trade with the Eskimos on the west side of Hudson Bay, in the vicinity of Whale Cove and Marble Island. The cove is a hundred yards long and forty wide, and on each side are

*An account of the Countries adjoining to Hudson's Bay, by Arthur Dobbs, Esq., London, 1744, p. 55.

†An account of six years' Residence in Hudson's Bay, by Joseph Robson, London, 1752.

smooth well-glaciated rocks of green arkose, rising at first steeply, and afterwards more gently, to about twenty-five feet above high water mark. At the back, between two rocky hills, is a grass-covered bar of sand and gravel, separating the cove from a wide flat, still covered with water at high-tide, as it was in 1746. The bottom of the cove, almost up to high-tide level, is composed of a fine soft silt brought in by the river. Across the mouth is a gravel bar, through which project two low bosses of rock. Between these the water drains out of the cove as the tide recedes, leaving it dry at low tide. To the north is a larger gap which has been blocked by a dam of pieces of timber, and large masses of rock, many of which have been blasted from some place in the vicinity, perhaps from south of the knolls, where the gravel bar has since been formed.

Depth of water in the cove.

In the gap at the mouth of the cove there is now four feet of water at high spring tide, but it is quite possible that before the dam was built, and the sand-bar formed, the entrance may have been somewhat deeper. Robson's map does not show the gravel-bars at either end, and if they did not then exist the fine soft silt that now forms the bottom would not have been there either, for the tide, rushing through the gap, would have scoured it down to the hard till or rock. Perhaps the building of the dam at the mouth of the cove, preventing this tidal scour, has been the chief reason why it has since silted up.

It is difficult to find a good wintering place for a small vessel in Churchill Harbour, as the ice may shift and break the anchor chains and moorings and carry it on the tops of large boulders. Since a vessel would be perfectly safe when once it had been floated into Sloops Cove, considerable exertions would doubtless be made to get it there.

Furnace and *Discovery*.

In addition to the sloops of the Hudson's Bay Company, local tradition has it that the *Furnace* and *Discovery*, two small ships sent to look for the North-west Passage, here spent the winter of 1741-2, and the words "FURNACE & DISCOVERY 1741," cut in the face of the smooth rock on the north side of the cove, would indicate that this tradition is correct. The *Furnace*, the larger of the two vessels, is said by Forster to have been a "sloop or bombketch," and would probably have a draught of from eight to ten feet, which could doubtless be lightened to six feet or less to take her into dock. That they were able to take the ships into and out of dock at high tide only is clearly shown by Robson's map, and also by the log of Captain Middleton, of the *Furnace*, who records that on June "9th and 10th (spring tide after the full moon of June 6th old style) got the ship out of her dock and moored her."*

* Dobb's Hudson's Bay, p. 17.

If the deepest part of the mouth of the cove can now be seen, and if the ships required six feet of water to float them into it, there would here be evidence of the rise of the land to the extent of two feet in the last century and a half, but as neither of these points are certain the evidence in favour of this rise is too indefinite to be considered at present.

Names cut on the rocks.

On the rocky walls of the cove, planed smooth by the second glaciation from the south-west, many names have been engraved and now appear as fresh as if cut but yesterday. Among these the one of most historic interest is that of "SL. HEARNE," the discoverer of the Coppermine River, and the writer's only predecessor into the Barren Lands around Doobaunt and Yath-kyed lakes, who, on "July y[e] 1 1767," two years before he started on his memorable journey to the Northern Ocean, appeared to have sat here with hammer and chisel in hand, beguiling the long hours of his tedious solitude by engraving his name among those of the masons and artisans from Fort Prince of Wales on this rocky point.

But other names are of more interest in connection with the question of the rise or fall of the land. During the winter the bottom of the cove becomes filled with ice up to the level of the highest spring tide, for at Churchill the spring rise is 15 feet 5 inches, and at times extraordinary spring tides rise to a height of four feet above ordinary spring tide level. On the 2nd of November, 1893, the bottom of the cove was covered with ice up to the level of the last spring tide, about an ordinary one, and the heights above the ice of the following names were measured and are given opposite to them :—

James Walker May y[e] 25 1753........	7 ft.
Guilford Long May y[e] 27 1753........	7 ft.
J. Marley, 1748....................	6½ ft.
J. Horner, 1746.....	6 ft.
J. Wood, 1757........................	6 ft.
Furnace and Discovery, 1741.........	3 ft. 3 in.

Ice in the cove.

As the ice does not leave Churchill harbour, on an average, until the 19th of June, and has not been known to break up in it before the 5th of June, the two names first mentioned above were undoubtedly cut while the ice was in the cove at its highest winter level, which at the present time would certainly be not more than six feet below them, and the surface of the snow would probably be still higher. Since the names would in all probability be cut not less than two feet above the ice, where a man could work sitting down, and could not have been cut below the ice, the greatest probable rise of the land since 1753 is between three and four feet, while the greatest possible rise is six feet. It does not appear in what month the names of the other men were cut, but probably in the long days of winter or spring, before the ice had gone out of the river, and the busy summer of fishing and trade had begun, in which case they would indicate a less rise of the land than that shown by the former names. The "Furnace" and "Discovery" reached Churchill in the autumn of 1741. Their names are cut in the almost vertical face of the rock, but whether they were cut before the bottom of the cove was covered with ice or not is uncertain.

Rings for mooring ships.

Besides the evidence of the comparative stability of the land furnished by the above-mentioned names, a number of rings have been placed in the rock at various heights for the moorings of the ships or sloops. As they are all well set in the rock, they were probably inserted there by the masons at work on the old fort during the last two decades of the first half of the 18th century. Those five feet or more above the ice of November 2nd, 1893, are still firm and strong, while others two feet and a half above the ice have been almost entirely rusted away. The former have evidently been comparatively free from the influence of the salt water, while the latter have been subjected to its influence, having been wet by very high tides, and splashed by the water in heavy storms. The positions and states of preservation of these rings clearly indicate that there has been no great change in the relative heights of land and water since the molten lead was poured round them as they were set into the rock.

Dates of opening and closing of Churchill Harbour.

Through the kindness of the officer of the Hudson's Bay Company in charge at Churchill, the writer was granted the privilege of inspecting a more or less broken series of "Journals of Occurrences" extending as far back as 1824, and from them was obtained the following record of the opening and closing of Churchill Harbour. The harbour opens suddenly, when the ice breaks up in the lagoon and goes out of the river with the tide. It closes more gradually, freezing from the shore out to the middle, and the date here given, in most cases at all events, is that of the final setting of the ice from shore to shore; for some days previous to this date the shore will have been pretty thickly covered with ice.

DATES of the opening and closing of the Harbour at Port Churchill.

Year.	Open.	Closed.	Length of open season.
1824	....	Nov. 2	
1825	June 12	" 18	5 mos. 6 days.
1826	" 11	" 22	5 " 11 "
1827	" 24	" 13	4 " 20 "
1828	" 22	Dec. 1	5 " 9 "
1829	" 10	....	
1833	" 18	....	
1834	" 21	Nov. 15	4 " 25 "
1837	....	" 1	
1838	June 27	" 4	4 " 8 "
1839	" 21	....	
1841	....	Nov. 25	
1842	June 24	....	
1843	" 25	....	
1844	" 24	Nov. 23	5 "
1845	" 19	....	
1846	" 10	Nov. 28	5 " 18 "
1847	" 26	....	
1848	" 19	Nov. 6	4 " 18 "
1849	....	" 27	
1850	....	" 15	
1851	....	Dec. 1	
1852	June 13	Nov. 28	5 " 15 "
1853	" 24	....	
1855	June 19	....	
1856	" 9	....	
1857	" 21	....	
1858	....	Nov. 11	
1860	....	" 8	
1861	....	Dec. 4	
1862	June 7	Nov. 5	4 " 29 "
1863	" 5	" 11	5 " 6 "
1864	" 21	" 14	4 " 24 "
1865	" 23	....	
1866	July 2	....	
1885	....	Dec. 4	
1886	June 17	....	
1892	" 19	Nov. 11	4 " 23 "
1893	" 19	" 4	4 " 16 "
1894	" 6	" 19	5 " 13 "
Average	June 19	Nov. 18	5 mos.
Earliest	" 5, 1863.	" 1, 1837.	
Latest	July 2, 1866.	Dec. 4, 1861 & 1885	
Longest season	....	....	5 " 18 days, 1846.
Shortest "	....	....	4 " 8 " 1838.

CHURCHILL TO YORK.

Mode of travel.

The winter journey from Churchill to York is usually made on the level land some distance back from the sea-shore. The country is almost entirely treeless, and the snow covering it is packed hard by the wind, so that men travel over it readily on small snowshoes, and the dogs and sledges rarely sink in the snow to any appreciable extent.

Farther inland the country appeared to be wooded, and in the woods the snow would be soft, and the rate of travel, both for men and dogs, consequently much slower.

After crossing the Churchill River on the ice, our course, for about twenty-five miles, was a little south of east, over level open country, interspersed with small lakes. Here and there a somewhat higher tract is wooded with small white spruce. Two ridges of sand or gravel, between twenty and twenty-five feet in height, were crossed in this distance.

Level country.

At a forest known as the "Eastern Woods," we turned southward and travelled over almost level marshy country, which, in some places, is quite open, but is usually thinly wooded with small white spruce and larch. A few groves of larger spruce were seen to the west of our course. Near White Whale Lake a gravel ridge, marking an ancient sea-beach, was crossed. As Salmon Creek is approached the country is covered with low scrub of dwarf birch and willow, or extends in wide grassy plains very similar in appearance to those of Manitoba east of the Pembina Mountains. Salmon Creek is a small stream about twenty feet wide, flowing between grassy or willowy banks.

Broad River, which flows through a wide, level, almost treeless, plain, is about a hundred yards wide, with low banks wooded with spruce. A few miles farther south, Owl River, eighty yards wide, flows across this same open plain.

On Stony River the woods descend to within a short distance of the sea-shore.

A short distance south of White Partridge Creek the open country ends, and we entered a forest of small white and black spruce and tamarack, the black spruce being the first that we had seen on the coastal plain.

Forest begins.

White Bear Creek flows through this forest with a width of about twenty-five feet. At the mouth of Duck Creek we reached the coast, and thence followed the west bank of Nelson River as far as a point opposite Seal Island. In this latter distance the bank, which had been very flat, and but a few feet above the level of the sea, rapidly increases in height, until at Flamboro' Head it rises from the edge of the water in steep scarped cliffs 100 feet high, where it consists of unstratified light-gray till, holding striated boulders of limestone, gneiss, granite, &c. From the top of the cliff a thinly wooded swampy country extends westward into the interior.

ROUTES EXPLORED IN 1894.

CEDAR LAKE TO REINDEER LAKE.

The course followed by the party, from Grand Rapids, up the Saskatchewan River to Cumberland, has been often described by others, and its general character is well known. The geology of Cedar Lake, and of the river below it, is given in some detail by the writer in his Report on North-western Manitoba, pp. 144 E—153 E, in the Annual Report of the Geological Survey of Canada, Vol. V. (N.S.), 1890-91.

A few notes may here be recorded on the river above Cedar Lake.

Saskatchewan River.

From Cedar Lake to The Pas, a distance of seventy-six miles, the river, often broken into several channels, flows through a wide marshy plain or lowland. No hills break the level monotony of this vast plain except at Pine Bluff, where three or four wooded ridges approach the river. They seemed to trend in a south-westerly direction, and are probably drumlins, though it was impossible to spare the time to go and examine them. The river banks everywhere are composed of fine stratified alluvial deposits, as far up the stream as the eastern limit of the Pas Indian Reserve, where the first stony bank slopes to the water. It is composed of a light-gray rather friable unstratified calcareous till, filled with irregular subangular pebbles and somewhat rounded boulders polished and scratched with glacial markings. The boulders are almost all of a pinkish Cambro-Silurian limestone containing crinoid stems, &c. This sometimes varies to a limestone conglomerate, occasionally with a sandy matrix. There are also a few boulders of red and gray gneiss, massive hornblende-rock, etc.

Pas Ridge.

At the Pas mission house, the low ridge, which rises fifteen or twenty feet above the water, is composed entirely of similar till. Four miles above the Mission a hill or ridge approaches to within a quarter of a mile of the north side of the river. It runs N. 50° E., and rises seventy feet above the level of the flat country to the west. In ascending it a terrace is met with at the height of thirty feet, and the upper twelve feet is as steep as gravel will stand. The ridge, on the summit at least, consists generally of fine rounded gravel, with a few rounded boulders. The material is not well assorted, varying from fine rock flour to boulders fifteen inches long. The ridge is wooded with Banksian pine and aspen poplar. As viewed from a distance to the westward, the summit of the ridge does not appear to be either regular or horizontal, dipping to the north as it does to the south.

This ridge taken as a whole, from the mouth of Birch Creek down the Saskatchewan to a mile or two below the Mission, is very similar in character to the ridge between Winnipegosis and Cedar Lakes, dropping abruptly towards the west and declining gently towards the east, the steep side being marked by shore-lines and capped by water deposits. This, then, may be a continuation of the same morainic ridge.*

Pine Island Lake.

Above The Pas, the banks of the river are again composed of stratified alluvial deposits to within a short distance of Pine Island Lake where the light-gray till reappears. The shores of this lake appear to be very generally composed of till. A low point touched at on its north shore, consisting of light-gray pebbly boulder-clay, is surrounded by a great number of boulders. These are chiefly of limestone, white, reddish and yellow, and for the most part are well glaciated. Some contain such fossils as *Favosites*, *Stromatopora*, etc., and seemed to have been derived from rocks of Niagara age. On the Sturgeon River, above Pine Island Lake, the banks are composed of till, except where low exposures of limestone show beneath it.

Sturgeon Lake.

At a prominent point on the east side of Sturgeon Lake a light-gray fine grained limestone outcrops near the edge of the water. Its surface is smoothed and strongly scored with glacial marking trending S. 20° W., crossed by many disruptive gouges opening southwards and showing the direction of glacial motion. No fossils were found in this rock, but the shore is covered with large angular masses of yellow porous dolomite, evidently derived from the immediate vicinity, holding *Receptaculites Oweni*, Hall, *Maclurea Manitobensis*, W., *Strophomena* sp. *Bumastus Trentonensis*, Emmons, *Cheirurus pleurexanthemus*, Green, etc., clearly distinguishing the beds as the equivalents of those at East Selkirk and Lower Fort Garry, or the horizon of the upper part of the Trenton. There were also some boulders of soft yellow sandstone, containing a number of fossils, among which are *Endoceras annulatum*, Hall, *Actinoceras* sp., *Maclurea Manitobensis*, W., and *Conradella* sp.

On the west side of Sturgeon Lake, are many exposures of horizontal thick-bedded white or salmon-coloured fine-grained limestone. One of these outcrops, which was more closely examined, was found to contain many casts of salt crystals and small fossils, among which are the following:—*Leptæna unicostata*, M. & W., *Plectambonites sericea*, Sby., *Dinobolus parvus*, Whitfield, *Metoptoma* sp., *Cyrtodonta Huronensis*, B., or *Canadensis*, B., *Cyrtodonta?* sp., *Trochonema* sp.

*See Report on North-western Manitoba, &c., pp. 54 E—56 E, Annual Report Geol. Surv. Can., Vol. V. (N.S.), 1890-91.

Loxonema sp., *Gyroceras* sp., indicating the horizon of the Trenton, but probably below the last.

The boulders on this shore are chiefly of fine-grained green Huronian rocks, giving evidence of the presence of this formation at no great distance towards the north-north east.

Sturgeon River.

The Sturgeon River, above Sturgeon Lake, is about 200 feet wide, with banks wooded with poplar. In many places the water flows over a bed of flat-lying limestone, while the west and south-west banks often consist of cliffs of this rock. The Red Rock portage, at the mouth of Goose River, is over horizontal white limestone, with a few traces of corals. Its surface is smooth and marked with glacial grooves trending S. 25° W. The river is generally very swift and shallow, from which it derives its common name of Rivière Maligne. In the twenty-five miles between Beaver and Sturgeon lakes there is a fall of about two hundred feet.

Beaver Lake.

Beaver Lake lies along the line of contact of the Archæan and overlying Palæozoic rocks, its west shore being formed of undisturbed horizontal white limestone, often cleanly jointed, while the east shore, and most of the many islands are of Archæan rocks, though the first island visited was of limestone. A small bare island, lying in the course of the canoes, was of thinly foliated wavy micaceous gneiss, striking S. 25° E., and dipping N. 65° E. at an angle of 70°. The surface is strongly glaciated, the glacial grooves all trending S. 20° W.

Northern edge of Palæozoic limestone.

The limestone escarpment follows the west side of the river up to Spruce portage, three miles above Beaver Lake. It is here about fifty feet high, and on its face, twenty feet above the river, is a terrace, apparently representing an old lake shore. The portage itself, on the east side of the river, is over a coarse red and gray augen-gneiss, very evenly foliated, striking S. 35° E. and dipping N. 55° E., at an angle of 50°. From Spruce portage to Snake portage the banks are rather low, with low bosses of gneiss rising here and there through the loose gray stony soil. For about two miles above the latter portage the river is winding, above which it runs for several miles in a narrow even valley between rocky ridges forty to eighty feet high, that to the south-west being bold and bare, while that to the north-east is more sloping and wooded. The valley runs along the strike of the thinly foliated biotite-gneiss, which in one place was found to dip N. 65° E. at an angle of 60°. The top of the ridge to the east is in the same place marked with glacial groovings trending S. 10° W. As the next portage is approached, where the river falls over a ledge of rather coarse reddish-gray granite, cut by veins of red pegmatite, scarps of

Gray gneiss.

Straight valley.

evenly and horizontally stratified gray sand twenty feet in height form the west bank, and for the next four miles, up to Leaf portage, a sandy terrace from twenty to twenty-five feet in height runs along by the river. The course of the river is now remarkably straight, following the strike of the rock, which at Leaf portage is a well foliated, fine-grained gneiss. The glacial striæ here trend S. 15° W. Above Leaf portage the river flows through small irregular lakes, to the south-west of which are high bare hills of light-gray granite.

Birch portage.

At Birch portage the rock is a coarse well banded red gneiss, striking S. 30° E. and dipping N. 60° E., at an angle of 40°. The surface is well striated, in the same direction as at Leaf portage. Above Birch portage the river is wide, with an easy current, flowing in a rocky valley with sides densely wooded with poplar. This wide straight stretch of river is separated from Crow Lake by a rapid, which is passed on Dog portage, a short carry over a low rocky island. The rock is a rather fine-grained micaceous gneiss, with large white porphyritic crystals of felspar. It strikes S. 30° E. and dips N. 60° E., at an angle of 20°. The surface is strongly marked by glacial striæ trending S. 10° E.

Pelican Lake.

At Crow portage on the opposite side of Crow Lake, the York boat brigade from Reindeer Lake was met on its way to Cumberland, carrying out the winter's trade in furs. Above this point the river breaks into a number of lakes, on one of which, called Pelican Lake, the Hudson's Bay Company has a small trading post. Between the trading post and Beaver Lake, a total distance of sixty-five miles, the river has an estimated fall of ninety feet.

At the short portage above Pelican Lake, the rock is a coarse gray micaceous gneiss, striking S. 35° W., and dipping S. 55° E., at an angle of 70°. Its surfaces show well rounded northern and craggy southern sides. Though much weathered and rather rough, it shows many glacial grooves trending S. 25° W.

Pot-holes.

A mile and three-quarters to the northward are two portages quite close together, the upper one past a pretty little fall about twelve feet in height, where the water tumbles over a ledge of gray micaceous gneiss. Both around the top and part way down the sides of the rock at the falls, are many pot-holes, from one to two feet in depth, worn out of the solid granite-gneiss by pebbles and boulders kept whirling by a heavy current. The largest pot-hole, which has been considerably deeper than the rest, has much of its northern side now broken away. It is close to the present fall, and about two-thirds of the way down the slope. Many of the pot-holes are clearly preglacial, the glacier having broken their northern and smoothly rounded their southern edges. The southern edge of the large pot-hole shows this smoothing very clearly. Two sets of striæ are here apparent, the first trending S. 15° W. and the second S. 30° W., but it is probable that there is not a great difference in their age. It would appear that a considerable stream, much larger than the present one, had flowed southward over this rocky barrier in preglacial or interglacial times, perhaps carrying the Reindeer River, or part of the Churchill River, the intermediate portion of the channel having since been blocked by till.

Frog portage.

At nine oclock on the evening of July the 10th, the party reached Frog portage, having travelled 180 miles from Cumberland, or 395 miles from the mouth of the Saskatchewan. The portage is about 300 yards long, over two low ridges of gray till studded with boulders of gneiss. To the west of the portage is the channel of the brook, much obstructed by boulders, cut off from the Churchill River, except at high water, by a narrow ridge of light-gray gneiss. The water south of the ridge was ten feet below that in the Churchill River. Opposite the north end of the portage the Churchill River is half a mile wide, with its banks and islands covered with poplar. On the nearest island is an old warehouse of the Hudson's Bay Company, while on a low rocky point just to the west of the portage, formerly stood an old trading house, perhaps the one built by Mr. Joseph Frobisher in 1775, when he first penetrated this then unknown wilderness to barter the products of civilization for the rich furs of the Indians. From him this great stream derived the name of English River.

Churchill River.

From Frog portage our course was down the Churchill River, for about twenty-one miles. The river at the narrower parts has a steady current of from two to three miles an hour. Its banks are composed of gneiss, which is more or less deeply overlain by till, and the hills are well wooded with poplar. Eight miles down the stream several bare sandy hills rise to heights of sixty feet on its northern bank. They are narrow, lenticular ridges of loose sand, with a few boulders lying on their summits. The sides are as steep as the sand will stand, while the ends slope easily down to the general level, the south-western end being steeper than the north-eastern. They trend S. 25° W. in the direction of the glaciation, and are thus typical eskers, the first observed during the course of this season's exploration. From these eskers to the Kettle Falls, ten miles further down the river, there is a well defined sandy terrace on the sides of the valley about twenty feet above the stream, doubtless caused by the damming up of the Churchill River both at the eskers and at the gap below the mouth of Reindeer River. The Reindeer River, and the Churchill River above

Eskers.

it, flow in one continuous valley, which the united waters leave by what appears to be a narrow gap in the hills to the east. At Kettle Falls the Churchill River precipitates itself in a magnificent cascade over a ridge of thinly foliated light greenish-gray gneiss, striking S. 15° E. and with vertical dip, while six miles to the north Reindeer River rushes in the opposite direction over a barrier of coarse light-gray porphyritic gneiss. Continuous valley.

For the next thirty-two miles up Reindeer River, to Steep-hill Falls and portage, this latter stream fills the bottom of a valley between hills from 200 to 400 feet in height, and has the character of a long narrow lake rather than a river, for only in three or four places could current be detected. On both sides deep bays frequently indent the shore. Some of the hills are rugged and almost bare, though most of them are covered with forests of aspen. The rock is a dark or light gray gneiss, with a generally roughened surface, though here and there a few points are smoothed and show glacial groovings. Below Steep-hill portage the rock is a coarse gray hornblende-gneiss, striking N. 20° E., and dipping N. 70° W., at an angle of 17°. Below Steep-rock Fall there is quite a heavy rapid, and at the fall the water flows in several channels between islands wooded with spruce, tumbling fifteen feet over a band of gneiss. The portage is over a hill rising forty feet above the water at its lower end, composed entirely of light-gray compact clay, apparently without boulders. In the next eighteen miles the river widens into several small lakes, and the banks rise in gentle rocky slopes, the knolls of bare gray gneiss peeping out here and there through the covering of poplar woods. Between the knolls the surface is underlain by light-gray till. Then for seven miles it flows in a regular, well-defined channel, winding through a low bottom-land wooded with small spruce and tamarack, behind which rise the rocky ridges. Reindeer River. Wide River.

At the upper end of this well defined channel the water rushes between high, almost vertical, rocky walls, forming what are known as Manitou Rapids, where the canoes ascending are passed with difficulty over a low rocky island in the middle of the stream, and then paddled with all possible speed across the rushing current to an eddy in a bay on the eastern bank, failing to reach which they are sometimes engulfed in the heavy waves below. Manitou Rapids.

Above Manitou Rapids, the river opens out into a small lake with rocky shores. Passing from the southern to the north-western angle of this lake, a distance of four miles, the stream is again encountered as it descends about sixteen feet in two distinct falls over a rocky ledge

White Sand portage.

composed of a rather coarse gray hornblende-gneiss striking N. 25° E., and dipping N. 65° W., at a high angle. The portage on the south side is over gneiss and light-gray sandy till with boulders. At the foot of the portage a rounded knoll shows strong glacial groovings trending S. 17° W. On the north side of the falls are cliffs about fifty feet high of orange coloured stratified sand and gravel, showing a section of the south end of an esker which stretches from this point away to the northward as a high wooded sandy ridge, culminating near its northern end in a point probably 150 feet in height. Above White Sand Falls the river opens out into another small lake, on both sides of which are sandy terraces fifteen feet above the water. Above this lakelet is a short stretch of current, at the head of which is a fall of eight feet. Canoes reach the quiet water above it by a short portage, across a bare island of similar gray gneiss striking N. 55° E., the surface of which shows distinct glacial groovings trending S. 17° W., as before. This island is known as Rock portage, and the open water to the west of it is the southern end of Reindeer Lake.

Rock portage.

Reindeer Lake.

Above Rock portage the country at once becomes much more barren and rocky. Below it the hills were fairly well covered with till, but now the till seems to have disappeared, and a few pines and spruces cling to the brown lichen-covered rocks. The sandy terrace is, however, still present at about fifteen feet above the water. From a small trading store of the Hudson's Bay Company our course was northward along the eastern side of Reindeer Lake, generally winding among its almost innumerable islands. Du Brochet post, at the northern end of the lake, was reached on the afternoon of the fifth day. The shores throughout are exceedingly rocky and the rock is generally a typical Laurentian orthoclase-gneiss more or less foliated. Till is notably scarce, but the sandy terrace or old lake beach is almost everywhere seen between fifteen and thirty feet above the water. The Hudson's Bay Company's store and the Roman Catholic mission at the north end of the lake are built on this terrace. The glacier of at least the latter part of the glacial epoch followed in a general way the long axis of the lake, as shown by the courses of the glacial striæ, flowing south-westward from its north-western end, and south-by-west towards its southern end. One set of striæ was all that could be found anywhere, and no evidence was found such as to indicate any other direction of glacial motion at any time during the glacial period. The dark lichen-covered hills bear a scattered growth of black spruce, with an occasional stunted canoe birch, on the lower slopes, while a few small Banksian pines and aspen poplars grow on the sandy terraces, almost to the north end of the lake.

Rocky shores.

Direction of glaciation.

The distance travelled from Frog portage to Du Brochet post was about 250 miles, and the total distance already travelled in canoes 645 miles, in which distance there are nineteen portages.

Cochrane River.

Du Brochet trading store and mission are situated on a sandy terrace near the north-eastern extremity of Reindeer Lake, three miles from the mouth of Cochrane River. Many of the islands in the bay to the south, are encompassed by high bouldery beaches, giving evidence of the presence of till, or more probably morainic detritus, in the vicinity. The position of the store was found to be in north latitude 57° 53′ 16″, while Mr. Dowling's survey of 1892 places it in east longitude 101° 52′ 42″. Variation of the compass in July, 1894, 20° 30′ east. Du Brochet post.

In ascending Cochrane River, the channel for the first seven miles and a half is very irregular, being often broken by wooded islands. In places it is about a hundred and fifty yards wide, with a current of two or three miles an hour; in other places it is much wider and with very little current, while towards the upper end of the stretch are two heavy rapids up which the canoe must be tracked with a tow-line. The water is clear and cool. The banks are low and grassy, and low, rocky points project into the water here and there. The surrounding country is low and swampy, underlain by sand and sandy till, and is wooded with small black spruce and larch. A low sandy ridge wooded with Banksian pine, extends along the east bank for a short distance. Seven miles and a half from the lake, the river falls about twenty feet over medium-grained gray hornblende-gneiss, the surface of which is indistinctly grooved S. 35° W. These falls are passed by a portage 420 yards long on the east side. The portage is over a drumlin ridge of silt and Laurentian boulders trending about S. 40° W. Ascending Cochrane River. Low banks.

Three-quarters of a mile higher up the stream is a heavy rapid with a fall of eight feet, the water flowing over a coarse light-reddish slightly biotitic granite. The surface is strongly glaciated, having been smoothed and grooved, the grooves trending S. 30° W. It is passed by a portage 180 yards long on the west bank, over a neck of land composed largely of boulders. A mile above this portage is a swift rapid a quarter of a mile long, up which the canoes were taken with tow-lines and poles. Reddish granite.

Two miles above this rapid the canoe-route for a time leaves the river (which continues on towards the north-east, and is said to be very crooked, with one bad rapid), and crosses through a chain of small Canoe-route leaves the river.

Four portages.

lakes, connected by four portages. The first portage connects a deep sandy bay on the west side of the river with a small lake of clear brown water a mile wide. It is 600 yards long, and crosses a ridge fifty feet high running S. 35° W. It has a steep slope at its south-western end. On the sides of the ridge are rounded depressions and smaller parallel ridges. These are in places composed exclusively of boulders, and represent an old shore-line twenty feet above the present water-level, or sixty feet above Reindeer Lake. The ridge, which is thinly wooded with Banksian pine, is merely one of a scattered group, some of which appear to be a hundred feet high. They all run in the same direction, parallel to the direction of glaciation, and they probably represent a commingling of glacial and fluvial deposits near the line of a terminal moraine, at the southern end of the esker ridge which extends from here towards the north-east.

Ancient shore.

The second portage is 375 yards long, across a ridge of sand and boulders thirty feet high, between lakes, the northern one of which is ten feet higher than the southern. The former lake, which has low wooded and swampy shores, is nearly a mile in diameter. From its northern end is the third portage, 650 yards long. This portage follows a valley between sandy esker ridges, the southern half being along the western side of one of the ridges, and the northern half in the bottom of the valley. The lake at the northern end, appears to be about five feet higher than that to the south, is a mile and a quarter long and very narrow. At its northern end is the fourth portage, in north latitude 58° 6′ 19″. It is 400 yards long over a very stony morainic hill, which has a wide sandy plain on its western slope.

Shallow lake.

At the west end of this portage is a shallow lake nearly a mile in length, with sandy shores. From its north-eastern end flows a creek sixteen feet wide, winding for a third of a mile through a sandy plain to the south end of a larger lake. At times paddling and at times walking in the water on the sandy bottom, the canoe was taken down this brook, and across the sandy bar into the outer lake. This lake, which is six miles and a half long, is constricted to quite a narrow channel about the middle. Some of its islands are rocky, one, half a mile north of the narrows, being composed of dark hornblende-gneiss striking N. 30° W., and dipping N. 60 E., at an angle of 30°. Others are drumlins of sand and boulders. One of these, near the north end, rises as a bare unwooded island to a height of sixty feet above the water.

Canoe-route returns to river.

The north end of the last lake opens by a wide channel into Cochrane River, up which the canoes were again directed. On the west bank a sandy terrace rises just behind the beach to a height of twenty-five feet. Half a mile further west is a high sandy ridge. For the next thirteen miles the river flows on a very direct course from north 28° east. The current is nowhere very strong, and in the wider places is hardly apparent. The banks are either low or rise in sandy ridges. Not many exposures of the underlying gneiss were to be seen. At the camp of the evening of July 22nd, where the east bank was more particularly examined, the flats were wooded with Banksian pine, behind which was a ridge of boulders twenty feet above the water, representing the boulder-pavement of an old beach. Half a mile to the east was a ridge, 150 feet high, and parallel to the river, composed of sandy rock-flour and boulders of Laurentian granite, gneiss and mica-schist. The ridge appeared to be composed entirely of unassorted detritus, and both it and many of the adjoining ridges may be classed as ispatinows deposited by the glacier on an uneven rocky floor, the positions of the ispatinows being determined by the existence of high rocky prominences, and their direction by the flow of the ice. The general character of these ispatinows, and the presence of a large amount of glacial detritus in this vicinity, and its absence from such considerable areas as that around Reindeer Lake, will be considered in a later chapter. The ridge is wooded with small Banksian pines, while the low land is covered with black spruce and birch.

Ispatinows.

At the north end of this straight reach of river, the boulder-pavement is particularly well shown, fifteen feet above the water. Near by is a rounded boss of a granular reddish, slightly biotitic granite, with dark schistose inclusions. The surface is well smoothed and shows strong glacial grooves trending S. 30° W.

Boulder pavement.

Here, in north latitude 58° 22′ 45″, the river leaves its well defined channel, and comes from the north-west, where it flows through a number of larger and smaller lakes. At the first narrows between these lakes there is a stiff current, and to the west is a high ridge of sandy esker-like hills. Other high bare hills of sand and boulders rise on every hand, and the country looks very desolate and barren. A few outcrops of the underlying rocks enable one to keep track of their character. One of these outcrops is on a small island three miles and a half from the last-named narrows, and consists of dark hornblendic gneiss striking N. 60° E., and dipping S. 30° E., at an angle of 60°. Its surface is distinctly marked with glacial grooves trending S. 13° W. A few miles further north, in latitude 58° 31′, a high hill of gneiss rises from the west bank, being the first conspicuous rocky hill seen in the ascent of this river.

Lakes.

Route to Island Lake.

Towards the north-east, a small river was said by the Indians to empty into the bottom of the deep bay that extends in that direction. Up this stream is a practicable canoe-route across a height-of-land through many small low-lying lakes connected by swampy portages to Nūeltin or Island Lake, and thence down Thlewiaza River to Hudson Bay.

North of the rocky hill the river contracts, and then widens again to a small lake, from the north-west angle of which is a portage 800 yards long, through a swamp and over a low ridge of clay and boulders. West of this portage is a long narrow lake which the canoes cross for two miles in a south-westerly direction, to a swift deep narrow creek 15 feet wide and 200 yards long, with a fall of 6 feet from the next lake above. Its banks are of boulders. Five miles and a quarter above this creek, through a curving lake and past a heavy rapid with a fall of eight feet, the next portage is reached. It is 1300 yards long and rises at its southern end to the top of a dry sandy plain thirty feet above the river. It keeps on this plain through most of its length, a sandy ridge twenty feet higher extending along to the north-east of it. Close to its north-western end the ground becomes rougher, and a few boulders are scattered through the sand. The total rise from one end to the other is about ten feet.

Du Brochet Lake.

The upper end of the portage is on the shore of Du Brochet or Pike Lake, the largest lake on Cochrane River between Wollaston and Reindeer lakes. Its altitude is about 1230 feet above sea-level. The lake appears to be shallow, with low shores of sand and boulders. To the south are some rather high hills, and to the north the country is low, swampy and wooded with black spruce, the low hills here and there being composed of gneiss. The general direction of the glacial striæ is about S.W. by S. The whole body of water known as Du Brochet Lake, which the canoe-route traverses for thirty-eight miles, is divided into three parts by two short reaches of stream, the first with an easy current, and the second, seven miles from the west end, is a heavy rapid with a drop of about eight feet. This latter was ascended with tow-lines. At the west end of the lake is a portage 300 yards long over a low swampy island covered with yellow cloud-berries (*Rubus chamæmorus*). In high water this portage is not used, for the canoes can ascend the channel of the river to the south of it.

Above this portage a small double lake, with rocky shores, extends for six miles, beyond which the river flows for two miles, with a strong current, between wooded sandy banks, to a narrow gap, where it cuts through an esker of stratified sand and gravel, extending as a long even ridge away to the south. A mile and a quarter above the gap in this ridge, a small tributary joins the river from the south, up which is the canoe-route to Wollaston Lake followed by the late Mr. A. S. Cochrane in 1881. Above the mouth of this brook, Cochrane River flows with a rapid current, over a bed of sand and boulders in a moderately straight channel down the west side of the esker. At a point on its east bank some old tent-poles showed us that here was a regular Indian camping place. The river still keeps its course from the north, but the canoe-route to White Partridge Lake leaves it here and crosses the sandy esker ridge by a portage 600 yards long.

The following description of the upper part of the route from Reindeer Lake to Wollaston Lake is extracted from Mr. Cochrane's manuscript notes taken in July, 1881. It starts from the mouth of the brook mentioned above:—

Mr. Cochrane's description of the upper part of the river.

"Leaving Hatchet Lake, we went up a very small and crooked river—the outlet of all the small lakes to be passed through. In it are two rapids, past the lower of which there is a portage at low water. The first lake reached I have called Spider Lake, from its many long arms and comparatively small body; the second Wolf Lake, from seeing a large white wolf watching us unloading the canoes, from a small hillock not far off. The next lake is reached by a very small, short and shallow stream, which flows from it, and a portage of say twenty yards. The next two lakes remain unnamed, and between them is a portage of 400 yards [the latter being again on Cochrane River about fourteen miles by the course followed from where it had been left at the mouth of the rivulet.] The country passed through has been swampy and very flat indeed, though occasionally high hills were seen in the distance. The land, as usual, has been sand and boulders; the timber stunted." In ascending Cochrane River, which has now turned and is flowing north-eastward, two miles are spoken of as a "very bad bit of river, with six rapids and two portages." The first portage is at the third rapid and is 300 yards long, and the second portage is at the fifth rapid and is 250 yards long. Both are on the south-east side. These rapids all occur where the river passes through a low range of hills, between sixty and eighty feet high, "of coarse, brown thinly foliated gneiss striking N. 15° E., and dipping S. 75° E., at an angle of 45°." "The hills here divide and run along on either side of the river. They are not burnt, but are covered with a sickly growth of small Banksian pine, spruce and birch."

Drifting Lake.

Five miles above the upper end of these rapids, Drifting Lake was entered, and a mile farther south "the rock suddenly ends, and the islands and points passed are composed of sand and gravel, with some boulders." Gray gneiss was seen outcropping at the water's edge in one or two places on this lake. The river, which enters Drifting Lake at some low country on its north-west side, is followed by the canoe-route for nine miles, past the mouth of Sunshadow River, flowing from Sunshadow Lake, seven or eight miles to the north. The canoe-route leaves the river on the west side of a small sheet of water known as Big-stone Sitting Lake, half a mile south of where Cochrane River enters it, and passing over three portages, respectively 400, 240, and 415 yards in length, reaches a deep bay in the north shore of Wollaston Lake, avoiding what was stated to be a long and rapid piece of river. In this northern arm of the lake the underlying rock is seen in very few places, "the points and islands being all either sand and fine gravel, or boulders and sand, all very low. The hills, also, bordering the shore-line, are all low."

Esker east of the river.

Let us now return to the portage on the route to White Partridge Lake. As stated above, the portage is 600 yards long over the sandy esker, which is here seventy feet high. At both ends are steep slopes, the eastern one leading down to the shore of a long narrow lakelet about fifteen feet above the river. The esker in general character is a regular, well-defined long sandy ridge, but in detail it here rises in many little knolls and ridges, sinks into deep depressions and spreads out into sandy plains wooded with an open growth of large Banksian pine. On the portage itself is a grove of fine tall white spruce, the best trees seen on the banks of Cochrane River, and here the Indians seem to resort regularly to obtain wood for their canoes, while birch bark can be procured from trees on the same sandy ridge a short distance farther north. The narrow lake now reached runs northward for three miles and a half, with the sandy ridge, wooded with large white spruce and birch, on its western side, and a ridge of gneiss to the east.

Chain of portages.

At the north end of this lake a portage 200 yards long leads over a sandy ridge to another small lake similarly situated to the last. Thence, extending in a direction N. 28° E., is a chain of five small lakes at about the same altitude, with sandy shores thirty to seventy feet high, thinly wooded with spruce, larch and Banksian pine. Towards the north some of the ridges contain a great many cobbles and rounded boulders, but no outcrops of the underlying rocks were to be seen. The lakes are, respectively, one, two-thirds, one and three-quarters, four, and two and a quarter miles long, and are connected by portages 20, 40, 800 and 1000 yards long, the longer ones being over sandy plains, with steep slopes forty feet high at each end. These portages and small lakes are on the height-of-land between Cochrane and

Thlewiaza rivers, at an approximate elevation of 1425 feet above the sea. West of the forty-yard portage is the northern bend of Cochrane River, above which the river comes from the south-west.

Thlewiaza River.

From the north end of the last of the above described lakes, a portage 700 yards long leads over bare rugged morainic hills of rounded cobbles and boulders to the southern end of a narrow lake, whose shores here rise steeply to the height of 70 feet, the hillsides being wooded with large white spruce up to seventy-six inches in circumference, three feet above the ground. The lake is fifty feet below the one just left less than half a mile to the south, and its sides are springy and wet. The water looks dark and blue in the bottom of the deep cirque-like depression, from which the Indians give it the name of "Blue Lake." The upper part of Cochrane River would doubtless drain towards the north-east down this or some adjoining valley, if the water were not dammed back, and directed to the south by the large moraine just crossed.

Blue Lake.

Obstructed drainage.

Blue Lake is a beautiful narrow lane of quiet water a mile and a half long, the eastern side of which is low, with a high ridge of boulders in the background, while on its western side is an even sandy esker thirty feet high, the face of which is wooded with white and black spruce, birch, alder, willow, and straight aspens four inches in diameter, the first of these latter trees seen for a long time. This lake is one of the principal fishing places resorted to by the Indians at some seasons of the year.

Deciduous woods.

Near its northern end, a portage 200 yards long crosses the esker to another small lake, rather over a mile long, beyond which is a portage twenty yards long, with a drop of eight feet, to the south end of Thanout or Gravel-ridge Lake. This is a narrow river-like stretch of water thirteen miles and a half long, and varying in width from 300 yards to a mile, extending almost straight N.E. by N. Near its south-western extremity it is said to receive a tributary from Trout Lake. The water is clear and cool. The shores are generally composed of low hills of sand and boulders, and terraces of stratified sand. At a narrows with current, six miles down the lake, is a small island of a whitish granular granite, with plagioclase and large crystals of biotite, and showing a slight gneissic foliation N. 40° E. Two miles further north the west shore is composed of an almost vertical well foliated gray gneiss, with an easterly strike. To the north rises a conspicuous rounded hill 125 feet high, of a coarse white granite con-

Thanout Lake.

taining a small quantity of biotite, while a mile to the north-east is a high island of similar granite. In many places the beach is a rough wall of large boulders, while here and there are a few sandy bays. A mile above the north end of the lake, Red Head, the chief of the band of Chippewyan Indians trading at Reindeer Lake, has a comfortable little house where he spends the winter.

Red Head's house.

From the north end of Thanout Lake, a stream twenty-five yards wide and moderately deep, flows with a stiff current between low sandy wooded banks. It soon widens and loses its rapid current. Rocky and sandy hills are to be seen on each side. Three miles and a half below the lake, the river plunges over a steep slope and disappears in a deep wooded valley extending towards the north. To avoid this gorge a portage was made over some rough stones for twenty yards, to a pond 200 yards wide, beyond which everything was carried across a portage 1800 yards long, in which there is a drop from one end to the other of seventy feet. For 1100 yards this portage is along a sandy or gravelly ridge, at a constant elevation, to the face of a steep escarpment; while the remaining part, 700 yards long, is over a low flat composed of broken angular masses of rock with little or no finer infilling. Walking with a heavy load on one's back over these large rough stones was very difficult and unsteady work. The portage ends on a swampy slope at the foot of the heavy rapids, and below it the river flows for two miles and a half, with a swift current, between stony ridges to the south end of Theitaga or Sandy Lake, in one place rushing over a band of schistose gneiss with a northerly strike.

Deep wooded gorge.

Theitaga Lake.

Theitaga Lake itself, through which the canoe-route to the north passes for fourteen miles, is an irregular sheet of clear water. Its shores and islands are composed of boulders and silt, often in elongated hills or rounded drumlins, among which are scattered a few hills of sand. A point near the middle of its west shore was found to be in north latitude 59° 35′ 43″, with a magnetic variation of 21° east. The lake has an elevation of about 1200 feet above the sea, and is said to discharge by a stream which flows into the west side of Nū-el-tin or Island Lake, a short distance north of where Denéchethé, a Chippewyan, one of the sub-chiefs of the band that trade at Reindeer Lake, has a house which he occupies in winter. Nū-el-tin Lake is said to be long, narrow and dotted with many islands. Its southern end lies within the woods, while its northern end stretches into the Barren Lands. From this end the Thlewiaza or Little-fish River flows down some heavy rapids to Thétinné, or Seal-hole Lake, beyond which it flows over other rapids to Edehon or Horn

Lower course of Thlewiaza River.

J. B. TYRRELL.—Photo. July 31, 1894.

NEAR THE SOURCE OF THLEWIAZA RIVER.
Narrow channel with even walls of boulders.

Lake. Below Edehon Lake it is said to flow with an easier current and to empty into Hudson Bay a day's journey north of Egg Island, or two days' journey south of Cape Esquimaux.

From the north end of Theitaga Lake, the canoe-route to Kazan River ascends a small stream, here called Thebayazie River, from the name of one of the Chippewyans who accompanied us. It is about fifty yards wide, with a fairly strong current, flowing over a bed of angular masses of gneiss. Half a mile above its mouth is a rapid, where the water falls over a ledge of light-gray gneiss striking N. 60° E. and dipping S. 30° E., at an angle of 30°. The canoes were carried past this rapid, on the east bank, over a portage 300 yards long. The track is a bad one, over rough, irregular masses of rock, and it was with difficulty that a spot could be found anywhere in the vicinity sufficiently level to sleep on. A flock of the beautiful Bohemian waxwing (*Ampelis garrulus*), was seen in a grove of small birches beside the rapid. As it was the 30th of July the birds were doubtless on their breeding ground, of which so little is known in North America. Unfortunately, time and the long journey still ahead of us did not allow us to search for the nests and eggs.

Thebayazie River.

Ampelis garrulus.

For fifteen miles, Thebayazie River comes through a chain of small lakes connected by rapids, where the river generally flows over a bed of boulders and between banks of boulders. The shoving of the heavy ice in spring has packed the boulders down to an even pavement, and shoved the sides back into even walls, giving the channel the appearance of a regularly built chûte of dry masonry. Up some of these rapids the canoes could be towed with a line, or hauled by hand while walking in the water, but in the latter case the bed of boulders gave a difficult and uncertain foothold. Past others it was necessary to carry everything over the rough stony flats or ridges of boulders.

Boulder walls and pavements.

The portages are as follows:—575 yards on the east side, 700 yards between the ends of two lakes in north latitude 59° 45′ 54″, 525 yards between two lakes, and 180 yards on the west bank. The surrounding country is low and swampy, but low ridges of boulders rise here and there, and one sandy hill stands on the east bank about a mile and a half above the mouth of the river.

Long chain of portages.

Above the uppermost of these small lakes, the river flows for two miles and a half in a winding channel, for the first mile between low marshy banks, and then through a plain of stratified sand, to the foot of a heavy rapid over boulders, past which is a portage, on the west bank, of 500 yards, along the side of an almost bare lichen-covered hill of till and boulders. Just above the head of the portage is a hill

Hills of granite.

of a rather coarse red biotite-granite, much jointed, and breaking into angular fragments, especially on its southern, but also on its northern side. Its surface is well polished in places. Coarse glacial grooves are entirely absent, but on the polished surfaces scratches and fine grooves can generally be detected, all trending S. 18° W. A mile and a quarter higher up the stream a hill of similar granite rises on the east bank. These were the first rock exposures seen since leaving the rapid at the mouth of the river. Three miles farther up the rapid crooked river, is a portage 240 yards long on the west side, and a mile farther is another portage 60 yards long, also on the west bank. Across a shallow lake a mile and a third in length, is a portage on the east bank, 475 yards long, over a low flat mossy swamp. A mile farther, across a similar shallow lake, is another portage 550 yards long on the west bank over an almost bare ridge of very bouldery whitish till. Seen from here the country appears generally low, flat and wooded with small black spruce, while ten miles away towards the north-northwest, half way between this point and Kasba Lake, Roosevelt Hill rises as a conspicuous landmark high above the surrounding plains.

Grassy portage.

A quarter of a mile to the north, across a small shallow pond, is Grassy portage, 1600 yards long, on the west side of the river, 1100 yards being across a marshy meadow, and 500 yards along a low sandy ridge to the head of the rapid, down which the river flows over angular masses of rock with a total fall of twenty feet. Three quarters of a mile higher up stream another portage of 125 yards on the same side runs across a grassy flat to the mouth of a small stream coming from the south-west, and carrying about half the water of the main stream. A quarter of a mile higher up stream, at a portage 50 yards long on the east bank, the latitude was found to be 59° 58′ 38″, and the magnetic variation 23° east.

Drumlins.

Half a mile up stream is another portage, 1750 yards long, on the east side. The portage is a good one, over gentle hills of sand and gravel. Here and there little hills of boulders rise abruptly above the general level. To the east are many drumlins or rounded hills and ridges of boulders trending southward. The portage passes a series of shallow rapids in the river, in one of which is an outcrop of a reddish-weathering biotite-gneiss, well laminated and lying horizontally. It has easily rounded contours, but is generally rough, with a few small polished surfaces, especially on northern angles, though no striæ could be seen. On the west side of the river is a long straight esker trending S. 2° E., and from fifty to seventy

J. B. Tyrrell.—Photo. Aug. 2nd, 1894.

MORAINIC RIDGE, NEAR THE SOURCE OF THLEWIAZA RIVER.

feet in height. Its surface is composed entirely of sand and gravel. Its crest is narrow, and its sides slope at angles of 32° to 35°. On its west side is a lower ridge, joining the higher one at its southern end, and making an inclosed hollow between them. A few small stunted aspens were growing near the foot of its western slope, marking the northern limit of the tree in this longitude, as far as observed.

Esker.

Northern limit of aspen.

A quarter of a mile above the head of this portage, another portage on the east bank, 180 yards long, leads over a hill of very much broken gneiss; and half a mile above, a portage 600 yards long, on the left bank, leads over a spur of the esker above mentioned to a wet stony spot beside the stream. At the foot of this portage is an outcrop of similar gray biotite-gneiss almost horizontal, or with a light dip towards the south. It is very much fractured and broken along jointage planes, so that in most places it looks more like a bed of boulders than rock in place. Here and there its surface is smooth and polished, but no striæ could be detected.

A mile and a quarter up the brook is a portage 500 yards long on the west bank. It is a rather bad one, on a gentle slope underlain by boulders, and through spruce and tamarack swamp. The tops of the surrounding hills are now for the most part bare of trees. A quarter of a mile beyond a small lakelet is another portage on the same bank, 475 yards long, through swamp at both ends, and for the rest along a bouldery hill side. Again, after crossing a small lake a mile wide, there is another portage of this chain, 500 yards in length, along a very stony and almost open hill. Up to this point the boulders seen were of Laurentian granite and gneiss, but on this hill there are also some of gray quartzitic sandstone and altered conglomerate, probably of Huronian age.

Huronian boulders.

A mile and a quarter higher up stream, beyond another small lake, is a portage 250 yards long over low stony ground. Half a mile beyond is a portage 300 yards long over a ridge of boulders, and nearly half a mile farther is another 150 yards long, across a broken ridge of very coarse red granite containing well formed crystals of orthoclase with biotite and rounded crystals of translucent quartz. A mile in the canoe, on a crooked lake, leads to a portage 500 yards long beside a shallow dry valley to the shore of Roosevelt Lake. A quarter of a mile east of the portage, Roosevelt Hill (so named by Mr. Munro-Ferguson after Mr. Theodore Roosevelt, of New York) rises with steep sides to a height of 200 feet above the lake of the same name, or 1650 feet above the sea, and is the highest point in the vicinity. It is composed of coarse or medium grained red biotite-granite, quite massive but cut by vertical joints. The hill is in the form of a short

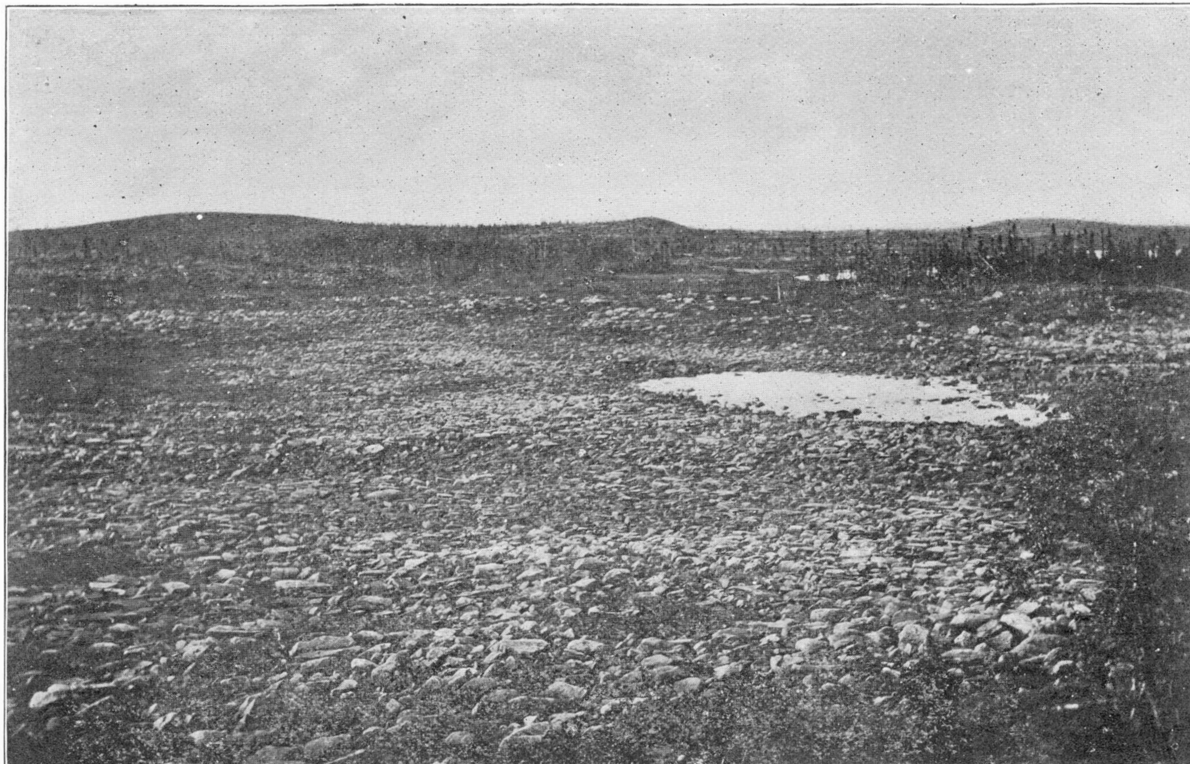
Roosevelt Hill.

ridge extending north-and-south, more rounded on its northern than on its southern side. From its summit an extensive view can be had of the surrounding country. Roosevelt Lake, dotted with thinly wooded islands, stretches out to the west, beyond which Kasba or White Partridge Lake can be seen as a shining white line in the distance, while in other directions lines of water may be seen to extend through the now almost treeless country.

Roosevelt Lake.

For about three miles the canoes crossed Roosevelt Lake, winding among its rough stony islands, which are wooded with small black spruce. The boulders of which they are composed are almost entirely of coarse red granite. At the bottom of a narrow bay a small brook flows among the stones into the lake, and to the east of it is a portage 400 yards long over rough boulders and boggy ground. At most of the portages on this route the landing places for the canoes are very bad, being on rough beaches of irregular angular boulders, which, when the wind is blowing and the water is at all rough, furnish very uncertain footing for the men, and may scratch or break the canoes.

Beyond a little lake a third of a mile long, a portage of 400 yards long leads over a stony hill. At the edge of the water is a low gently rounding outcrop of red biotite-granite. Its surface is usually rather rough, but some parts are smooth, and show on northerly slopes distinct glacial striæ and groovings trending S. 28° W. On smoothed points the surface is very much broken by minute cross fractures, which doubtless assist greatly in the rapid disintegration of the rock under the influence of the weather. A narrow lake extends for a mile and a quarter, and beyond it is a bad portage, 1000 yards long, over rough angular boulders among small black spruce. The two small lakes next on the route are separated by a rough stony ridge, over which is a portage 300 yards long, with a descent to the north of twenty-five feet. In the middle of the second lake is a little meadow, across which the loaded canoes were dragged by hand, while beyond it is a portage 1400 yards long. This portage is over rough hills of boulders, strewn and bristling with small dead spruce, the drop from its southern to its northern end being about forty feet. The boulders are chiefly of coarse red granite, but many, about a twentieth of all, are of Huronian (?) conglomerate or greenish-gray sandstone. Beyond this portage are three very small lakes separated by two portages respectively 160 and 180 yards in length, the first over a low sand-ridge and through a swamp, and the second over rounded boulders. Below these lakes is a portage 800 yards long, over rough hills and ridges of boulders, many of which are of greenish-gray quartzitic sandstone and conglom-



J. B. TYRRELL.—Photo. Aug. 3, 1894.

SHATTERED SURFACE OF GNEISS, THE MASSES BEING ESSENTIALLY IN PLACE.

Near the source of Thlewiaza River.

erate, in a matrix of sand and gravel. The lake at its western end has a considerable extent from north to south, but on the course followed, from east to west, it had a width of a mile, to where a brook flows westward from it down a swift rapid in a very stony channel. A portage 80 yards long was made over the stony flat on the north side of this brook. Below the portage is a small lake, a third of a mile long, from which flows a stream forty feet wide. We descended this stream for 200 yards, to the head of a portage on the north bank, below which the brook flows for a few yards to the brink of a long steep slope, down which it rushes over a bed of cobbles and boulders to the east shore of Kasba Lake, descending 110 feet in this the last mile of its course. Beside it are scarped banks of sand and coarse gravel. About half of the pebbles and boulders are of granite, while the other half are of coarse green conglomerate, sandstone, schist, etc. The portage, which is 1700 yards long, begins on the north bank of the river on a sandy terrace 120 feet above Kasba Lake, and follows the bank of the river for a short distance to a bend, where a fine view is had of the lake beneath. It then turns north-westward along an old gravel beach 140 feet above the lake, which it follows for several hundred yards, when it again turns and descends a long thinly wooded slope to a sandy bay on the lake shore. The lake was reached, in north latitude 60° 10′, on the evening of the 5th of August.

Portage to Kasba Lake.

Kasba Lake.

Kasba (White Partridge or Ptarmigan) Lake, the large reservoir near the source of Kazan River, lies at an approximate elevation of 1270 feet above sea-level, as determined by aneroid readings taken on the lake, compared with readings of a standard barometer at Churchill, and estimates of the rise and fall of the land on the route from Reindeer Lake. It has a length, in a north-northwesterly direction of about fifty miles, and a greatest width of about ten or fifteen miles. It is narrow in the middle, and along its sides are arranged a few stony islands, but otherwise the lake is an open stretch of water. The temperature of the water in the open lake on the 8th August was 46° F. It is said to receive several small tributary streams; among these are the Hasbala River on the south, up which is a canoe-route through Hasbala Lake, and then by a long chain of small lakes and portages to Sunshadow Lake, and thence to Cochrane River, a few miles below Wollaston Lake; Klokul River from the west, flowing from Klokul (or Fish-passing) Lake, and Thelwel or Snow-bird Lake, by which there is a canoe-route across to Daly Lake.

Extent and position.

Tributaries.

High granite hill. Old beaches.

South-east of the point where we reached the shore of the lake, a conspicuous rounded hill rises to a height of 430 feet above the level of the water. On its sides are two very distinct ancient gravel beaches, one 50 and the other 120 feet above the lake, while there is a third, but less distinct sandy beach, at a height of 200 above the lake. Up to this latter height the hill is largely covered with boulders and stratified sand, but here, on the north side, is an outcrop of granite. The surface inclines gently towards the north-northwest, and is scored by glacial markings trending S. 30° W. The hill, which raises its bald summit high above the surrounding country, is composed of a red moderately even-grained granite, consisting of orthoclase and quartz with a little biotite, cut by horizontal and vertical jointage planes. The surface, on the summit and northern slope, is well smoothed and often polished, but with the exception of those mentioned above, no striæ could be found. The south sides of the little rocky bosses are rough, and the south side of the hill is rugged and often precipitous. The summit and sides are strewn with boulders, chiefly of green conglomerate, quartzite, and other Huronian rocks.

Berries.

Cranberries, blueberries, crowberries and willow berries (*Vaccinium vitis Idæa* and *uliginosum*, *Empetrum nigrum* and *Arctostaphylos arctica*) were found in abundance. A magnificent view is had from the summit of this hill. To the south-east are many shining lakelets, and gentle green slopes thinly wooded with dark spruce. To the north and north-east long lanes of water run between the wooded ridges, while a high sandy terrace marks an old shore-line of the lake. To the west Kasba Lake extends as a beautiful sheet of open water to the blue hills on its further shore.

Survey of Kasba Lake.

The line of survey followed the eastern side of this lake, from the foot of the long portage to the point where the lake pours its waters down the Kazan River, a distance of thirty-four miles, measured from point to point. For twenty-nine miles, the course was north-northwestward along an irregular shore. In the bottom of its secluded bays are gently sloping sandy beaches, while its salient points and adjoining islands, are piled round with irregular walls of boulders, often from ten to fifteen feet high. Many of these boulders appear to be of Huronian schists, quartzites, etc. No rock was seen in place, but the boulders are mostly rough and angular, and in some of the islands, at least, appear to be very close to the parent rock. They are evidently thrown and beaten into their present positions by the broken ice in the early summer. Behind the beach the country is thinly wooded in its southern part, while farther north it rises gently in green grassy slopes to hills, some of which are several hundred feet in

No rock in place.

height. At the end of the above distance, and where the shore changes its direction towards the north-north-east, an esker crosses the country, forming a chain of sandy islands across the lake and rising in hills on its eastern side. These hills form a long ridge, or chain of narrow parallel ridges, some of which are 180 feet high, running N. 40° E. They are composed of sand and gravel, with narrow knife-edge crests, and sides as steep as the sand will stand. Their summits are almost bare, while on their sides and in the pit-like depressions between them, are some spruce and larch trees of moderate size.

In the bay at the head of the river, is a small island of bare rock, with a very irregular broken surface, composed of a white or light-gray rather coarse crystalline limestone, associated with large veins or masses of white quartz. This limestone is probably of Huronian age, being almost undoubtedly associated with the quartzite and green schists mentioned above. Crystalline limestone.

KAZAN RIVER.

Kazan River flows from Kasba Lake with a slight current, over a bed of boulders, and then, for three-quarters of a mile, rests in a quiet lakelet. Below this it forms up in a well-defined channel, which varies in width from 100 to 300 yards, and rushes down a series of swift crooked rapids. These continue for a mile and three-quarters, to the head of a cascade with a descent of fifteen feet. The cascade occurs over a morainic ridge of boulders, and the channel is deep and narrow at the top, but spreads out over the boulders at the bottom. Past this rapid the canoes and cargo were carried for 300 yards, on the north-west bank, over the top of a rough stony hill. Character.

Below the rapid, the river continues swift, in a shallow but well defined winding channel, with wooded banks of sand or boulders. No rock in place was seen. The surrounding country is moderately level, and declines in a long even slope north-eastward from the vicinity of Kasba Lake, which seems to be held up by an accumulation of morainic material. Towards the bottom of the slope, the river passes through a small lake about three miles long and a mile wide, into the south end of which Chawatili River is said to flow. The lake is surrounded by low hills and banks of sand. Two miles farther down the river, and about ten feet lower in altitude, is a rather larger body of water, called in the Chippewyan language Tabané Lake, with very irregular shores, low wooded points and islands, and a high wooded ridge, perhaps of a morainic character, along its eastern shore. The northern outlet of this lake was found to be in latitude 60° 39′ 07″. Moraine. Tabané Lake.

For three miles farther the river continues as a very rapid stream between steep stony banks, until the bottom of the slope is reached at the south end of the long narrow arm of Ennadai Lake. The descent from Kasba Lake, a distance of sixteen miles in a straight line, is about 170 feet.

Ennadai Lake.

Position and extent.

Ennadai Lake is a long narrow sheet of clear water, lying in a north-easterly and south-westerly direction, and at an elevation of about 1100 feet above sea-level. Its greatest length in a straight line from end to end is fifty miles, and its greatest breadth seven or eight miles. At its southern arm, near where the river enters it, a low ridge of boulders runs along its eastern shore, while an even sandy esker, a hundred feet in height, forms its western shore. This esker runs out into the lake in a long bare sandy point, about four miles from the mouth of the river, beyond which are some sandy islands in the same line. A mile south of the point is a sandy bay where the Chippewyans come in the autumn to spear the caribou as they cross this narrow part of the lake. To the west of the bay, the esker, which is here lumpy and rather irregular, rises to a height of from 200 to 300 feet. It is composed of white silt, sand and rounded pebbles, many of the latter being of green Huronian schist or red quartz-porphyry and red Athabasca sandstone. The lower and more sandy hills are thinly wooded with larger white spruce, and some small canoe-birch. The view from the top of these hills shows the open lake, almost without islands, stretching away to the north-east, while all around are gently sloping, thinly wooded hills.

High esker.

From the sandy point the lake runs E. N. E., with moderately even shores, behind which are low gently sloping green hills of sand or till. At the south end the hills are usually wooded, but within a few miles the forest disappears, or becomes confined to the ravines, and the hill-sides are grassy or bare. The islands near the south-east shore of the lake, up to the first narrows, are low bare piles of boulders or drumlinoid ridges of till surrounded by walls of boulders. Many of the boulders are quite angular, and have evidently been derived from the immediate vicinity. The first island, two miles and a half from the point, is composed of large masses of dark green Huronian schist, almost in place; while the boulders around others are of granite, green schist, coarse gray diorite, and white crystalline dolomitic limestone. North of the first narrows are several small islands, along the shore of the largest of which, cliffs of peat rise from the water's edge. North of this large island the lake opens out to its greatest width, and some

Forest disappears

Cliffs of peat.

high hills rise both on its eastern and on its northern shores. A prominent point on its north-western side is composed of till and angular masses of light-green diabase.

At the north side of this expansion of the lake, on a little peninsula on the west shore, is an exposure of a green chloritic schist, striking N. 35° E., and dipping N. 55° W., at an angle of 80°, cut by some irregular veins of opaque white quartz. It was also seen from the canoe to be cut by a wide dyke of green trap, having a north-westerly trend. The surface is well rounded and smoothed, but no striæ or grooves could be detected, although the northern sides are the smooth and gently sloping ones, while the southern sides are steeper and more irregular. With the exception of the small island of crystalline limestone near the outlet of Kasba Lake, this is the only exposure of the underlying rock seen along the canoe-route after leaving the hill near the south end of that lake. The depressions, now filled by at least portions of both these lakes, appear to be along bands of Huronian schists, which have been more easily eroded than the surrounding granites, or than the Huronian conglomerates and quartzites, boulders of which are so numerous near the north end of Kasba Lake, and which may compose some of the hills on the east side of that lake. A short distance north of this outcrop of chloritic schist, the lake becomes very narrow, contracting to about three-quarters of a mile, while high barren hills of till and boulders rise on each side. Farther north, on the east side, the shore is composed of a ridge of green Huronian schist striking N.N.E., and dipping W.N.W., at an angle of 60°, a mile north of which is a prominent hill, 200 feet high, of bright red granite, similar to that on Kasba Lake. Two miles farther north, the party was detained in camp from the 11th till the 14th of August by a heavy storm with rain and snow. The camp was pitched on a sloping hillside, where a little rill, trickling through the stones, nourishes on the wet ground a small grove of dwarf black spruce and larch. The surrounding country is quite barren. The beach is a wall of heavy boulders, while behind the camp a hill rises 280 feet above the lake. This hill is composed of red granite, which in places shows traces of gneissic structure, striking northward and dipping westward at a high angle. Its summit is well smoothed and polished, and in places shows distinct glacial groovings trending S. 40° W. Here the first ptarmigan and the first arctic hares of the season were seen. An observation made the magnetic variation 26° east.

Chloritic schist.

Hill of schist and granite.

Three miles to the north-west, on the opposite side of the lake, a low ridge of gray gneiss crops out through the surrounding prairie, striking N. 20° E., and dipping N. 70° W., at an angle of 55°, associated with which is a band of dark fine-grained mica-schist, with the same dip and strike.

Barren-ground caribou.

Here, on August 14th, 1894, the barren-ground caribou (*Rangifer Groenlandicus*) were met for the first time that year, as they returned southward on their annual migration, and a day was occupied in shooting them and slightly drying some of their meat.

In this vicinity also, signs of old Eskimo encampments were first found.

Toward the north end of the lake, sandy ridges rise behind the east shore, one at least of which is thinly wooded with white spruce, while on the west side of the lake is a rolling grassy meadow sprinkled with boulders. At the end of the lake are low, irregular and probably morainic hills of boulders.

Kazan River below Ennadai Lake.

Rapid stream.

Below Ennadai Lake, the Kazan River for two miles forms a heavy rapid, over a bed of boulders, along the east side of a rather high stony hill. Then turning sharply east-northeastward it continues to flow with a rapid broken current in a winding channel, over a bed of boulders. The surrounding country is low and gently undulating, composed of gravelly till and boulders, occasionally rising in little drumlins. It is moderately well grassed, with a few groves of larch of fair size on the sides of the low ridges. At the foot of this swift water is a heavily marked path, indicating a favourite crossing-place of the caribou.

Rocky hill.

A mile and a half south-southeast of this crossing-place, is a conspicuous rocky hill 150 feet high. On its western side it is seen in many places to be composed of a medium-grained red granite-gneiss, often well foliated in curving wavy lines striking west. The summit is generally covered with boulders, pebbles and glacial débris, but the gneiss projects in places, showing polished surfaces with distinct striæ trending S. 50° W. On the southern sides of some of the knolls on the crest of the hill, on lee surfaces and in grooves all down its western slope, are many evidences of another earlier glaciation which has left the rock, in these protected places, polished, grooved and striated. The direction towards which this glacier moved was S. 65° E. That the glacier moved in this and not in the opposite direction is clearly shown by the following circumstances:—(1) The western side of the hill itself rises in a rounded slope composed of smooth, and generally bare, well glaciated rock, while its eastern side is somewhat more abrupt and is covered with boulders and loose masses of rock, no

Cross striæ.

Evidence for direction of motion of glacier.

rock in place having been observed. (2) Salient points and angles facing westward are rubbed smooth. (3) Vertical surfaces facing south-westward, or those vertical surfaces which have been protected from the later glaciation from the north-east and are nearly parallel to and slightly facing the direction from which the first glacier came, are well polished and striated, while other vertical surfaces are not. (4) Little pits in similarly protected parts of the rock are smooth on their eastern and rough on their western sides. (5) Similarly protected salient points and angles facing eastward are not smoothed or polished. (6) The rock faces below these salient angles are also rough and unglaciated.

There is here, therefore, evidence of the existence of a névé-ground to the west of the Kazan River, at a date previous to that of the latest glaciation from the north-east.

For two miles below this crossing-place, the river flows with a swift current towards a small lake a mile and a quarter wide, which has low sandy shores, that to the east being thinly wooded with larch. Below this lakelet the river turns sharply eastward and flows for two miles and a half with a swift current between banks of boulders. To the north-west is a low wet country, moderately thickly wooded with small black spruce and larch. This is the last wooded area of any considerable extent seen while travelling down the Kazan River, though, as will be recorded later on, small patches of wood occur in favourable spots, under the shelter of the hills, all the way to Yath-kyed Lake.

Last considerable wooded area.

The small shallow lake entered below the woods, stretches south-eastward to the foot of a hill of gray gneiss, the north-western side of which is of smoothly rounded rock. Below this lake the party followed the rapid river, as it wound through an open unwooded country of low bouldery hills, among and through which the channel often scatters and becomes very ill-defined. Caribou were constantly seen roaming over the country in larger or smaller bands, and they often swam across the stream in front of the canoes.

At a bend in the river, north of a third small lake, is a conspicuous high sandy ridge, evidently of the character of a kame or esker, but the need of hurrying on prevented the closer examination of this as well as of many other natural features.

Esker.

From the bend two miles below Ennadai Lake, the river flows eastward, with an almost continuous rapid current in a shallow channel over a bed of pebbles and boulders, descending about 200 feet in a distance of seventeen miles measured in a straight line. The rocky floor underlying this slope would seem to be much more irregular than that of the similar slope below Kasba Lake, but the surface is, like it, composed of till and morainic detritus.

A short distance below Sandy Hill Lake, the river bends sharply to the north, and continues very rapid for two miles, when it gradually widens, and the current slackens, until, at some sandy ridges, it opens into the south end of a narrow lake, along each side of which is a stony ridge. About the middle of the east shore of the lake several families of Eskimos were encamped on the stony beach. These camps, inhabited by family groups, appear to be more or less permanently situated at spots resorted to by the caribou in crossing the river. These animals are here speared in great numbers, some being eaten immediately, while the carcasses of the others are piled in heaps and covered with large stones for winter use. This camp might be called Kopanuak, from the name of its chief man.

Camp of Eskimos.

The water discharges on the east side of this lake in a swift rapid down a rocky cascade, past which the canoes were carried for two hundred yards on the north bank, over bare rock. This rock is a well foliated gray biotite-gneiss, striking N. 30° W., and with a vertical dip. Below the portage is a small lake which the party crossed in the drizzling rain, and then they descended the rapid stream, which had low stony banks, to the tent of a little old bald Eskimo named Hikuatuak, at the south end of another lake. This lake is a long irregular sheet of clear water, with low grassy shores which run into gently sloping hills, or extend in wide sandy and grassy plains. The hills are strewn with boulders, but the general appearance of the whole country is that of a level prairie, with a few elongated hills rising above its otherwise even surface. Two or three outcrops of gray gneiss were observed along its western shore, one of these being at a narrows close to the camp of Kei-ū-tēto. Attūterly's camp was passed without being visited, as it was situated at some distance off the direct route, in a bay on the left, into the bottom of which a small stream was said to flow. A few trees were seen on the hillside beyond this bay, and we stopped to eat beside some small black spruce scrub at the north end of the lake, where a little wood could be obtained to make a fire.

Hikuatuak.

From the north end of this lake, the river flows N. E. by E. for five miles in a very direct course, with a swift current, between low banks of boulders, to the south end of a lake where three Eskimo families occupied two large deer-skin tents. Hallo was the name of the chief man in this camp, and the other two men were Ahyout and Kak-kuk, father and son. The latter were induced to accompany the party as guides, and their services proved invaluable, not only in leading the

Guides ecured.

way through the intricate lakes and down the many difficult rapids, but also in obtaining a plentiful supply of caribou meat.

From Hallo's camp a long narrow sheet of water extends northward for thirteen miles and a half, broken in the middle by a light rapid, half a mile above which Annūki had a camp of two tents on the east shore. The lake has low shores, its southern expansion being generally sandy on the east, and covered with boulders on the west side. At Annūki's camp there is a stony hill on the east side, with a clump of small black spruce scrub behind it, while across the strait is a low sandy hill, breaking down in steep cut-banks on the shore. West of the northern expansion of the lake rises a high sandy ridge trending southward. Beyond the lake the river continues northward for a couple of miles, and then, doubling round the end of the sandy ridge, it flows with a constant rapid current over a bed of pebbles and boulders until it strikes against the foot of another long straight sand and gravel ridge trending N. 15° W., not improbably in the direction of the earlier of the two glaciations previously mentioned, although no glacial striæ had now been observed for a long distance. On the low banks of the rapid river are a few scattered groves of small larch and black spruce bushes. On the outer side of this abrupt bend, at the foot of the gravel ridge, the gravel and boulders are piled in a high even wall by the river ice, while on the inner side is a gently sloping boulder-pavement. Some of these boulders are of red Athabasca sandstone, conglomerate, quartz-porphyry, etc., the same as the rocks found north of Doobaunt Lake.

High gravel ridge.

Boulders of Athabasca sandstone, etc.

The swift stream flows along the foot of the ridge for a short distance, and then swings towards the north-east, past a hill of coarse dark-gray biotite-gneiss, striking N. 35° E., and with vertical dip, to the southern end of a narrow lake near which Ūliū had pitched his camp. Here, as at the other camps, many deer had been slaughtered, and their skinned carcasses had been covered with heaps of stones, on the tops of which were fixed several pairs of long branching antlers, to assist in finding the heaps when the ground is covered with snow in the winter. The surrounding country is low and wet, with low parallel drumlins of boulders rising here and there, all lying with their long axes S. 25° W.

Caches of deer for winter use.

The next lake is very similar to the last, being a long narrow sheet of clear water, lying in a low grassy country underlain by glacial deposits. At its north end, Nūyellik is the chief man in a camp of three tents. The river flows out of the north-eastern end of the lake, and is a swift winding stream between low banks, all along the edges of which bosses of gray gneiss crop out. At one place the rocky points, approaching one another from each side, form a very swift deep rapid.

Gray diorite. Five miles below the lake, as the crow flies, and opposite the camp of Eiyégiak, is a rounded boss of coarse gray diorite. The surface is clearly striated near the water's edge, the striæ running S. 80° E.

A mile and a half below Eiyégiak's camp is a small lake with low shores underlain by gneiss. In a bay on its northern shore were several Eskimo tents.

The river, which had been flowing in a general direction almost due north for about sixty miles, now turns eastward and runs out of the east side of this lake. For seven miles it occupies the bottom of a channel 200 to 120 yards wide, and from twenty to forty feet deep. The current is at first light, but increases to four miles an hour. The banks descend with very steep slopes to the edge of the water, and are composed of rock and till. At the foot of this channel, where it opens out into a lake, a high, and probably rocky ridge rises from the eastern bank, the surface of which is covered with grass, and on its sides were perched hundreds of gulls. Opposite the ridge is a low rocky point of very coarse pegmatitic hornblende-granite. Its surface near the water's edge is strongly glaciated. The first glaciation, seen on the surfaces sheltered by higher points, is S. 75° W. The last glaciation, trending N. 5° E., seems to have been light, for it is to be seen on southern slopes only. It not improbably indicates a local glacier flowing down this river-valley.

Angikuni Lake.

Below this rocky ridge, where an Eskimo grave was conspicuously marked by some tall upright pieces of wood, the river enters the upper extension of a large lake, called by the Eskimos, Angikūni Kamanyie, or Great Lake, doubtless the Titmeg Lake of Samuel Hearne. Many

Many Eskimos.

Eskimos were camped in the vicinity, and at one time our two Peterboro' canoes were surrounded by twenty-three Eskimo kyacks. For three miles and a half our course was along the western shore of the lake, which was generally low and strewn with boulders. Beyond the eastern shore some high ridges were seen in the distance. Our canoes then passed through a shallow strait, the principal channel being doubtless further east, crossed open water, past a small island of green and red hornblendic gneiss, to a rocky strait, on the south side of which

Hills of gneiss.

was Enetah's camp, situated on the slope of some hills of well foliated red gneiss striking N. 25° E., and dipping N. 65° W., at an angle of 40°. The surface here is generally polished and shows well marked glacial grooves trending out into the lake, S. 57° E., the direction of motion of the glacier being clearly indicated by the rounded and polished north-western surfaces, and the curved transverse fractures in the grooves, all opening towards the south-east.

The party was here delayed half a day by adverse wind, during which time it was visited by an Eskimo trader, named Anŭleah, who makes an annual trip to the trading store at the north end of Reindeer Lake, taking out the few furs collected by his neighbours, and bringing back tobacco, ammunition, needles, &c. He was greatly surprised to find that these white men were not traders, and would not even accept from him the skins of foxes or wolves, but to him, as to all the other natives who were met, small presents were given in token of friendship. He agreed to carry a letter to the trading store, and the letter reached Ottawa *viâ* Cumberland and Winnipeg, in safety, on March 5th, 1895. An Eskimo trader.

Seven miles east of Enetah's camp, along a low shore strewn with boulders or angular fragments of gneiss, the party was detained for the greater part of three days on a large island off the south side of the lake, under the shelter of a hill of medium-grained reddish-gray biotite-gneiss. Observations showed this camp to be in latitude 62° 14′ 9″, and the variation of the needle to be 24° 30′ east. Delayed by a storm.

The time was chiefly spent in obtaining a vocabulary of the language of this inland tribe of Eskimos from our two Eskimo guides, who were both men of a high grade of intelligence. Eskimo vocabulary.

The lake stretches away beyond the limit of vision towards the south-east. After leaving the island our canoe-route continued a little south of east, keeping among islands outside of the long points which project from the northern shore. Most of the islands show rocky exposures at the water's edge, above which is a covering of glacial detritus. The points first passed were of gray gneiss, while a small island seemed to be of highly ferruginous schist much reddened by oxidation, but as the island appeared to be sacred to the Eskimos, it was impossible to land on it and retain their friendship. A small island, off a point six miles from the storm camp, was found to be composed of dark medium-grained diabase, containing much pyrite, cut by many veins of white quartz. In the vicinity is a fine-grained dark mica-schist, through which the diabase is probably intruded. Sacred island. Diabase.

Three miles further on is a small island of dark-green almost massive chloritic schist, sloping gently on its western side and dropping more abruptly towards the east. The glacial markings are here very beautifully shown. The rock is strongly scored, but it does not appear

Three sets of glacial striæ.

to have been much rubbed down, for three distinct striations can be clearly seen in this one little rocky island. The last, on the eastern surfaces, and over all the others, but not running down north-western slopes, trends N. 30° W. The next earlier one, also shown by polished surfaces deeply grooved and scratched, trends S. 50° W. A still earlier one, seen on south-western slopes protected from the other two, trends S. 5° E.

Four sets of striæ.

The same three sets of striæ are also beautifully exhibited on a rocky point half a mile to the north-east, while half a mile still further eastward is another small bare island of gneiss and diabase, which not only shows the three sets of striæ mentioned above but a still earlier and very strong set trending S. 85° E. The country rock is here the coarse gray gneiss, which strikes S. 75° E. and dips S. 15° W. at an angle of 70°. It is cut from north to south by a mass or dyke of the dark-green diabase.

A little less than three miles further east, where camp was made for the night on the rocky point of a grassy island, a medium-grained gray biotite-granite crops out at the water's edge. On its western slopes are strongly marked glacial grooves and striæ directed S. 80° E.

Trap dykes.

Six miles and a half beyond this camp, the river flows out of a deep bay at the north-eastern extremity of the lake. On the south side, where the current is first felt, there is a bare rocky point composed of fine-grained green chloritic schist, striking N. 55° E., and with vertical dip. It is cut, almost along the strike, by a narrow dyke of dark-green diabase, and also by a dyke of red augite-porphyrite. Under the microscope this latter rock is seen to consist of a micro-crystalline groundmass, abundantly stained with brown iron oxide, and showing beautiful flow structure, containing phenocrysts of plagioclase, augite, biotite, sphene and apatite. The plagioclase is in irregular individuals much smaller than the phenocrysts of augite and biotite; the augite is greatly altered to calcite and chlorite; the biotite, in distinct crystals imbedded in the augite, has undergone considerable leaching, and on account of the removal of a large part of the iron, shows brilliant chromatic polarization; sphene in irregular brownish masses and strings in the biotite; the apatite is in large beautifully sharp, doubly terminated crystals. The relative ages of the two dykes could not definitely be determined. Through the schist are also some irregular veins of white quartz.

The full size of Angikūni Lake is as yet unknown, but it evidently extends a long distance towards the south-east, and is broken by many projecting points, and long islands. The beach is generally of sub-angular boulders, while the surrounding country is a rolling grassy prairie underlain by stony till. A few small willows, and a very few stunted black spruce a foot or two in height, at the storm camp, comprise all the wood that was seen growing on its shores, and with the exception of one or two small groves, the country below it is treeless. Its elevation is about 800 feet above the sea.

River below Angikūni Lake.

Where the river leaves the lake, it first spreads out over a wide bed of boulders, becoming very shallow, and then contracts to seventy yards in width, and rushes as a deep rapid and almost straight stream, between banks which rise in gentle slopes from the edge of the water. These slopes were covered with grass and low willows. Many caribou were lazily lying down or feeding among the bushes, and turning their heads, they looked in quiet wonder at the strange apparition of the two canoes that had penetrated to the centre of their northern home. The whole landscape, seen in the early morning light, presented such a picture of wild, but quiet beauty, as I have seldom had the good fortune to enjoy.

Beautiful landscape.

From the outlet of Angikūni Lake, the river flows eastward for forty-four miles, measured in a straight line, with a constantly varying current, at times rushing headlong down a narrow channel, and at times spreading out over a wide bed of boulders, packed by the ice into as even a pavement as the size and shape of the boulders admits of. In two places the river expands into small lakes.

For nine miles, to the first lake, low exposures of green chloritic schists outcrop here and there along the bank. On this reach of rapid river, Elrayuk and family have a camp of two tents containing twelve or fourteen persons.

Chloritic schist.

The lakelet is three miles and a half long, and below it the river continues its headlong course between banks and ridges of boulders, passing to the north of an Eskimo camp of three tents containing about twenty persons, where Ungalluk is the chief man. From these Eskimos we obtained in exchange for needles, thimbles, etc., a supply of deer-skin clothing to protect the men of the party against the severities of the rapidly approaching winter, and also a considerable quantity of deer tallow and dried deer meat.

Ungalluk.

Subsequent to our visit on the 25th August, a party of Chippewyan Indians who trade at Churchill came as far north as Ungalluk's camp in their search for deer, and reported the fact to us on their arrival at Churchill in November. This appears to be as far north as the Chippewyans range at the present day.

Below the camp of Ungalluk, the river flows with an easy current to a small lake, on the north-east side of which is a straight rocky ridge apparently composed of light-gray gneiss. A short distance below the lake the river falls twenty feet over a ridge of reddish-gray gneiss, and then flows with a rapid current to a second fall, below which is a heavy cascade through a narrow rocky gap, where the river enters a gorge sixty feet deep, that being the total descent from the head of the upper fall—a distance of a mile and a half. These obstructions are passed by two portages, both on the south side, over grassy and mossy ground sprinkled with willows, the upper one being 250 yards long and the second one three-quarters of a mile. The rock, as examined closely at the lowest cascade, is a red and gray well foliated gneiss, striking S. 75° W. and dipping N. 15° W. at an angle of 40°. It is cut by a dyke of dark-green coarse-grained diorite, striking N. 60° W. straight up the river. Its surface is strongly marked by glacial grooves and striæ running S. 25° E. Many of the boulders lying about are of green trap and red Athabasca sandstone and conglomerate.

Gray gneiss.

Pasamut.

Four miles down the rapid stream, between bare stony hills, Pasamut is the chief man in an Eskimo camp of seven large tents and about fifty-five people. The camp was situated on a very pretty grassy terrace on the south side of the rapid stream, and at the time was well stocked with fresh fish and partly dried meat. On our arrival Pasamut gave us the very discouraging information that the river which we were descending flows into Chesterfield Inlet not far from the mouth of the Doobaunt River, but afterwards he said that it might be possible for us to leave this river below Hicoliguah Lake and, carrying our canoes over a long portage, to reach the head of another river that discharges into Hudson Bay opposite the Walrus or Seahorse Islands. It was decided to attempt this latter route.

Rocky portage.

Below Pasamut's camp, the river has a general width of about 250 yards, and the channel is often obstructed by boulders or large masses of rock. The banks are composed of red till and rounded pebbles and boulders, with occasional bosses of green schist or diabase and gray gneiss. Many of the boulders are of coarse or fine red sandstone, red quartz-porphyry and green diabase. The surrounding country is in general a plain of red till with pebbles but without many boulders.

For thirteen miles the river is one almost continuous heavy rapid, at the end of which distance is a portage, half a mile long, on the south bank, past heavy broken water, where the river drops in a series of cascades over rocky ledges, descending about twenty feet. The portage is a rough one over boulders and smoothly rounded bosses of rock, which are evidently covered by the high water of the early summer. The rock is a well-foliated highly garnetiferious biotite-gneiss, striking N. 35° E., and dipping S. 55° E <50°, cut by a number of dykes of green diabase running S. 70° E. The lower end of this portage was found to be in north latitude 62° 15′ 23″.

Below this rocky portage the river flows rapidly eastward for five miles, breaking into two channels around a high oblong grassy hill, and uniting again just above four Eskimo tents which were pitched among the boulders on its right bank. Aūnah, a venerable old Eskimo, with long white locks, and his old blind, white-haired wife, Otūēlik, were the heads of this family group, which seemed to consist of about twenty-seven persons all told. Aūnah

To Aūnah's camp, the river had kept a general course almost due eastward for eighty-four miles, measured in a straight line, from the outlet of the small lake above Angikūni Lake, but it now turned abruptly and flowed almost due northward for thirty miles, measured in a straight line, till it emptied into the western angle of Yath-kyed or Hicoliguah Lake.

Below the bend, the river continues for ten miles to flow over a bed and between banks of boulders, with a general strong current. On each side are gently sloping hillsides, in one place dotted with small black spruce bushes, the largest seen since leaving Angikūni Lake. Here is also a low exposure of well foliated red and green gneiss, striking N. 5° E. The surface is plainly scored by glacial markings running S. 25° E.

At the end of this ten-mile reach, the river opens into a small lake two miles long, with sandy shores rising in low but regular terraces. These terraces, the highest of which is about 500 above sea-level, would appear to correspond to the highest sandy shore-lines on the Doobaunt River below Doobaunt Lake, giving a measure of the depression of the land in post-glacial times, or marking the distance inland reached by the sea in those times. Marine terraces.

On the west shore of this lakelet, in a sandy valley, is a grove of larch and scrubby black spruce—the only grove of the first named tree seen on the river between Angikūni aud Hicoliguah lakes. The surrounding country is a series of low rocky ridges, with grassy sides, separated by moderately level plains underlain by reddish till with pebbles and a few boulders. Last grove of timber.

At the outlet of the lake is a heavy rapid, where the water falls ten feet over a ridge of gray gneiss, cut by a dyke of green diabase 100 feet wide. The canoes were carried past this fall on a portage 140 yards long, over the slippery rock on the west bank.

For five miles and a half below the portage, the river flows with a moderate current in a channel which swings round towards the west, until it rushes with a very strong current between rocky islands, and then in a low fall over a rocky ledge. This the canoes were able to run, down a very narrow channel close to the west bank.

Sandy banks.

Below the rocky islands the river widens and becomes less rapid, flowing between sandy banks, and over an almost level sandy bed, with here and there bars or low islands. The sandy soil of the surrounding country is warmer than the till, and produces a stronger growth of grass, dwarf birch and willow, and the country had the appearance of a fertile rolling prairie. Many caribou were feeding among the brush on the rich brown hillsides.

Palelluah.

Ten miles below the islands is a place called by the Eskimos Palelluah, where the river is deep and narrow, and the caribou, in their migrations, regularly swim across the stream. It is probable that this is where Samuel Hearne crossed the Kazan River above Yath-kyed Lake in 1770 at a point called by him Cathawhachaga, and which he describes as a celebrated deer crossing place. He, however, places it in latitude 63° 4′, or 28′ north of Palelluah and 25′ north of where the river discharges into Yath-kyed Lake, although he states that he made several observations for the latitude.

Deep river.

Below Palelluah the river is deep, with a slackening current, and the banks, instead of being sandy slopes, are rugged walls of angular boulders. The general surface is composed of rocky ridges, while some high hills, not improbably also of rock, rise on the east side of the river. The rock on the west bank is a light-gray gneiss, rather indistinctly foliated, striking N. 35° E. and dipping S. 55° E. $< 65°$. On the very summits of most of the smooth glaciated undecayed knobs of rock, angular blocks often rise several feet, having been thrust up along jointage planes by the freezing of water under them and afterwards supported by smaller fragments of rock falling under and around them.

The surface of the knolls is striated N. 35° W., or in an almost directly opposite direction to that last seen on the river, and no signs of any other glaciation could be distinguished.

The willows and dwarf birch had now become very stunted, and *Cassiope tetragona* was seen for the first time on this river.

Hicoliguah or Yath-kyed Lake.

Kazan River gradually widens to a bell-shaped mouth, without any trace of a delta deposit, where it flows into this lake. The lake itself is an extensive body of clear water, which had a temperature of 46° Fahr. on the 31st of August. It extends as an almost open sheet of water, away to the south-east farther than could be seen from any of the points or islands on which we landed. A large high rounded island lies across the centre. The immediate shores are generally low, rising in green sandy slopes without boulders. Across the bottoms of the bays indenting the north-west shore, is a high conspicuous ridge of hills, while similar hills were seen in the distance along the north and south shores. The beach consists for the most part of a wall of irregular boulders. The north-east shore, as followed between points and islands, is twenty-nine miles in length from the mouth of the inflowing river to the head of the outflowing one. The principal underlying rock seemed to be a gray Laurentian gneiss. Character and extent.

A small island in latitude 62° 43′ 30″, six miles off the mouth of the river, is of this gray gneiss, cut by a dyke of dark-green diabase. Its surface shows strongly marked glacial grooves and striæ, made by a glacier that moved N. 35° W., the direction of motion being clearly shown by numerous crescentic cross fractures opening north-westward. Island of gneiss.

Seven miles farther north, a hard massive coarse-grained gray diorite outcrops on a point on the north-western shore. The rock has a rounded surface which is smooth and fresh, and shows two very distinct sets of glacial striæ, the first running S. 60° E., and a later one N. 30° W. The next point, nearly five miles distant, is composed of gray gneiss, lightly foliated N. 35° E., cut by many wide veins of coarse red granite. The point is strongly scored by the last glaciation, here trending N. 33° W. Gray diorite.

Into the bottom of the deep bay, north of this point, Nūtarawit River is said to empty. This is a small rapid stream flowing from Nūtarawit or Dead-child Lake, which lies a short distance towards the north-west. Nūtarawit River.

The next point, nearly six miles distant, where camp was pitched on the night of the 31st of August, is an outcrop of greenish-gray, irregularly foliated gneiss, striking N. 75° E., cut by a dyke of fine-grained, dark-green diabase. Its smooth fresh surface is generally covered with glacial markings. Those on the western slopes run S. 60° E., while those on the summit and eastern slopes run N. 35° W. The rest of the shore was low and faced with a wall of boulders.

Portage.

To avoid travelling around a very long point of land, the Eskimos paddle down to the bottom of a shallow bay at the north end of the lake, and then carry their canoes for 400 yards across a narrow neck of land and launch them again in the river. The portage is across a low wet grassy flat underlain by till, with very shallow water at both ends. The water reached in the river is very slightly below that in the lake, so that there are evidently no rapids in the river above this point.

River below Yath-kyed Lake.

Below the portage, the canoes descended half a mile of swift current, and crossed a small lake with low green shores for four miles to a point of coarse gray gneiss, the surface of which is striated S. 55° E. The river flows out of this little lake in a swift and narrow, but deep, rapid, over a ridge of gneiss, and then expands for a short distance between pleasant sandy beaches. For a mile the stream runs smoothly, and then breaks into a boisterous rapid over boulders and irregular ridges of gneiss. The upper portion of this rapid was descended with a line, after which the canoes were carried for 150 yards over a pavement of huge boulders on the west bank.

Deep rapid.

For the next three miles the river continues its rapid course northward down a gently and evenly declining valley. The bed of the stream is of rounded boulders, over which the swift and clear water seemed dangerously shallow. Pitched on the right bank a small deerskin tent sheltered an Eskimo family of three persons. A mile down the stream precipitous naked cliffs of red till overlook the water on the outer side of a bend. This till, like much of that seen on the river since leaving Augikūni Lake, seems to be composed to a considerable extent of débris of the red rocks of the Athabasca series, brought there by the south-eastward glaciation.

Bed of boulders.

The river opens into a small oval lake two miles in length, and then suddenly contracts and rushes with a current of five miles an hour down a shallow stony channel 150 to 200 yards wide, with boulders piled in massive walls on each side, through which low outcrops of gneiss project here and there.

Eskimo camp.

About two miles and a half below the lake several families of Eskimos were camped on the east bank, and here it was learned positively that this river flows into Chesterfield Inlet, that there is a high fall not far above its mouth, and that there were three more camps of Eskimos on its banks. The two Eskimo guides now positively asserted that the only possible route to the sea was by continuing down the river. Afterwards, however, they acknowledged that there was another, but much more difficult route, over a chain of portages, to the head-waters of a stream flowing through Kaminuriak Lake. Six additional Eskimos were employed here to assist in carrying the canoes over these portages, the agreement with them being that they should supply their own provisions, that they would be furnished with sufficient tobacco for a smoke at night, and when the portages were passed that they would each receive a box of a hundred gun caps and a twelfth of a pound of tobacco. On the fifth day, when the portages were passed, they were delighted to receive in addition half a plug of tobacco, two sewing needles and a thimble full of beads. One of the men, who knew the way, also consented to accompany the party to the mouth of the river on the shore of Hudson Bay.

Alternative route.

On the morning of September 1st, after the above arrangements had been completed, the party left the Eskimo camp and descended the rapid stony river to a little bay of quiet water on the right, where the canoes were unloaded and carried up the low stony bank to a wet grassy meadow.

Kazan River left.

We were now in latitude 63° 8′—the most northerly point reached. The Kazan River had been followed for 400 miles in its rapid course towards Chesterfield Inlet, and although a portion of that stream still remains untravelled, sketches of it were obtained from the Eskimos, and from these its course has been indicated on the accompanying map. Sketches of the adjoining lakes and streams were also obtained from time to time whenever their positions could best be pointed out or located, and these are shown in broken lines on the map.

The Twelve Portages.

From the bank, where the canoes were carried ashore, the bearing for two miles back up the river was S. 63° W., while down a straight reach of river for several miles it was N. 10° E. The canoes were now carried for 2000 yards in a direction S. 67° E. over level wet ground underlain by a gravelly till, directly towards the foot of a rather high grassy ridge, to a small shallow lake. The day was bright and clear, and a good meridian observation of the sun gave the latitude of the point reached near the north end of this lake as 63° 7′ 51″, while the magnetic variation at the south end of the lake was found by solar compass to be 20° 45″ E. These observations proved very opportune, since for the next twenty-three days the weather was continually stormy or overcast.

First portage.

Observation for latitude.

The shallow lakelet, which is a little more than a mile in length in a direction S. 30° E., is discharged northward into the Kazan River by a small brook. The brook which flows into it was ascended for 200 yards. Another portage 600 yards long, over flat land covered with willows, leads to a pond a quarter of a mile across, above which another similar pond, with grassy banks, is reached by a portage 190 yards in length. A fourth portage, 1300 yards long, over very wet sedgy land, by the edge of the little stony brook, brought the canoes to a point on its bank above which it was navigable for half a mile. The fifth portage, 600 yards long, was over a wet plain overgrown with small dwarf birch *(Betula glandulosa)* to a shallow pond 200 yards across. The sixth portage, over which everything was carried through a drizzling rain, is 2000 yards in length. It crosses the same wet dreary plain, keeping a little way to the north-east of the brook, and at its south-eastern end reaches a narrow lake with low grassy shores. This lake, a mile and three-quarters in length, is very shallow, and its muddy banks are thickly strewn with boulders, among which the canoes must be hauled carefully by hand. The seventh portage is 150 yards long, between two lakes, over a low ridge covered with dwarf birch, and above it the canoes were pushed or paddled for half a mile across a very shallow muddy pond. The eighth portage is 1300 yards long, at first south of a very shallow arm of the pond, then across the brook, here ten yards wide, where some low bosses of gneiss project above the surface, and then over wet flat land along the north-east side of the brook, to another very shallow pond 400 yards wide. Beyond this the ninth portage, 300 yards long, leads across the same desolate plain to a shallow lake lying at the head of the brook flowing towards the north-west side of Kazan River. The tenth portage is 4400 yards long, over level wet grassy land and past a rocky knoll of dark hornblende-gneiss striking S. 60° W. and dipping S. 30° E. $<70°$. The portage is across the local watershed, dividing the waters flowing towards Chesterfield Inlet, and those flowing directly towards Hudson Bay; it crosses a very small brook flowing eastward, passes to the south of a pond and ends on the boulder-beach of a narrow lake. This lake is two miles long and very shallow, so that in some places it was necessary to wade beside the canoes. A little rill, overhung with willows, flows from its south-eastern end, running noisily between banks of sub-angular boulders. The eleventh portage is 1400 yards long in an east-south-easterly direction, to a shallow muddy pond a third of a mile across, on the eastern side of which is a clump of willows four feet high. The twelfth portage is 800 yards long, and leads from this pond down a very gentle slope with a drop of twenty-five feet, through a

Second portage, etc.

Watershed.

grassy marsh with water up to the knees, to the low, muddy and stony shore of Ferguson Lake.

Grassy plain

This chain of portages leads across a great, gently sloping, grassy plain, between rather high grassy hills. Patches of dwarf birch are scattered here and there, and clumps of willows grow beside the brooks and lakelets. Everywhere the land is wet and marshy, the frozen soil doubtless greatly hindering the formation of drainage channels, while the two brooks are but slightly depressed below the general level. The subsoil is a pebbly till with boulders, but very few boulders can be seen except in the brooks.

Ferguson River.

Extent and character.

Ferguson Lake, on which the canoes were launched on the morning of September 5th, is seventeen miles in length and from one to three miles in width. Its contour is very irregular, dropping back into deep bays and projecting in long points. Grassy slopes and terraces, the latter underlain by sand and gravel, rise from the beach to heights of from thirty to fifty feet above the water, above which rise bare craggy hills of gneiss and diorite. The beach is usually composed of a wall of boulders, but here and there are sandy bays, while some of the points and islands are of smooth glaciated rock.

The survey of this lake, and of the rivers and lakes between it and Hudson Bay, was made during a long continued period of stormy weather, with high easterly winds which constantly dashed the waves over the canoes and often blew a heavy rain or sleet in our faces, making it impossible to see far ahead. The season was so late that it was necessary, for the safety of the party, to push onwards with all possible speed, and many places of undoubted interest had to be left unexamined. A few places, where the storm delayed us for several hours or perhaps days, were examined carefully.

North shore.

From the last of the twelve portages we followed the north shore of the lake for two miles and a half, past low projecting bosses of granite, to a point of massive, coarse, gray, highly hornblendic diorite. This has a rounded surface which almost everywhere shows strong glacial grooves running S. 50° E., but there also appeared to be some occasional traces of an earlier glaciation running N. 33° W. North-east of this point, a deep bay extends away to the north, but directly southward, across the lake and past some low rocky islands, is a low point of gray gneiss and dark-green diorite. The point is well scored by glacial markings trending S. 45° E., the direction of motion being clearly shown by the curved transverse fractures opening south-eastward. South of the shore, the hills behind a gravelly terrace appear to be of green diabase. Two miles and a half farther east along the shore the points are composed of coarse white granite, with irregular inclusions of biotite-gneiss and dark-green trap, often highly ferruginous. Two miles and a half further down the lake, the route lay through a rocky narrows, 100 yards wide, between steep rounded hills of gray gneiss, after which it followed the north-east shore for three miles, to a bare rocky island of gray gneiss and dark-green diorite. A little more than a mile and a half beyond this island, the outlet of the lake was reached, where a shallow river thirty yards wide flows down a swift rapid over boulders, descending eight feet to another lake.

Rocky narrows.

Last Eskimo camp.

A mile east of this rapid, a camp of four Eskimo tents was pitched south of the lake on a grassy terrace twenty feet above the water. These were the last Eskimos that we were to meet, and we purchased from them some tallow and a good supply of half-dried caribou meat. The lake has grassy shores, descending to a beach of boulders, and rising in regular terraces which mark the coast-lines of the post-glacial sea when Hudson Bay was very much larger than it is at present, and when it was in all probability connected with the Arctic Ocean along the line of the wide depression in the bottom of which now lies Chesterfield Inlet and Schultz and Aberdeen lakes. The lake is five miles and a half long, and at its eastern end is discharged by a small stream about fifty yards wide, which flows for a mile and three-quarters, with a very rapid current over a bed of boulders between low stony banks, into another small lake. The river flowing from this lake was said by the Eskimos to be shallow and impassable for our canoes. It was therefore necessary to make a portage from the north shore of the lake north-eastward for 2800 yards across a rather low wet grassy ridge of red till, with rounded and angular boulders, to the shore of another small shallow lake. Six Eskimos, who had accompanied us from the last camp, were paid a third of an ounce of tobacco and six gun caps each, for every trip with a load across this portage.

Marine terraces.

Long portage.

Half a mile northward across this little shallow lake the river was again entered. For three miles and a half it flows northward through moderately level country between banks of boulders and over a bed of boulders, but the water was at the time so low that the stream did not as a rule occupy more than half the width of the channel. The men waded in the cold water beside the canoes through much of this distance, at one place making a portage eighty yards long across a sandy point on the west bank.

At length this rapid stream emptied into the south side of a narrow lake eight or ten miles long, and to avoid the high north-west wind which was blowing at the time, the canoes crossed this lake, with some difficulty, to its north shore, reaching it at a prominent point of coarse gray gneiss. Two miles and a half farther east is a point of massive dark-green diabase cut by veins of red granite. Its surface is strongly glaciated. Its western slope is planed and grooved in a direction S. 53° E. Its eastern side, which is much more broken than the western, shows a well marked striation running S. 16° E., and older than the other, and another very light striation crossing it in a direction N. 40° E., perhaps the earliest of all. North of the lake the country rises in a high rocky ridge. The river flows out of the east end of the lake and soon breaks into a long shallow rapid over a bed of large boulders, at the top of which is a ridge of banded gray and black micaceous gneiss, striking N. 50° E. and with almost vertical dip. Its surface is distinctly scored by glacial markings trending S. 40° E.

Narrow lake.

Past the rapid the canoes were carried for 800 yards along the right (south) bank of the river, which is steep and thirty-five feet high. A terrace of boulders runs along the face of this bank, while the plain to the south is grassy, wet, and underlain by till. Here and there little tufts of dwarf birch furnished fuel for a fire at camp on the boulder terrace. The little river is about a mile long, and as it flows into the western arm of Kaminūriak Lake it spreads out over a wide expanse of boulders, past which it was necessary to carry the canoes for 250 yards, on the south bank, over naked boulders. The rocky country had now been left behind for a time, and in front of us was a broad undulating till-covered plain.

Heavy rapid.

Kaminūriak Lake is a beautiful sheet of clear cold water lying in the till-covered plain at an elevation of about 320 feet above sea-level. Its extent is as yet unknown, for although the south-western shore is only twelve miles long, its waters were said by the Eskimos to extend a long distance northward. Its northern shore, as indicated on the map, is from Eskimo information and sketches.

Kaminūriak Lake.

Where seen, the beach is in some places sandy, but more generally of large boulders, which, on the more exposed parts of the shore are arranged in a regular wall to the height of from eight to twelve feet, while in the bays they are scattered over a shallow floor of sand or till. Back from the lake the country stretches in wide treeless plains, or rises in low grassy hills, which show no signs of any underlying rock.

Surrounding country.

Caribou.

Caribou were moderately plentiful around this and the two following lakes, as far as the grass-covered country extended, but it was almost impossible to obtain fuel to cook their meat, for there was very little dwarf birch to be found and no black lichen. The ice was now (September 10) forming around the ponds at night, indicating that the season of open water was almost over.

River below the lake.

Following the south shore of Kaminūriak Lake to its south-eastern angle, the river was again reached. It was now a much larger stream, sixty yards wide and two feet deep, with banks and bed of large boulders. The stream for a third of a mile is very swift, with a drop of about four feet, and then it opens into a small lake, below which it flows in two channels, inclosing between them a large flat grassy island. The eastern channel is wide, and the current in it is light, to the head of a heavy crooked rapid, where it is obstructed by a trap dyke, over which the water falls in an irregular cascade with a drop of fifteen feet. At the foot of this cascade the western channel again joins the eastern one, having flowed for some distance along the foot of a bare rocky ridge, which, a short distance to the south, rises high above the general level. At the bottom of a bay, just above a little island at the head of the rapid, the canoes were landed and unloaded on the bare rock, and carried southward for 900 yards over a ridge of smooth gray gneiss, foliated S. 75° W., to a wet gravelly flat beside the the river. The rocky ridge was covered with the coarse black hair-like lichen *(Alectoria divergens)*, this being the first place in 1894 where this lichen was seen in any abundance.

Below this portage the river flows with a strong current, along the foot of the high rocky ridge, to the end of a lake which extends towards the south-east for about seven miles, having an average width of from three-quarters of a mile to a mile and three-quarters. This lake has a very regular outline and low shores of sand and gravel, which rise in gentle grassy slopes to the level of the surrounding country. From its south-eastern angle the river flows southward for two miles and a half, at first with an easy current, and then swiftly, over a wide bed of gravel and boulders, making straight towards the foot of a high hill, and at length reaching the north-west end of a narrow lake similar in size to the last. The north-western shore of this lake is generally low, composed of sand and boulders, among which are many of green Huronian schist, while beyond its south-western shore rise bare craggy hills, marking the outskirts of the rocky country which extends from there all the way to the western shore of Hudson Bay. One of these hills stands out boldly across the east end of the lake.

Rocky country.

The rapid stream flows from the end of the lake north-eastward for two miles, till it passes the northern end of this hill in a rocky gorge, when it turns south-eastward and flows for two miles and a half among bold rocky hills, in whose protected recesses are green grassy terraces, to a heavy rapid. Here the water rushes through a narrow obstructed channel between steep walls of green diorite slightly foliated S. 60° E., and dipping N. 30 E. <70°. The canoes were carried for 900 yards past this rapid, over a rather high ridge of the smooth green diorite, on the summit of which irregular angular blocks have been shoved up by the frost. On the smooth surface some light glacial striæ may here and there be seen running S. 25° E. The hills are covered with black lichen, while some willows grow beside the little ponds in depressions in the rock. At its lower end, the portage descends to a sandy beach on the shore of a little bay of the river below the rapid, apparently quite encircled by the steep bare rocky walls. Portage.

Below the portage, the river flows eastward for two miles in a straight channel with steep rocky banks, and then passes through a small hill-girt tarn, which we crossed in the deepening gloom of the late evening, in showers of snow and rain. Camp was pitched on a sandy grass-covered terrace at the foot of a rocky hillside, the rock in which is a fine-grained dark-green diabase, with obscure slaty cleavage striking southward, and is cut by many small irregular veins of white quartz. Small lake.

Below the outlet of the tarn, the stream was descended for three-quarters of a mile down a rocky rapid, after which the canoes were carried for 800 yards along the east bank, past a rapid, over boulders and jagged points of rock. The rock is a massive light-green diorite, which, in the valley, is strongly scored by glacial markings trending S. 15° E. The summit of the ridge above is all blackened with lichens, but it appears to have been planed off in a direction S. 60° E., the rounded surfaces facing westward, and the broken ones eastward. Green diorite.

Below this portage the river is swift, but sufficiently deep for canoes, and flows between banks of similar rock, to a little fall which was run with half loaded canoes. The fall is caused by a band of white quartzite which here crosses the stream. This quartzite is distinctly and rather thinly bedded, the surfaces of the beds often showing beautiful ripple markings. It strikes N. 55 E., and dips N. 35° W. at angles between 40° and 60°, extending away towards the north-east as a high conspicuous straight white ridge, while towards the south-west the eye cannot follow it far among the surrounding hills of trap. Some willows grow on the southern side of this ridge, and among them was an alder bush, the first that we had seen for a long time. The quartzite is similar to that of Marble Island, and is probably of Huronian age. White quarazite.

Quartzite Lake.

Below this *demicharge* the river opens into Quartzite Lake, which has a very irregular outline and lies amidst bare rounded hills that either descend abruptly to the water, or are skirted by grassy slopes and terraces marking old shore-lines of the ancient sea. On one of these terraces, seventy feet above the lake, a great number of shells of *Leda arctica* were lying just where they had been thrown upon the ancient beach.

Heavy storms.

The progress of the party through this lake was much impeded by heavy storms. One point examined on the south shore, four miles from the mouth of the river, was a ridge of massive green trap, in places showing a vertical slaty cleavage striking N. 50° E. Its summit was smoothed and clearly scored in a direction S. 25° E., and boulders of white quartzite are plentifully scattered about, while none were seen north of the quartzite ridge. For several miles farther eastward the shore consists of similar rocky cliffs, and then it becomes low and is composed of boulders. Low stony islands surround a point composed of the scarped edge of a boulder terrace thirty feet high.

Half a mile beyond this point the river forms up and flows in a wide and rather indefinite channel among boulders and points of rock. After a course of a mile and half, it rushes in a turbulent rapid between jutting points of rock into another small lake. Two seals were seen disporting themselves in the eddies near this rapid, one a square flipper (*Erignathus barbatus*), and the other a ringed seal (*Phoca fœtida*). Here camp was pitched on the evening of September 13th. During the night the north-east wind rose to a gale, and at break of day drove before it a heavy shower of snow, which during the following night changed to torrents of rain. A delay of a day and a half was thus necessitated, but the time was improved in enlarging and correcting the Eskimo vocabulary which is given in an appendix to this report.

Seals.

Eskimo vocabulary.

Travel on the afternoon of September 15th was through the fog or drizzling rain. The course for three miles was along the low north shore of the small lake, while to the south rose rugged hills and naked rocky islands. From the north-east angle of the lake the river flows northward for a mile and a quarter, over a rocky floor, to the west end of a very irregular shallow sheet of water about four miles in length, with many low islands of till and boulders, between which there is a current in several places. Some rather high rocky hills rise south of the western end of the lake, but generally speaking the surrounding country appeared to be low and flat.

Hills of rock.

The rapid river, which flows out of the east end of the shallow lake, was descended for a third of a mile to where the water breaks.

over a ledge of rock, and here the canoes were carried for 400 yards along the north bank, to within a short distance of the shore of another small lake. The portage is a good one along the grassy and mossy bank, past a shallow rapid in which are two rocky ledges, one at the top and the other at the bottom. The rock is a massive green trap, similar to all that lately seen. The surface is well-rounded and glaciated, the summit and northern sides being strongly grooved S. 17° E. On a lee surface, well protected from the grinding of this later glacier, some strong glacial grooves were seen trending S. 60° E. No traces of any other glaciation could be detected.

The next day broke with an east wind and driving rain, and was very cold and boisterous. The wind soon went around to the north-east, and then into the north, gradually rising to half a gale. The rain turned to snow, and throughout the afternoon the storm was so severe that it was almost impossible to face it. From the portage downward the course was through a small lake, and down a rapid stream through till-covered country studded with low hills of boulders, to a swift chûte where the river with heavy crested waves rushes through a narrow gap in a high ridge of similar trap. The river then passes two more shallow rapids over boulders, and enters the north-west end of a narrow lake about six miles and a half long. Two bold rocky hills rise on the north shore of this lake, but for the rest the country is generally covered with till and boulders. Till-covered country.

This was the last lake on Ferguson River, and from its south-eastern end the stream flows in a south-south easterly direction down a regular and comparatively steep decline, in a shallow channel over boulders and low ridges of trap. After travelling six miles down the impetuous, and usually shallow current, the increasing storm forced the party to camp in the snow on a stony hillside. The surrounding country was a great stretch of low hills of boulders, probably morainic. The boulders are rounded, and there appears to be barely sufficient finer material to fill the interstices between them. The morainic hills evidently lie on an undulating floor of dark-green trap. Last lake.

Throughout the 17th of September the storm continued to rage, and it was impossible to launch the canoes, but on the 18th the wind had gone down. The river continues its very rapid course south-eastward for a mile and three-quarters, and then turns abruptly eastward and flows with an easy current in a wide channel, with ridges of boulders roughly parallel to it on the south and a low escarpment of till about a mile distant to the north. For two miles further eastward it continues with varying current to a heavy crooked rapid a third of a mile long, over a bed of rock. Below this rapid, which was run by the canoes without much difficulty, there is half a mile of easy water to the head of another short rapid with a fall of ten feet, past which the canoes were carried on the east bank, over boulders and smooth glaciated rock. The rock is a gray massive granite, with angular inclusions of fine-grained green trap. The surface is well scored by glacial markings running S. 35° E.

Massive granite.

For three-quarters of a mile below this portage, the river has a moderate current, and then it contracts and rushes swiftly between steep walls of granite and trap. Immediately below this short gorge it spreads over a wide bed of rounded pebbles, and flowing swiftly for two miles and a quarter passes through a rocky gap, and empties into Hudson Bay at the bottom of Neville's Bay. A band of the white Marble Island quartzite crosses the river just at its mouth. As seen from the canoe the surface of the quartzite appeared to have been eroded, and then unconformably overlain by the green trap, but it was impossible to take time to finally decide this point.

Reach Hudson Bay.

Date.

The mouth of the river was reached at noon on September 18th just a week earlier in the season than the writer had visited the same place in 1893, having then walked to it over the deep crusted snow from camp at the entrance to Neville's Bay.

The Eskimo guides were now paid off, and they hurried back up the river to show their countrymen what the white men had given them while the party of six men, in the two Peterboro' canoes, paddled southward along the coast of Hudson Bay. Assisted by favourable weather, Churchill was reached on the evening of October 1st. Some of the incidents of this part of the journey have been given in the Summary of Proceedings, while the geological and geographical details observed have been incorporated in the general account of the west shore of Hudson Bay, on pp. 86 to 98.

CHURCHILL TO SPLIT LAKE.

Winter journey.

This route was travelled on snowshoes in the dead of winter, when the ground was deeply covered with snow, so that little could be seen but the general features of the country adjoining the line of travel. As the records are fragmentary and disconnected, they will be better understood if they are given in journal form, very much as they were entered in my note-book, the personal details and courses being omitted, the latter being shown on the accompanying map.

Leave Churchill.

November 28th.—We left Churchill at 7.30 a.m., just at the first rosy streak of dawn, the thermometer standing at —40° Fahr., and crossed the bay to Mosquito Point, where there is a low exposure of greenish gray arkose, similar to that behind the Mission. This was the last rock seen *in situ* until we were within a few hours journey of the banks of the Nelson River. We crossed Churchill River from Mosquito Point, over the very rough jagged ice, to the east shore. The river is here nearly a mile wide, and flows in a swift shallow rapid over a bed of large boulders, into the tidal water of the long shallow lagoon. For the rest of that day we walked without snowshoes on the ice up the river, keeping close to its east bank. The mouths of Churchill and Fishing creeks were pointed out to us as we passed them on the opposite side of the river, as well as the low willow-covered "Neverfail" Island, where the hunters from Churchill usually come every winter to shoot willow ptarmigan. The east bank of the river is low, thinly wooded with white spruce, and apparently underlain by clay and boulders. The river seemed to be shallow throughout, flowing down an even steady slope over a bed of boulders, and was still open at places where the current was swiftest. Camp was built in a grove of white spruce on top of the low east bank, behind some wooded islands.

Wide and shallow river.

November 29th.—The thermometer stood at —10° F. as we started at 6.50 this morning, with a moderate south-east wind blowing in our faces. We ran for six miles and a half without snowshoes on the ice, under the low but steep thickly wooded banks of the Churchill, often behind low wooded islands, to within a short distance of the mouth of Deer River. We then ascended the bank, put on our snowshoes, and started across an extensive level plain, with not a hill anywhere in sight. The snow was hard and crusted. Our course was through thin woods of small black spruce, (the first black spruce that we had seen since we had crossed Yath-kyed Lake, three months before) and then across open country skirting the east bank of Deer River. Where this river was first seen it is sixty yards wide, winding through the plain in a tortuous valley thirty feet deep. The plain is covered with moss or lichens and dotted with small lakes, and is evidently very wet in summer. Camp was made this evening in a grove of large white spruce beside the Deer River. The banks are here twenty feet high and generally very thinly wooded. The river is seventy-five yards wide and for the most part appears to be very shallow and full of granite boulders. In some of the deeper holes the ice was now twenty-five inches thick. On a sandy flat close at hand, were a number of small aspens (*Populus tremuloides*), and two or three small balsam poplars (*Populus balsamifera*), this being the most northerly point where the latter tree was seen in this district, while a

Leave Churchill River.

Deer river.

Grove of poplar.

few small specimens of the former were observed on the terraces on the sides of the hills at Churchill.

November 30th.—The thermometer stood at —6° F., with a light northerly wind, as we left the camp-fire this morning and started across a wide level plain covered with crusted snow, cutting across from bend to bend of the river which continued to flow to the west of us. The plain is generally lichen-covered, with thin groves of small black spruce and larch scattered here and there. A low ridge, probably representing an ancient shore-line, ran along to the east of the course for a short distance during the morning, but throughout the day no other hills were passed. Camp was made on the bank of Deer River, the stream being here thirty yards wide, and the banks thirty feet high and apparently of till. A bar of boulders near the camp was closely examined. All the boulders are Archæan granite, gneiss, mica-schist or hornblende-schists. No fragments of post-Archæan rocks could be found, either of Palæozoic limestone or of the Churchill arkose beds.

Wide level plain.

Boulders.

Since leaving Churchill we had travelled for about sixty miles, as the crow flies, southward, up a gradually ascending slope, and had now reached an elevation of about 175 feet above sea-level.

December 1st.—The temperature this morning was —3° F., with a light south-west wind.

We ascended the river for about eleven miles, walking much of the distance without snowshoes. The stream retains a very constant width of twenty to thirty yards, without noticeable rapids, so that in summer it would doubtless be good for canoes. The channel is often very crooked, and the banks, which are about thirty feet high, are steep and probably of till, no signs of bed-rock being seen. At first long points of boulders project into the bends, but afterwards these become less frequent, and the stream is overhung by willows. The boulders are all of granite and gneiss, but in some places higher up the bank a few smaller glaciated cobbles and pebbles of white or buff Palæozoic limestone were observed. The sides of the valley are at first thinly wooded, but as the river is ascended the timber becomes much thicker and heavier. At the end of the above distance the river bends, coming from the south-west. Here we finally left it, and climbing its east bank walked through thin woods of small black spruce and larch, and over some little lumpy hills, probably sand-dunes, to a grove of black spruce beside a small lake, where we built a camp for the night.

Crooked channel.

Leave Deer River.

December 2nd.—The thermometer this morning was 0° F. with a light south wind and snow. Our course all day was S. S. W.

through woods of stunted black spruce and larch, and across many small open swamps. Shortly after leaving camp we crossed two roundish lakes, each about a mile in diameter. The country generally was level, but about noon we crossed a ridge of low hills, so deeply covered with snow that it was impossible to determine their true character. No sign of rock in place was seen anywhere. Stunted forest.

We had now entered the more or less continuous woods, and we built a camp by a brook in a thin grove of black spruce, but about six o'clock the wind shifted into the north-west, and we were obliged to build a new camp. The elevation was here about 275 feet above sea-level.

December 3rd.—Thermometer this morning—6° F., with a moderate wind from the N. W.

The forest had now become much more dense, so that it was necessary to keep men with axes walking ahead and cutting out a track for the dog sledges. For twelve miles our course was through the almost continuous woods over apparently level ground, which, however, the barometer showed to be gradually rising, till we reached the foot of a long ridge or escarpment. Continuous woods.

The next mile was up the face of this slope, which consisted of low parallel wooded hills trending in a north-west and south-east direction. They are probably composed of sand or gravel. As shown by the aneroid, afterwards compared with the reachings of the standard barometer taken at the same time at Churchill, the crest of this ridge is 600 feet above the sea-level. From its brow a magnificent view can be had of the level wooded plain that extends north-eastward as far as the eye can reach. The writer was strongly reminded of another view seen some years before, when he stood on the brow of the Duck Mountain and looked away over the similar level plain that extends from an old shore-line then beneath his feet to the west side of Lake Winnipeg. The ridge on which we stood was perfectly well known to our Indian companions, who said that it extended a long distance south-eastward, being continuous with the ridges crossed just south of Fox River, on the winter track from York Factory to Oxford House, and that it also extends in the opposite direction an unknown distance beyond Churchill and Seal rivers, being probably continuous with the sandy terraces above Yath-kyed Lake and below Doobaunt Lake. It undoubtedly represents an old post-glacial shore-line of Hudson Bay, formed when the land stood between 500 and 600 feet below its present level. As far as could be determined it is the highest raised sea-beach west of this part of Hudson Bay. Old shore-line.

Camp was built by a thick spruce grove just behind the crest of this ridge, where many fresh caribou tracks in the snow gave us some assurance that should our stock of provisions fail, we would have a chance to secure a local supply of meat both for men and dogs.

Deep snow.

December 4th.—Thermometer this morning—1° F., with a light south-east wind. The snow in the woods was now four feet deep and very soft, and it was necessary for several men to walk ahead of the dogs and tramp it down with their snowshoes in order to make a track for the sledges; but the small feet of the dogs still went down deep through the snow of this beaten track, so that they could not obtain a good footing and had very little power in dragging the sledges. Combined with this the mild weather, and the constantly falling snow-flakes, made the running very slow and heavy, and it was necessary to harness one of the men in front of each of the sledges to assist the dogs.

Source of Owl River.

We thus travelled south-westward for about four miles, through thick woods of black spruce up to four inches in diameter, crossing a diffuse ridge, and descending its south-west slope about forty feet, to a lake a mile wide in the direction of our course, and two miles long at right angles to it. This lake was said to be the source of one of the branches of Owl River, which empties into Hudson Bay some distance north of the mouth of Nelson River. Three miles farther over the snow, amid the bristling dead white trunks of spruce that had been burnt more than eighteen years before, brought us to another small branch of Owl River, thirty feet wide, flowing in the bottom of a wide shallow valley. One of the Churchill Indians who was accompanying us, stated that he had descended this stream in four days on a raft, from a short distance below this point to its mouth, that he had encountered no rapids, and that he had seen no sign of the underlying rock anywhere. Camp was built beside this creek, among the dead spruce, where an abundant supply of firewood could be obtained. A grove of tall white spruce was growing beside the stream not far from us. The elevation was found to be 615 feet above sea-level. The surface of the country is now rough and uneven, rising into low hills and ridges, having a very different appearance from the level plain that we had been crossing for the previous six days.

Elevation.

December 5th.—Thermometer 6° F. this morning, with a light N.W. wind. Three of the men were sent ahead to break a track through the deep snow, while the others, with the dogs, remained in camp to rest, in order to avoid *mal de raquette*, which was beginning seriously to annoy some of them. The dogs were very much fagged, and most of them slept steadily throughout the day.

December 6th.—Thermometer 4° F., this morning, with a light south wind. We proceeded for eight miles over hills and along ridges with gentle slopes, through the half-open ancient brulé, the country being probably underlain by till, or at least it has the gently rounded and ridged contour commonly assumed by till. Two small branches of Owl River were crossed in this reach. Afterwards we travelled for a few miles through a wooded country, crossing a well-defined hilly ridge 100 feet high, and then a country of small swamps, and low intervening hills and ridges, the latter of which seem to have a general trend south-westward. The general deep covering of snow made it impossible to tell whether these hills were composed of gneiss or of morainic material, but they presented much the same winter appearance as the low gneissic hills in the country east of Lake Winnipeg, though there the rock could occasionally be seen on the steeper slopes, or in protected places. A caribou was shot this evening, and furnished a day's additional food for the men and dogs. Rough, uneven surface.

December 7th.—Temperature this morning—1° F., with a moderate south-east wind. Our course to-day was over a gently undulating country, wooded with small black spruce and larch, with intervening open bogs, across a small lake somewhat more than a mile in length, through thick woods, and then through almost open ancient brulé, along a ridge sloping gently westward to a wide shallow valley. The whole country is doubtless underlain by till or other Pleistocene deposits. Gently undulating country.

December 8th.—Temperature this morning 9° F., with a stiff south-east wind, driving before it a light shower of snow. Birch trees were seen for the first time. Our course for about six miles was southward through thick woods, at first over undulating country with small lakes, and afterwards over a much more level country with but few lakes. At length a lake was reached whose shores rise into high rounded ridges, those to the north being covered with a rich growth of dark evergreens, while those to the south are now almost treeless. Its banks, close to the water's edge, are clothed with white and black spruce and some small poplars. A run for two miles and a half south-eastward, over the ice of the lake, brought us to the head of a river thirty feet wide. We descended the river for about half a mile, when one of our Churchill Indians recognized it as the Kissé-mitiskun, or Old Fish-weir River, which he said flows into Nelson River a short distance below Limestone Rapids, and at the same time he recognized the lake just crossed as Niski or Goose Lake. We immediately retraced our steps up the river, followed the south shore of Niski Lake to its south-western angle, crossed a low ridge to a small narrow lake, on the shore of which, in a small bluff of spruce, we built a camp for the night. First birch trees. Kissé-mitiskun River.

December 9th.—Thermometer this morning 14° F., with a light S.S.E. wind.

Wapinihi-kiskow Lake.

We travelled over some low ridges for a mile to the shore of Wapinihikiskow or White-spruce-bluff Lake, which has been our immediate objective point since we left Churchill twelve days ago. It was said to drain into Niski Lake, and thence by the Kissé-mitiskun River to Nelson River. This lake, over which we walked for three miles, has a rather evenly rounded outline, with steep banks about thirty feet high rising to a moderately level plain or terrace, doubtless of sand or clay. The elevation of this lake is about 570 feet above sea-level, and the surface of the plane or terrace would therefore be about 600 feet above sea-level, or at the same level as the highest shore-line of Hudson Bay seen farther north a few days before.

Indian hunters.

At the south end of the lake was a small log house, in which three Indian families were living very comfortably, supporting themselves by fishing with nets under the ice of the lake, and by hunting caribou and rabbits in the surrounding forest. These Indians—originally Crees from York Factory—now regularly carry their furs to the trading stores at Split Lake to exchange for ammunition, clothing, etc. They had cut out and blazed a good sledge-track all the way to these stores, so that there would no longer be any uncertainty as to the route that we were to follow. Here we purchased some fish for our dogs, and then crossed a low ridge to another similar lake with low even shores, beyond which we travelled for a mile through woods and swamps to

Namaco Lake.

the shore of Namaco or Trout Lake, which lies at the head of Mittitto or Limestone River and at an elevation of about 590 feet above the sea-level. From the west side of this lake there is said to be a portage to a stream flowing into the Little Churchill River, giving a summer route to Churchill River. On the shore of Namaco Lake was a small log house in which several families of Cree Indians were living.

The dogs that had hauled our sledges all the way from Churchill through the soft unbroken snow were now very lean and weary. After some difficulty and considerable talk, we here succeeded in hiring a man and team of four dogs to accompany us for the rest of the way to Split Lake.

December 10th.—Thermometer this morning 22° F., with light south wind and snow.

Namaco Lake, across which we travelled for three miles and a half, has very regular outlines with but few hills near its shores. Mittitto or Limestone River flows from it near its southern end. After leaving

Namaco Lake the trail crosses a wooded ridge for a mile to Wapisew Sakahigansis or Little Swan Lake, at an elevation of about 560 feet above the sea; it is two miles and a quarter long and is generally very similar to the others. Beyond it the trail continues through thick woods of small black spruce over low hills and ridges, and across marshes and small lakes to the shore of Wapikopow or Willow-point Lake, where we had the good fortune to shoot a couple of caribou just as we were about to build a camp on the thickly wooded bank. The day had been warm and dull with light flurries of snow, and the water in many places was standing on the ice, so that the hauling was very heavy. Wapisew Lake.

December 11th.—Thermometer this morning —3° F., with a very light wind from the east, but the day was dull and mild.

Wapikopow Lake lies at an elevation of about 525 feet above the sea, and our Indian guide stated that Mittitto River flows through it, entering its northern end, and flowing out of its south-eastern side. It is about a mile and three-quarters long, but is contracted in the middle to a low willowy narrows only sixty yards wide. The shores are usually low, but towards the south-west, an esker-like sand-ridge a hundred feet or more in height, rises conspicuously above the surrounding country. From the south end of the lake the trail passes for a mile over a spur of this ridge to Wasegamow or Clearwater Lake, at about the same elevation as the last. The north-west shore of this lake here consists of high rounded hills, doubtless of sand, though it was impossible to see the surface on account of the deep covering of snow. The lake is three miles in length, and as its south-western end is approached the shores gradually decline to but a few feet above the level of the water. From the end of the lake the trail crosses a sparsely wooded ridge and descends a slope for a total distance of half a mile, to Asagiew or Crayfish Lake which lies sixty-five feet below Wasegamow Lake. This small roundish lake, less then a mile in diameter, lies in the bottom of a deep bay in the edge of the higher country to the north, which sweeps round it in an even curve, rising everywhere in a moderately steep slope to a height of ninety feet. To the south the shore is low, and the lake drains by a brook into Mittitto River. The cliff to the north is very probably underlain by Pleistocene deposits, and was very likely cut by a post-glacial river, or by the waters of Hudson Bay when the land stood 450 feet lower than at present, that being about the present elevation of Asagiew Lake above the sea. Wapikopow Lake. Wasegamow Lake. Asagiew Lake.

A little more than half a mile from the lake, we reached Mittitto River, here a small stream thirty-five feet wide with low banks overhung with willows, and for two miles we followed its south bank Mittitto River.

through thick woods, and over small ponds with steep banks. We then climbed a steep hilly slope 120 feet high on the south side of the valley, and reached a gently undulating table-land, at an elevation of about 575 feet above the sea, where we built our camp for the night.

December 12th.—Thermometer this morning 20° F., with a moderate south wind. During the day there were occasional flurries of snow with much water on the ice, and the hauling was very heavy and bad.

The higher undulating land was crossed for several miles through woods of small black spruce, much of which had been killed by fire, and then we descended a long slope of low flat land and willow-covered swamps. Two miles and three-quarters across this low land, and over a ridge fifty feet high, brought us again to the banks of Mittitto River, which had swept around a long course and was now flowing towards the east, between stratified alluvial banks fifteen feet high. White spruce. These banks are wooded with tall white spruce, which looked very beautiful after the monotony of the stunted black spruce forest. The aneroid gave this place an elevation of 340 feet above the sea. The river was crossed, and then a small lake half a mile long, on the alluvial flat, which is known to the Indians as Peeshew Pukwâgan, or Wildcat-fishing Lake. Esker. South of this lake the sledge-road crosses a long, narrow, and undoubtedly sandy, ridge or esker, which runs as far as the eye can see both N. 85° E. and S. 85° W. Its crest is here but a few yards wide, and both sides are very steep. At the trail it is ninety feet high, but the line of the crest is undulating, and in places it appears to rise to a height of two hundred feet, where the ridge seems to be wider, with a mammillated surface. Besides some spruce it is thinly wooded with Banksian pine and some small birch, the most northern point at which the former tree was seen on this overland trip. As seen from its summit Mittitto River appears to follow the northern side of this esker eastward for a long distance.

We slid down the very steep south side of the esker, and then for half a mile travelled through hilly and evidently sandy country, Banksian pine. thinly wooded with black spruce and Banksian pine. Four miles further, over gently sloping wooded ridges, brought us to the shore of Mūsogetéwi or Moose-nose Lake, on a small island in which we built a camp for the night. Close to camp, projecting through the snow, was a low rock exposure, the first seen since leaving Churchill River. First Archæan rock. It consists of a light gray, well foliated Laurentian biotite-gneiss striking S. 50° W., and dipping N. 40° W. $< 60°$. The lake has an elevation of about 320 feet above sea-level, and appears to lie along the line of outcrop of the Archæan rocks. It has generally rather high shores, wooded with white and black spruce, birch and poplar, and its many islands are also rather high and thickly wooded. The Mūsogetéwi River discharges it into Nelson River, and the regular canoe-route from Split Lake to Namaco Lake passes here, the canoes being carried from this lake to Mittitto River.

December 13th.—Thermometer 13° Fahr., with a rather stiff south-east wind. The lake was crossed just as the day was breaking, and a small stream, about twenty feet wide, that flows into its southern side, was ascended for several miles. Then for four miles and a half we travelled south-south-westward over an undulating country which rises gently to a ridge, evidently sandy, twenty feet high and a hundred feet wide, wooded with birch and small Banksian pine. It runs N. 55° W. and S. 55° E., and is probably an old beach or bar, but whether it was formed in a lake, or in an arm of the sea, is uncertain. South of the ridge is a low pine-clad slope, descending towards a small willow-shadowed brook, beyond which is another rise to a diffuse ridge about the same height as the last. A mile and a half farther, over almost level country, brought us to the low banks of Nelson River, a short distance above Gull Rapids, where it spreads out into Kiasko or Gull Lake. Here the survey was connected as closely as possible with the instrumental survey of Nelson River made by Mr. Klotz, of the Dominion Lands Branch, in 1884.

Undulating country.

Reach Nelson River.

An island in the lake, half a mile from where we entered it, showed a number of low outcrops of gray gneiss, all smoothly planed, and with strong glacial groovings trending N. 70° W. The direction of flow of this glacier is clearly shown by the smoothed and scored eastern sides of the rocky bosses, and their unglaciated, jagged and broken western sides. The many boulders in the vicinity are all of Archæan rocks. The north shore of the lake was followed westward for several miles, a point of land was crossed on a well-cut trail, and we built a camp on the shore in black spruce woods, not far from some rounded islands of well foliated gray gneiss, striking S. 15° E.

Gull Lake.

December 14th.—Thermometer this morning 27° F., with a light south-east wind. We followed the north shore of Gull Lake to its western end, and then, as the Nelson River was still quite open, we struck inland for several miles through woods and over frozen swamps, until we reached the river again at a point wooded with tall white spruce, opposite an elongated kame-like island. The next point is of red gneiss cut by dark-green diabase. Above it, it was necessary to clamber over the rough broken blocks of thick ice piled up beside the rapid stream, as far as a high cut-bank, apparently of till, a short distance above which is an exposure of a coarse dark-gray diorite,

Ascend Nelson River.

associated with fine-grained diabase. The roar of a heavy fall was heard a short distance to the south, but we passed it without seeing it, by crossing a neck of land north of the river. We built a camp in the woods on the north bank a short distance above this fall.

December 15th.—Temperature this morning—16° Fahr., with a fresh north wind. We continued to travel along under the north bank of Nelson River, which was flowing clear and open to the south of us, until we reached Split Lake, which we crossed to the trading store of the Hudson's Bay Company, where we were very kindly received by Mr. William Aiken, the trader in charge, and our journey through the unexplored country from Churchill was accomplished.

Reach Split Lake.

Split Lake to Norway House.

The journey from Split Lake to Norway House, a distance of about 225 miles by the sledge road, was made in eight days—between December 17th and 24th. It was over a well cut out sledge road, which had been more or less constantly travelled by loaded dog teams. Much of the journey was accomplished in the night, so that it was quite impossible to carry on even a roughly approximate survey, or to go even a few hundred yards aside from the course, on which we were almost constantly running. to examine the country, however interesting it might appear to be. The few notes recorded below were made at points where we were obliged to stop to sleep or to take our meals.

Sledge road.

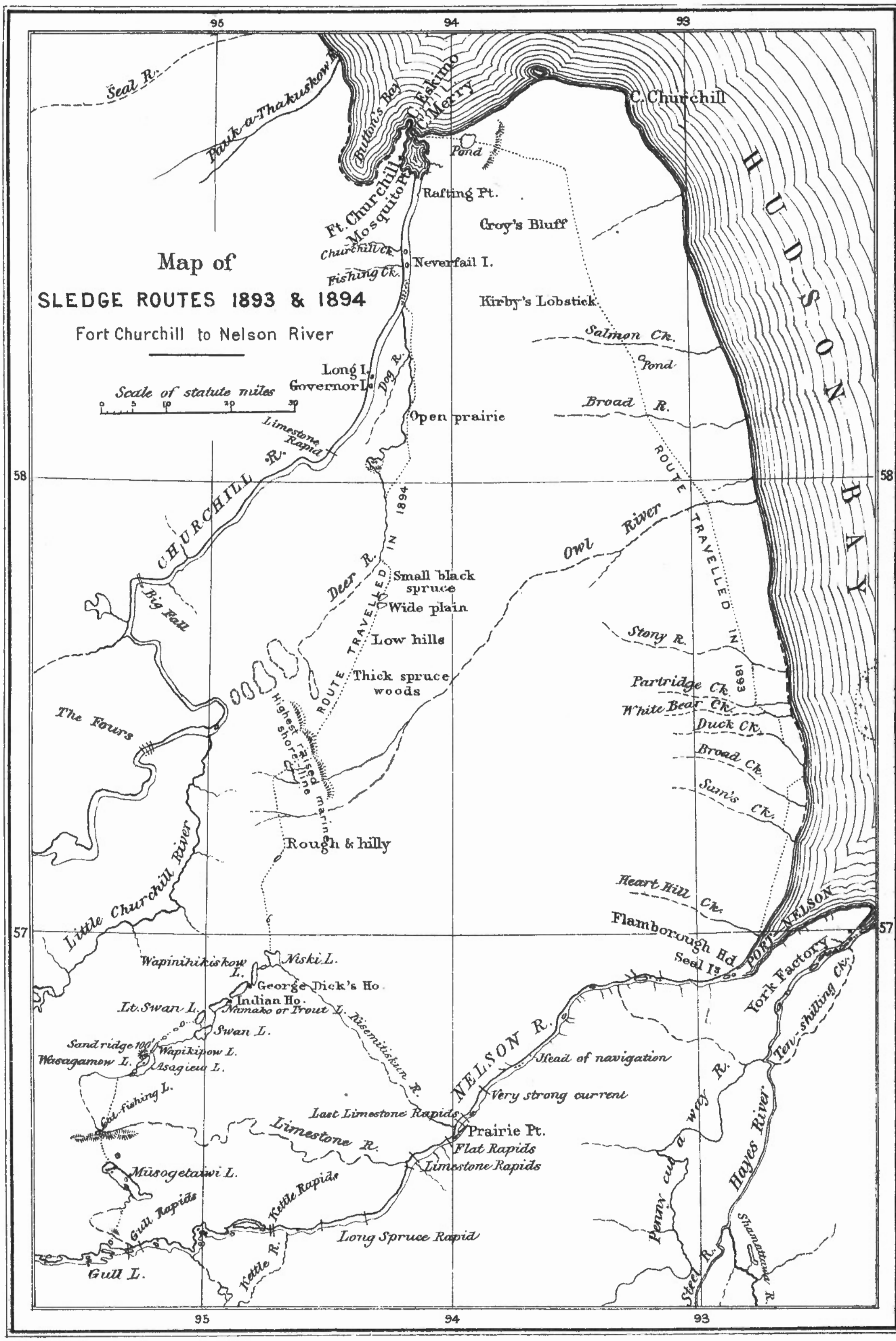
The first day we travelled on Split Lake, running on the ice beside its rocky banks, and we camped for the night near the head of the lake within sound of the heavy falls on the Nelson River.

Ascend Grass River.

The next morning we left the Nelson River to the east and struck up Grass River, keeping on the ice or going up into the woods for short distances to avoid rapid stretches of open water. The banks were chiefly of rounded gneiss, etc., not very high but occasionally rising into little hills. The lower intermediate land appeared to be clay or sand. All was wooded with small black spruce and aspen, with some birch and Banksian pine.

The next morning, December 19th, we travelled fifteen miles, at first through woods and then along small streams and across lakes. The general contour of the country was low and flat, with a few rocky knolls rising here and there, but the ridges, which were wooded with small spruce, Banksian pine and poplar, seemed to be generally of clay and sand. At the end of the above distance we reached a small lake called Natawéwinan or Egg Lake, on the islands in which several families of Indians were living in low log houses, fishing and hunting.

Natawéwinan



Compiled and autographed by C.O. Senécal.

South of Egg Lake the trail continues through the woods over low hills, which are probably of sand or clay, to a small branch of Muskooskow or Grass River, where camp was built on a low pleasant point among spruce and poplars.

The next day was a stormy one with a heavy fall of snow. Our course was at first up Grass River among low rounded rocky hills, which looked strangely weird, in the gloom of the night and early morning, as we passed them through the heavily falling snow. We then crossed a small lake and ascended a very winding creek overhung with willows, after which for a couple of miles we crossed low hills and ridges, generally trending about S. 55° W., and wooded with Banksian pine and small poplar. South of the hills is a plain, probably sandy, wooded with Banksian pine, spruce and poplar, and on it we built our camp on the bank of a brook flowing southward.

Rocky hills.

December 21st.—The course was still southward for eleven miles, through thin woods of small spruce and Banksian pine, much of which had been fire-killed, over undulating country to Susaskwàgamoos or Sturgeon Lake, whose white snow-covered surface was beautified by many small green islands. We crossed this lake, for three miles and a half, and continued over small lakes, and across several ridges of land wooded with spruce and fine tall Banksian pines, to some Indian houses at Cross Portage, on the north shore of Seepiwisk Lake, where a dinner of fresh moose meat renewed our strength for the remainder of the day.

Spruce and pine woods.

Near the houses are some beautifully smoothed and rounded bosses of well banded red gneiss, striking S. 80° W. They are strongly scored by glacial scratchings trending S. 68° W. Many curved cross fractures opening south-westward, and rough lee surfaces, indicate quite clearly the direction of motion of the glacier.

Red gneiss.

We continued ten miles up the shore of the lake to a wooded point, where we camped for the night.

December 22nd.—To-day we ran about fifty-five miles, to the Hudson's Bay Company's store at Cross Lake, part of the time without snowshoes on the ice of Seepiwisk and Cross lakes, and part of the time on snowshoes through the intervening woods.

Cross Lake.

December 23rd.—After obtaining a fresh supply of provisions at the store, we continued to the head of Cross Lake, crossed Whisky Jack portage, about four miles in length, over lightly rolling and probably sandy hills, covered with spruce and large Banksian pine, travelled on the ice for a few miles over a lake, crossed another short portage, and then ran about two more miles over a lake to an island where there was an Indian house. Here we passed the night, having come about twenty-five miles.

December 24th.—We crossed the lake ahead of us, about twelve miles in length, and then struck across Ross Island for fifteen miles to Little Playgreen Lake, over a rather low country, occasionally wooded with poplar, but chiefly with small black spruce and larch. A few groves of large white spruce were found. We reached Norway House at six o'clock in the evening, having been obliged to leave one of our dogs behind us on the road, worn out by the continuous travel.

Norway House.

We remained at Norway House four days, enjoying the kind hospitality of Mr. and Mrs. Macdonald, resting both men and dogs before starting on our final tramp across Lake Winnipeg.

PHYSICAL GEOGRAPHY.

Country described.

The present Report refers to explorations made between north latitudes 56° and 65° and west longitudes 90° and 106°; an area bounded on the east by the west coast of Hudson Bay, on the south by the Churchill and Nelson rivers, on the west by the Chipman and Telzoa or Doobaunt rivers, on the north by the lower portion of Doobaunt River, including Aberdeen, Schultz and Baker lakes and Chesterfield Inlet. The area thus defined includes about 300,000 square miles.

Line of travel.

Through it a line was travelled northward from Black Lake to the forks of the Doobaunt River, while another line, roughly parallel to this, and from seventy-five to one hundred miles further east, was followed from Reindeer Lake to a point on Kazan River in north latitude 63° 8′. The lower eastward-flowing portion of Doobaunt River, with Chesterfield Inlet; the Ferguson River a hundred miles further south; and the west coast of Hudson Bay, from Chesterfield Inlet to Churchill, were also explored. Besides which, two lines were surveyed in winter from Fort Churchill to Nelson River.

Relief of surface.

The general relief of the whole country is very low and unpronounced, much of it having the appearance of vast undulating plains underlain by sandy or stony till and covered with stunted spruce and larch, or short grass and deciduous northern plants. Here and there rise rounded rocky hills, the highest of which, in the neighbourhood of Kasba Lake, have altitudes of about 1,700 feet above sea-level. North-east of Doobaunt Lake, some prominent hills of green trap and red conglomerate form conspicuous features in the otherwise monotonous landscape. From Kasba and Daly lakes the country has a general and moderately regular slope north-eastward, until it reaches the highest raised sea-beaches or post-glacial shore-lines, after which the slope is more directly eastward towards the present shore of Hudson Bay. South of Yath-kyed Lake and Ferguson River, the slope of the country was not directly determined, but it would seem to be almost directly eastward towards Hudson Bay.

Altitudes.

The following are the approximate altitudes of some of the principal features of the country, obtained by a comparison of the readings of two aneroids with standard mercurial barometers read at Fort Chippewyan, Fort Churchill and York Factory, and by estimations of the rise and fall of the streams :—

	Feet.
Selwyn Lake	1340
Height-of-Land north of Selwyn Lake	1350
Daly Lake	1290
Doobaunt Lake	500
Baker Lake	20
Kasba Lake	1270
Ennadai Lake	1100
Angikūni Lake	800
Yath-kyed Lake	300
Kaminūriak Lake	320
Highest shore-line, S.W. of Churchill	600

Divisions.

The country may conveniently be divided into two distinct portions, one of which may be designated as the "Interior Upland," and the other the "Coastal Plain."

Interior upland.

The Interior Upland lies south-west and south of Doobaunt and Angikūni lakes and has a mean elevation of from 900 to 1000 feet above the sea. Its surface is composed largely of sandy till and rounded boulders or broken fragments of rock, the latter of which are chiefly derived from rock in place somewhere in the vicinity. Low drumlinoid ridges of boulders are common over the surface, and rugged irregular hills of boulders mark the positions of moraines of the Keewatin glacier which centred in the northern part of the area. Long straight sandy ridges or eskers stretch across the country, extending in uninterrupted courses over the surfaces of hills and valleys alike. A few gravel beaches mark the shores of some small extra-glacial lakes, which existed in some places when the Keewatin glacier was finally retreating towards its centre of accumulation.

Coastal plain.

The Coastal Plain lies between the highest ancient post-glacial sea-beach and the present shore of Hudson Bay, sloping gradually from a height of 500 or 600 feet above the sea, down to sea-level. Much of the surface is composed of stony till, like that of the Interior Upland, but the till is diversified with sandy plains, and on all the steeper slopes gravel terraces or coast-cliffs mark the lines of the old sea-shore. Many of the terraces fill narrow gaps between adjoining hills, and the lower ones are often strewn with shells such as are found in the adjoining sea at the present time. The waves have reduced the surface irregularities of this portion of the country to some extent, but the more rocky portions in the vicinity of Chesterfield Inlet, are still, except for the presence of the little terraces, as rough and rugged as before they were covered by the sea, and the higher parts are probably barer, for any loose material that had been left by the glacier has been washed by the waves into the depressions. Farther south many of the stony hills seem to have been very little modified by the action of the waves.

The breadth of this plain in the vicinity of Fort Churchill is probably about fifty miles. Farther north it becomes broader, until in the latitude of Yath-kyed Lake it has a breadth of about 125 miles, and at the north end of Doobaunt Lake it has a breadth westward of 300 miles. North of the Doobaunt River its extent is not yet known, but many of the sand plains and terraces reported from the banks of Back's River probably mark old shore-lines on this coastal plain, there sloping northward to the Arctic Ocean.

River valleys.

As in the country south-west of Lake Athabasca, the rivers, however large or rapid, have not excavated deep valleys, and very often they flow in ill-defined channels over beds of boulders or rude fragments of broken rock. Whatever valleys may have existed in preglacial times were filled with glacial detritus during the glacial period. Since the disappearance of the Keewatin glacier, the streams have had very little power of erosion, for they are frozen up most of the year, and each spring, as they open, the ice packs the boulders that form their banks into massive walls which resist erosion almost as effectually as the unbroken rock itself. Besides this, the time since the disappearance of the glacier may not have been very long.

Watershed

The watershed, dividing the streams flowing westward into the Mackenzie River and those flowing eastward into Hudson Bay, strikes along the height-of-land north of Selwyn Lake, and thence turns southward to Wollaston Lake, through the centre of which it passes, for this large lake has two almost equal streams flowing from it in opposite directions.

Chipman River.

Chipman River discharges its waters into the Mackenzie. It flows from Selwyn Lake, which has an elevation of 1340 feet above the sea, and, together with this lake, it has a total length of ninety miles. In its upper portion it is a beautiful quiet stream, broken by but five rapids, which are passed by a similar number of portages, with an aggregate length of a mile and a quarter. Its lower portion, below Chipman Lake, is a wild broken torrent. The Indians do not attempt to navigate this part of the stream in their canoes, but they traverse a chain of six small lakes which are connected with each other and with

Black and Chipman lakes by seven portages, having an aggregate length of four miles.

Streams flowing to Hudson Bay.

The remainder of the country is drained by streams that flow more or less directly into Hudson Bay. Three of these have been examined, viz. :—The Doobaunt or Telzoa, the Kazan and the Ferguson, while two of the upper tributaries of the Thlewiaza River were also explored. Of the remaining streams, shown in dotted lines on the accompanying map, the mouths of some were seen on the shore of Hudson Bay, beyond which, all that is known of them, was learned from Eskimos or Indians.

Telzoa or Doobaunt River.

The Doobaunt River, the largest of the above-mentioned streams, rises in Daly Lake, at an altitude of 1290 feet above the sea, and flows north-northeastward for 285 miles, following its windings, to Doobaunt Lake, descending in this distance about 790 feet. Of this distance 175 miles is through the quiet water of larger or smaller lakes, while 110 miles is running water, which thus has an average descent of rather more than seven feet to the mile. The channel is shallow, and the banks and bed are both usually composed of boulders. Doobaunt Lake is a body of fresh-water of unknown extent, which, in August, 1893, seemed to be largely covered with still unbroken ice. Its shores descend in grassy slopes, and are the favourite feeding grounds of numerous bands of caribou.

Below Doobaunt Lake, this river continues its course north-north eastward for 142 miles, to the Forks, 94 miles of which is running water. In this distance is the heavy rapid above Grant Lake, in which the river descends 100 feet in two miles and a half.

At the Forks, the river turns abruptly eastward, and, passing through Aberdeen, Schultz and Baker lakes, discharges into the head of Chesterfield Inlet. Its total length from the head of Daly Lake to this point is 750 miles. If to this is added Chesterfield Inlet, extending from the mouth of the river to the west coast of Hudson Bay, the total length of the Doobaunt or Telzoa River is 875 miles.

Kazan River

The Kazan River rises in Kasba Lake, which lies fifty miles east of Daly Lake, and at about the same elevation. From this lake the river flows for 220 miles north-northeastward, parallel to the course of the Telzoa River, to the west end of Augikūni Lake. Throughout this distance the shores are sloping, and largely composed of boulders or boulder-strewn till. From the west end of Augikūni Lake the river turns sharply eastward for ninety miles, and then northward for thirty-five miles to the south-west angle of Yath-kyed Lake. Yath-kyed Lake has here a width of thirty miles, and appeared to extend a long distance south-eastward, for its south-eastern shore could not be seen from any of the hills ascended. From Yath-kyed Lake the river was again followed for twenty-five miles north-eastward, below which it has a probable length of ninety miles to its mouth on the south side of Baker Lake, giving it a total length of 490 miles. In its course it is not only approximately parallel to the upper portion of Telzoa River, but is also roughly parallel to the west shore of Hudson Bay.

Thlewiaza River.

Two of the upper tributaries of Thlewiaza River were examined. for an aggregate length of 100 miles. One of them heads in some small lakes on the north side of the moraine north of the head of Cochrane River, while the other rises near the south end of Kasba Lake. Flowing in almost opposite directions, through a boulder-strewn country, they unite their waters in Theitaga Lake, from which the Thlewiaza or Small-fish River is said to flow eastward to the west coast of Hudson Bay.

Cochrane River.

Cochrane River is one of the two almost equal streams that discharge the waters of Wollaston Lake. It flows from that lake north-eastward, following the general course of drainage adopted by the above-mentioned streams. In latitude 59° 7′ it strikes against a heavy moraine and by it is turned sharply southward. From this point it continues to flow in a southerly direction for 120 miles, until it empties into the north end of Reindeer Lake. Its total length is about 180 miles.

Ferguson River.

Ferguson River rises in Ferguson Lake, in latitude 63°, about twenty miles east of the north end of Yath-kyed Lake, and flows east-southeastward, parallel to Chesterfield Inlet, and at right angles to the course of Kazan River, directly into the west side of Hudson Bay. Its total descent, from source to mouth, is about 400 feet, and its total length is about 180 miles. In its lower portion it flows through a country of bare rocky hills, but the lakes in its upper portion lie in the midst of undulating grassy prairie.

Hudson Bay shore.

The shore of Hudson Bay has been described in some detail in a preceding part of the report. From Chesterfield Inlet, which is as far north as is known to the writer, southward to Wallace River, it is composed largely of bare rounded Archæan rocks, which descend rather steeply into the sea. In some places deep water extends up to the foot of the rocks, while in other places a terrace of sand and boulders, about the level of mean tide, extends seaward from the foot of the cliffs, forming shallow water for a few hundred yards from shore. In a few places strings or bars of boulders extend outwards a considerable distance from the rocky points. Many of the islands are bare rounded knolls of rock, while others, and especially those off the mouth of Neville Bay, are composed largely of sand and boulders.

From Wallace River to Churchill, the shore descends to the water with a much more gradual, even slope, and any rock exposures seen were low knolls of granite and gneiss rising but a few feet above the surrounding turf. This gentle slope continues seaward for many miles, and the beach, between high and low tide, usually several miles in width, has the appearance of a great muddy boulder-strewn plain.

Flora.

Forest.

The region may also be divided into Forests, and Treeless Plains, or "Barren Lands," by a line which curves around the bottom of Button Bay, and then continues within sight of the shore as far as Hubbart Point, beyond which it strikes north-westward, almost at right angles to the magnetic meridian, crossing Kazan River at the southern Narrows of Ennadai Lake, and Telzoa River about the middle of Boyd Lake.

Northern limit.

Black spruce and larch.

The forested country is chiefly wooded with small black spruce (*Picea nigra*), and larch (*Larix Americana*), while the lowlands are almost everywhere covered with deep mossy swamps. Proceeding northward the woods become confined to the lowlands and the tops of the hills remain treeless. Such are the conditions of the surface around Kasba and Daly lakes. Further northward the wooded plains give place more or less suddenly to level or rolling grassy plains, which constitute the Barren Lands. As the forest disappears, much of the surface is covered by deep frozen mossy bogs or tundras, but these occur only along the edge of the forest, and do not form part of the Barren Lands proper.

White spruce.

Besides the two species of trees above mentioned, the white spruce (*Picea alba*), grows to quite a large size on some of the dry eskers, and on the stony, well-drained, banks of the Telzoa River. It extends northward almost to Doobaunt Lake, forming a larger tree than either of the others. At Fort Churchill, near the shore of Hudson Bay, small white spruce were found to have entirely replaced black spruce in the swamps. A few miles farther inland, black spruce again takes its normal place in similar swamps, and white spruce almost disappears.

Banksian pine.

Banksian Pine (*Pinus Banksiana*) grows on the sandy plains along Stone River, and northward, on dry sandy ridges, as far as Selwyn and Theitaga lakes, but it does not extend as far north as spruce or larch.

Canoe-birch. Canoe-birch (*Betula papyrifera*) grows to a fairly large size on the esker at the head of Thlewiaza River, but as a rule it is a small tree in this region. It gradually decreases in size and disappears at the edge of the Barren Lands. Some small aspen trees (*Populus tremuloides*) was seen as far north as Daly Lake on Telzoa River, latitude 60° on the head-waters of Thlewiaza River, and at the mouth of Churchill River on Hudson Bay.

Aspen.

rren Lands. The Barren Lands, or more properly the treeless plains, characterize the larger part of the country depicted on the accompanying map. They consist very largely of rolling plains, underlain by stony till, and covered with short grass or sedge. Doubtless the ground is permanently frozen at no great distance below the surface, and the surface in summer is almost constantly wet, like the plains of Assiniboia and Saskatchewan in early spring. Rounded rocky hills rise here and there through the clay, and on these, as well as often on the more stony parts of the till, the surface is dotted with a thick growth of lichens, such as *Alectoria ochroleuca*, *A divergens*, and *Cetraria Islandica.* Many flowers brighten these plains during the short summer. A list of these, with the other plants, will be found in Appendix III.

Isolated groves of timber. On the banks of the streams that flow northward from the forest country, scattered groves of spruce and larch were met with far out into the Barren Lands, and their positions are marked on the accompanying map. It is also evident, from the amount of driftwood found at the forks of Doobaunt River, that groves exist on the west branch of that river, not very far above the forks. Some Eskimos, stopping at Churchill, also reported that there is an isolated wooded area, within the Barren Lands near the head-waters of the Thaanné River.

Fauna.

The following is a synopsis of the notes made concerning the fauna of the district :—

Fish. Fish seemed to be everywhere abundant in the lakes and streams, though very few were caught. The lake trout (*Cristivomer namaycush*) and whitefish (*Coregonus clupeiformis*) appeared to be the most abundant and valuable food fishes, the latter being especially abundant in Doobaunt Lake. Pike (*Esox lucius*) and one or more species of suckers, were also seen. It is probable that some of the true salmon ascend the inlets and streams west of the northern part of Hudson Bay, but the fact was not definitely determined.

Birds were remarkably scarce throughout the whole region. A flock of the beautiful Bohemian Wax-wings (*Ampelis garrulus*) were seen in a grove of birch trees, near the shore of Theitaga Lake, on their breeding grounds. Water-birds were scarce in the interior, back from the shore of Hudson Bay. Ducks were rarely seen, for the clear water of the lakes and streams does not seem to furnish them with food, but the American Merganser (*Merganser Americanus*) was occasionally seen near rapids. Both the Common and Red-throated Loons (*Urinator imber* and *U. lumme*) were common in the smaller lakes, and made the nights hideous with their screechings. Towards the shore of Hudson Bay the Black-throated Loon (*U. arcticus*) was also occasionally seen and was often heard. Near the north shore of Doobaunt Lake a brood of Canada geese (*Branta Canadensis*) was seen, and several flocks were observed later in the year on the sandy plains near the west end of Aberdeen Lake. Birds.

The Canada and Ruffed Grouse (*Dendragapus Canadensis* and *Bonasa umbellus*) are not uncommon in the wooded country, and the Sharp-tailed Grouse (*Pediocœtes phasianellus*) was seen near York Factory. The Willow and Rock Ptarmigan (*Lagopus lagopus* and *L. rupestris*) were abundant in summer throughout the Barren Lands, and the former species collects in great numbers in the woods as soon as winter sets in.

Moose (*Alces Americanus*) were found on Stone River, but were not found farther north. Barren-ground Caribou(*Rangifer Groenlandicus*) roam in scattered herds almost everywhere over the Barren Lands. One vast herd, which at the time was estimated to contain from one to two hundred thousand deer, was seen on the shore of Carey Lake. These deer were migrating southward towards the edge of the woods, where they would spend the winter. Musk oxen (*Ovibos moschatus*) seem to be confined to the country north of that portion of the Doobaunt River between Doobaunt Lake and Hudson Bay. None were seen in the course of either of the two expeditions, but the Eskimos at the head of Chesterfield Inlet had a number of fresh skins. The Eskimos on Kazan River reported that there were no musk oxen in their neighbourhood. Moose. Caribou Musk ox.

The wolf (*Canis lupus occidentalis*)—both gray and white varieties were found in this region, the former roaming northward a little beyond the limit of the timber, the latter being common throughout the Barren Lands. During the summer, while the young pups are unable to travel far, the wolves remain in families in one locality, but during the autumn and winter they roam from place to place. Wolf.

Foxes. Red, black and cross foxes (*Vulpes vulgaris*) range as far north as the northern limit of timber, but they do not extend over the Barren Lands. The white fox (*Vulpes lagopus*) is found everywhere on the Barren Lands, but more especially along the coast, where it appears to be very numerous. Wolverine. The wolverene (*Gulo luscus*) is one of the most common carnivorous animals throughout the whole region. It doubtless lives on any of the other animals that it is able to overcome, but it would seem to be particularly adept at hunting cariboo. In one instance four of these animals were following one full-grown deer, and they seemed to be driving it gradually down into a lake.

Marten. Marten (*Mustela Americana*) are particularly abundant in thin woods in the more southern part of the district. Otter. Otter (*Lutra Canadensis*) also live on the banks of the streams throughout the wooded country, but neither of these two species appeared to extend into the Barren Lands.

Bears. The Black Bear (*Ursus Americanus*) has a similar range towards the north. White Bears (*Thalassarctos maritimus*) were seen on several occasions near the shore between Wallace River and Churchill, but they are no longer abundant, as they would appear to have been a century or more ago. Hare. The Arctic hare (*Lepus glacialis*) was found to range everywhere throughout the Barren Lands from the edge of the woods northward, but it was nowhere found in any abundance.

Natives. A few bands of Chippewyan Indians inhabit the more southern portions of the region shown on the accompanying map, roaming Chippewyans. northward towards the edge of the Barren Lands. They live chiefly on the fish which they catch in the rivers and lakes, and on the Barren-ground Caribou, which they kill in large numbers as these animals attempt to swim across the rivers and narrow parts of lakes. During the winter they trap some fur-bearing animals, chiefly martens, which, in the spring, they take to the traders at Lake Athabasca, Reindeer Lake, or Churchill, and exchange for guns, ammunition, hardware, tobacco or such other articles as they may need. They then scatter to the lakes, where they live on fish throughout the summer. In the autumn they again return to the traders, with a few more furs, after which they depart into the woods to live in their tents, or camps made of brush and moss, for the winter, and are usually not seen again until the following spring. They are timid and sombre in disposition, and rarely make any exuberant display of either joy or sorrow.

Eskimos. The Eskimos, who live chiefly on the banks of Kazan River, north of the edge of the woods, are quite different in disposition from their morose neighbours to the south. Active and volatile, they have no hesitation in exhibiting their emotions. One moment they would be uproariously happy, and the next they would be shedding floods of tears.

Food and clothing.

The tribe of Eskimos met with in the summer of 1893 and 1894, live almost entirely on deer, which they spear from their kyacks while the animals are swimming in the water. Several hundred carcases of deer might be seen around one camp, and what were not immediately used, were piled in heaps, and buried under large stones, so that they would be safe from wolverenes, and available for use during the following winter. Their clothing, both for winter and summer, is made of deerskin, and their kyacks, or single canoes, are made of deerskin parchment, sewed over a light wooden frame.

Number.

This tribe of Eskimos appeared to number between five and six hundred souls. They seem to live entirely inland, and thus to differ from the maritime seal-hunting Eskimos who inhabit all the Arctic coasts from Greenland around to Behring Sea.

Language.

Their language is very distinct from the Eskimos of Labrador and the north side of Hudson Straits, and also from that of the Eskimos of the delta of the Mackenzie River. A vocabulary of about 300 words was taken down with great care from one of the two men who accompanied us down the Kazan and Ferguson rivers, and is given in Appendix II.

GEOLOGICAL SUMMARY.

Classification.

The rocks and geological features described in detail in the preceding portion of this Report, may be briefly classified according to the following scheme :—

Recent.

Present shore-lines of Hudson Bay, and of the lakes in the interior. River channels, with their low and often stony banks. Weathered and fractured rock surfaces.

Pleistocene.

Old shore-lines of the sea, rising to heights of from 500 to 600 feet above the present sea-level, marked by gravel beaches, coast-cliffs, terraces, etc. Old lake shores, such as those of Hyper-Kasba Lake, sand plains, &c.

Till, Drumlins, Moraines, Eskers, Ispatinows.

Silurian.

Loose masses of limestone at Churchill, which have evidently been derived from rock in place somewhere in that vicinity.

Cambro-Silurian.

A small outlier of Trenton limestone on an island in Nicholson Lake. A still smaller outlier near Fort Churchill. The limestone on Sturgeon and Beaver lakes.

Cambrian.

Athabasca sandstone and conglomerate. Masses and dykes of dark-green basic eruptive rocks, such as pitchstone, diabase, minette, etc. Flows and dykes of reddish acid eruptive rocks, such as rhyolites or quartz-porphyries, andesites, augite-porphyrites, etc. Churchill arkose.

Huronian.

Marble Island (white) quartzite. Greenish quartzite, intimately associated with eruptive rocks. Diabase and gabbro.

Laurentian.

An undifferentiated mass of granite and granitoid gneiss, undoubtedly representing in the main the Fundamental Gneiss of other parts of the Protaxis, in regard to the age of which very little new information has been obtained in this region. With these rocks, on the north shore of Baker Lake, are associated some bands of reddish crystalline limestone, possibly representing parts of the Grenville series of the better-known parts of Canada.

LAURENTIAN.

Application of name.

The name Laurentian is thus here applied almost exclusively to the crystalline, massive, or altered, crushed and contorted rocks of the Fundamental Gneiss or "Basement Complex," consisting of granites and diorites, and granite and diorite-gneisses which it has so far been impossible to separate in any definite time-series.

Granite and gneiss.

As a rule, the massive and gneissic rocks are very similar in composition, and, in the opinion of the writer, are different phases of development of the same fluid or semi-fluid magmas, though in different places and at different stages in development of the crust these magmas have differed considerably in composition. On the north shore of Baker Lake, the gneisses, as above stated, are associated with bands of red crystalline limestone similar to those found in the Grenville series in southern and eastern Canada, but nothing definite was determined respecting the true character or origin of these bands. Some portions had a decidedly clastic appearance, but it seemed very difficult to draw any line between these and the surrounding granitoid gneisses.

Crystalline limestone.

As yet, it is very uncertain what proportion of the region shown on the accompanying map is underlain by these rocks, but the three north-and-south lines of travel explored would seem to indicate that they underlie most of the country between latitudes 59° and 62°, though from this must be taken the Huronian area around Kasba and Ennadai lakes. On the most westerly line of travel, the granites and gneisses extend northward from Black Lake to Doobaunt Lake. Thence they continue north-eastward along the west shore of Doobaunt Lake and down the Doobaunt River to Lady Marjorie Lake, though throughout this distance they are often in contact with the overlying Huronian and Cambrian rocks. North of Lady Marjorie Lake the Laurentian rocks disappear under the Cambrian strata, and they are not again seen until the Cambrian belt is crossed and the north shore of Schultz Lake is reached. Proportion of country underlain.

On the second line of travel, the Laurentian rocks underlie the country from Reindeer Lake northward, across the head-waters of Thlewiaza River, to Kasba Lake, throughout which distance they appear to be largely represented by massive granites. From the south end of Kasba Lake, northward for seventy-five miles, the country is thickly covered with drift, but the few rock exposures seen, and the abundance of broken angular rock-masses, indicated the presence of an area of Huronian.

From Ennadai Lake north-eastward, to beyond Yath-kyed Lake, with the exception of a small Huronian area near Angikūni Lake, granite and gneiss seemed to be the prevailing rocks.

On the low flat shore of Hudson Bay, between Seal River and Cape Esquimaux, few rock exposures occur, but those seen consisted of granites and gneisses of typical Laurentian aspect. For forty miles north of Cape Esquimaux, no rock in place was seen, and thence north-eastward to Baird Bay some of the points consisted of granite and gneiss, though the shore generally consisted of Huronian rocks.

The country along the upper portion of Ferguson River is also underlain by Laurentian gneisses.

Similar granites and gneisses occur along the north shore of Baker Lake, and down both shores of Chesterfield Inlet to its mouth, whence they extend southward along the shore of Hudson Bay to a short distance north of Baker's Foreland.

Huronian.

The largest area of Huronian rocks found in this district, extends more or less continuously for 120 miles along the west coast of Hudson Bay, from near Baker's Foreland to a point forty-five miles north Areas.

of Cape Esquimaux. From the shore of Hudson Bay inland, up Ferguson River, they were traced for seventy miles.

Another area was crossed while descending the Telzoa River between Schultz and Baker lakes. A third occurs on the Kazan River below Angikūni Lake. A fourth appears in the basins of Kasba and Ennadai lakes. Fifth and sixth areas are represented by outcrops of white clastic quarzite on the north shore of Doobaunt Lake, and on the east shore of Wharton Lake.

The rocks constituting this system may be divided into three more or less distinct groups, viz. :—The Marble Island quartzites; the greenish quartzites and graywackes; and the more or less highly altered and often schistose diabases and gabbros.

Marble Island quartzite.

The Marble Island quartzites are composed of hard white quartzite consisting of more or less rounded grains of quartz, of moderately regular size, cemented together by intestitial silica. They are very distinctly bedded in thick or thin beds, and the surfaces of the beds are often covered with beautiful ripple-markings. The heavier beds also often show distinct false-bedding. They are usually in a more or less inclined attitude, but they were nowhere seen to be very much crumpled or squeezed into minute folds. Their total thickness was not determined.

These quartzites were first noted by Dr. Bell from Marble Island, and though this island was not examined by the writer, rocks of undoubtedly similar character to those described by Dr. Bell, were seen at many places on the shore, and consequently the name is here retained.

In one place, near the *câche* on the west shore of Hudson Bay, a thickness of sixty feet of this quartzite, in a nearly vertical attitude was seen almost in contact with the Laurentian gneiss, there being but a narrow drift-filled gap between the two. This would indicate either the existence of a fault, or that here the quartzites are the base of the Huronian, or that the gneiss represents an eruptive rock which has risen up through or into the Huronian subsequent to the deposition of the quartzites.

The white quartzites on the north shore of Quartzite Lake, dip regularly north-westward, away from the hills of diabase to the south, and the latter, therefore, probably underlies the quartzite, though it is not necessarily older than it. In other places very little evidence was obtained as to the relative ages of the white quartzite and the other parts of the Huronian. However, it would seem not improbable that this Marble Island quartzite is the oldest part of the Huronian in the region near the shore of Hudson Bay, and that the diabase, and other basic eruptions which are associated with it, have been intruded beneath it, and have also flowed over it.

That the Marble Island quartzites were once extensively spread over a large portion of the region under consideration, is shown not so much by the few scattered outliers mentioned above, as by the fact that the overlying Cambrian conglomerates, covering such large areas south-east of Lake Athabasca, and between Doobaunt and Baker lakes, are composed largely of pebbles of this white quartzite, while the Churchill arkose also contains pebbles of similar clastic quartzite.

In the vicinity of Kasba Lake, numerous boulders and angular fragments of Huronian rocks were seen, among which were many of greenish quartzite, and coarse schistose conglomerate containing large rounded pebbles of gneiss, indicating the presence of these rocks in the immediate vicinity, but the rock itself was not seen.

Eruptive rocks.

Dark-green eruptive rocks, chiefly diabase, often very much squeezed and altered, are largely developed in the Huronian, composing a considerable proportion of the rocks of this system. On the west coast of Hudson Bay, these rocks are cut by many veins of white quartz, highly charged with iron- and copper-pyrites.

Graywacke.

Associated with the massive diabases, and often indistinguishable from them except on close examination, are many beds of fine-grained, often schistose, graywacke, or greenish quartzite, which appear to have been caught up in, or surrounded by, the eruptive rocks. Whether they have formed a portion of the Marble Island series, or whether they are quite independent of it, has not been determined, but the former hypothesis would seem to be the more probable.

CAMBRIAN.

Athabasca sandstone.

The Athabasca sandstones and conglomerates represent the basal portion of the Cambrian in the northern part of the country shown on the accompanying map. They consist of 400 feet or more of reddish thick-bedded sandstone or conglomerate, often showing false-bedding, and are comparatively unaltered and undisturbed over large areas. In some places, as on the islands near the north-west shore of Doobaunt Lake, they dip regularly at a moderate angle.

Composition.

The rock varies from a coarse conglomerate to a fine-grained red mottled sandstone. The pebbles in the conglomerate are well-rounded and waterworn, and consist almost entirely of white clastic quartzite like that of the Huronian. The occurrence of quartzite pebbles, to the almost total exclusion of pebbles of Laurentian rocks, would indicate that these Cambrian strata were deposited off a shore composed very largely of Huronian quartzites.

Acid eruptives.

The Athabasca sandstones are cut by dykes and masses of both acid and basic eruptive rocks. The acid eruptives were first met with in a hill of red quartz-porphyry at Teall Point, on the west shore of Doobaunt Lake. A similar massive quartz-porphyry forms a heavy east-and-west dyke some distance further north on the shore of the same lake, and in the vicinity of the dyke the surrounding conglomerate is very much hardened, so that it breaks indifferently through the matrix or through the pebbles. In places the porphyry contains little or no quartz.

Towards the north end of Doobaunt Lake, the orthoclase of the porphyry is replaced by plagioclase, thus forming an andesite or dacite. This andesite is largely developed, and seems to underlie a large tract of country, along the Doobaunt River between Lady Marjorie Lake and the Forks, and again it was found on the islands towards the east end of Baker Lake.

Basic eruptives.

Dark-green basic eruptive rocks, chiefly, or perhaps exclusively, in the form of dykes, are more or less extensively developed throughout the area covered by the Athabasca series, often altering these rocks into a quartzite or quartzitic conglomerate.

On Doobaunt Lake, and on the Doobaunt River near the Forks, most of these dykes are of more or less typical diabase, showing ophitic structure, with interlocking lath-shaped crystals of plagioclase, between which are crystals or crystalline masses of augite, often altered to chlorite. Apatite and iron ore are also usually present.

The heavy dyke, cutting the conglomerate at the gorge above Grant Lake, has a much newer appearance, being composed of a dark pitchstone with glassy matrix, through which are scattered many minute feathers of iron ore.

The heavy diabase dyke, crossing the Telzoa River at Loudon Rapids, cuts the surrounding acid eruptive rocks, and is clearly newer than them. In most cases, however, the acid and basic eruptive rocks were not seen in contact, and their relative ages were not determined; but since the latter are also common in the Huronian and Laurentian, it would seem probable that some are older, and some are newer than the acid eruptives.

Absence of fossils.

Though fossils were carefully looked for in the Athabasca sandstones, none could be found, so that the age of this formation must be determined on stratigraphical and lithological grounds alone.

Stratigraphical position.

That they are separated from quartzites of the Huronian by a great unconformity, is shown by the fact that the conglomerates are composed largely of rounded and waterworn pebbles of these quartzites, which had therefore been altered, hardened and recemented with interstitial silica, before they were broken down by meteoric agencies, and carried out into the water off the shore to form the later conglomerates. They are also certainly older than the flat-lying Cambro-Silurian limestones which were seen on Nicholson Lake, for, though the two were not seen in contact, pebbles and boulders of Trenton limestones were found in many places, evidently derived from other outliers of the limestone than the one seen, and none of them showed any signs of alteration from contact with the numerous trap flows that cut the sandstone and conglomerate. Therefore, since they hold a position unconformably above the Huronian and below the Cambro-Silurian, they may be assigned with probability to the Cambrian. Lithologically the whole terrane presents a remarkable resemblance to the red sandstones and Cambrian quartz-porphyries of the Keweenawan rocks of Lake Superior. This resemblance is so strongly marked that small specimens of rocks from the shore of Doobaunt Lake, are usually indistinguishable from specimens from Lake Superior. The two terranes are regarded as holding similar positions in the geological time-scale.

The Athabasca series was first met with during the explorations here reported on at Teall Point, on the west side of Doobaunt Lake, and thence it was found to underlie many of the islands and more prominent points along the west and north shores of the lake, to its outlet. Whether it extends eastward to, or beyond, the east shore of the lake was not determined, but it is not improbable that the lake lies in a basin underlain by these rocks. Extent.

From the north end of Doobaunt Lake, northward to the Forks of Doobaunt River, the sandstones and traps occur at intervals, overlying the Laurentian granites and gneisses. From the Forks the Athabasca series extends eastward, along both shores of Aberdeen Lake and on the south shores of Schultz and Baker lakes, as far as Bowell Island, a total distance of 180 miles. Whether it continues farther eastward was not determined. These rocks were not observed on Kazan River, as far as this stream was descended, but below Yath-kyed Lake many boulders of red sandstone and quartz-porphyry were scattered about, and the till had quite a reddish colour, as if it had been derived from these rocks.

Toward the west, the Athabasca series probably extends a long distance up the valley of the Thelew River, and may perhaps cross the low watershed and connect with the similar rocks on the shores of Great Slave Lake.* The reported existence of low flat country, through

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*Note to accompany a Geological Map of the Northern (N.S.) Portion of Canada, by George M. Dawson, Annual Report Geol. Surv. Can., vol. V., 1886, p. 16 R.

which there is a passable canoe-route from Great Slave Lake, to the Forks, would favour the assumption that the region is underlain by these flat-lying sandstones. It is not improbable also that the Athabasca series continues north-westward, and is directly connected with the Cambrian sandstone, traps and quartz-porphyries (?) on the Coppermine River, from which the Indians have, for ages, obtained a supply of native copper.*

The sandstones of the Athabasca series, which occur in the south-west corner of the accompanying map-sheet, and which extend into the large region south and east of Lake Athabasca, have already been described by the author in his "Report on the Country between Athabasca Lake and Churchill River." They are there very similar in character to the beds further north, and in fact, it is quite possible that the two areas may be connected down the valley of Slave River, and through the valley of Great Slave Lake.

Churchill arkose sandstone.

The Churchill arkose sandstone is also placed provisionally in the Cambrian, though its exact position is still somewhat uncertain. It consists of a highly felspathic quartzite, very much hardened, and tilted at various angles. It is thick-bedded, and often shows false-bedding. The grains are moderately well-rounded and rather even, but a few of the beds contain well-rounded pebbles, up to the size of one's fist, of white quartzite like that of the Huronian of Marble Island. It is also cut by occasional veins of white quartz.

The rock is very much more altered than most of the sandstone of the Athabasca series, but it resembles it in containing pebbles of the white quartzite, and it lies unconformably below the Cambro-Silurian limestones.

Cambro-Silurian.

The only representatives of rocks of this age found within the area of the accompanying map, are two small outliers; one on an island near the north end of Nicholson Lake, and the other just north of the mission at Churchill.

Nicholson Lake outlier.

The exposure in Nicholson Lake occurs for 130 paces along the shore of a small low island. It consists of a few feet of white limestone in regular beds, slightly tilted so that it dips at a low angle towards the west. Fossils seemed to be scarce and poorly preserved, but the few that were found indicate that it is of about the age of the Trenton of Eastern Canada.

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* *Loc. cit.* p. 28 R., *et seq.*

The only determinable species found are enumerated on pp. 55 and 56.

Other areas of similar limestone doubtless also occur in the vicinity, for a few boulders of white limestone were found on the surface at various points north of Barlow Lake, but none of these areas were located.

Churchill outlier.

The Churchill outlier consisted of a few square feet of yellowish compact limestone in the bottom of a fissure, along a line of bedding in the Churchill arkose. It was composed largely of three species of corals, which seemed to be in the same position in which they originally grew on the surface of the arkose. Associated with the corals were broken fragments of shells of Orthoceratites, etc. The occurrence was so small that it was almost entirely worked out by the writer. The rock was very similar to the Trenton limestone of Manitoba, and the fossils collected from it and enumerated on page 91, would indicate a horizon near the upper part of that series.

Besides the small exposure of Trenton limestone found in place, many angular fragments of similar limestone are scattered along the beach, showing the presence of larger areas in the vicinity.

The only other outcrops of Trenton limestone, etc., examined during the seasons of 1893 and 1894 were on the shores of Pine Island, Sturgeon and Beaver lakes. These will be found described on page 101.

SILURIAN.

Silurian rocks in place were not seen during the course of the two explorations here treated of. But masses of white limestone are scattered along the river bank near Churchill, having evidently been derived from some parent beds near at hand.

Loose masses near Churchill.

The limestone is very similar to that found at the mouth of the Saskatchewan River, and four at least, out of the five species of fossils here collected and enumerated on page 91, are common to these two localities, and three of them have, as yet, not been found elsewhere.

PLEISTOCENE.

There is probably no part of North America to which the student of glacial geology looks with greater interest than to the region lying north-west of Hudson Bay, for, during a part, or perhaps during the whole, of the glacial period, there here existed a great névé or "gathering ground," from which the ice flowed outward in all directions.

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* See Report on North-western Manitoba, by J. B. Tyrrell, pp. 202 E and 203 E. Ann. Rep. G.S.C., vol. V. (N.S.) 1890-91.

Keewatin glacier.

The vast glacier thus formed has been called by the writer the Keewatin Glacier, from the Cree Indian word Kī-wē′-tin, which means north, or north wind, and the name is considered appropriate, not only because the gathering ground lay partly within the district of Keewatin, but also because it was the most northern of three great centres of glaciation—the Cordilleran, the Keewatin and the Labradorean.

Intermediate in time and position.

Previous observations have shown* that the Keewatin glacier was intermediate in time, as in position, between the first and last of those above-named. But, unlike them, the centre, from which its ice flowed outwards in all directions, was situated on a wide and moderately level plain, which is now from 400 to 800 feet only above sea-level and slopes seaward from higher land towards the south-west. Whether this plain was higher during any part of the glacial epoch than it is at present, has not as yet been determined, but no satisfactory evidence of such elevation has been found.

At the close of the glacial period the land here stood several hundred feet below its present level, as is shown by the old beaches which rise one above another to heights of from 500 to 600 feet above sea-level on the maritime plain west of Hudson Bay.

Absence of evidence of high elevation of the land.

As may be seen by reference to the accompanying sketch-map, the centre (or centres) of ice distribution was situated close to the sea. If the Arctic Sea and Hudson Bay were open, as they are at present, they would have furnished a supply of moisture which, in the prevailing low temperature of that epoch, would have been precipitated as snow on the adjoining land. The snow would have gradually accumulated to a great depth, and would thence have spread outwards with a long easy slope towards the interior of the continent, and a more rapid descent towards the sea-coast. This would agree with all the phenomena observed, and appears to the writer to represent the conditions that obtained here in glacial times. A general rise of the land of 700 feet above its present level, would have drained Hudson Bay, and would have carried the water a long distance from the present Arctic coast. If these conditions had prevailed, it is exceedingly difficult to understand whence the moisture could have been derived to form the vast accumulation of ice which, apparently, covered the interior plains of the north from the State of Iowa northward to the Arctic Ocean.

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* Glacial Deposits of South-western Alberta, by G. M. Dawson. Bull. Geol. Soc Am., vol. VII., pp. 31-66, 1895.

The Genesis of Lake Agassiz, by J. Burr Tyrrell. Journ. of Geol., vol. IV., No. 7, 1896, pp. 811-815.

If the land was not higher than it is at present, the ice must have accumulated to a great thickness to enable it to move southward and south-westward over the gradually ascending country, but that the ice of the glacial period did ascend to very considerable heights, has been shown by many observers. Nowhere is this ascent more conclusively seen than on the Duck Mountains in Northern Manitoba. These are high hills of Cretaceous shales and sandstones rising from 1000 to 1600 feet above the low and moderately level country towards the north and north-east, which is underlain by Archæan and Palæozoic rocks. The summits of these hills are morainic accumulations, composed largely of boulders which have been derived from the older rocks of the low country, and which have been raised to their present position by the Keewatin glacier as it moved upwards from the north. Upward movement of the ice.

The whole of the northern country near the centres from which the Keewatin glacier was distributed, is composed of a vast irregular plain of till, through which rise rocky knolls, formed largely of more or less angular fragments of local rock. Some of these knolls are very much fractured, and often a whole hill seems to consist exclusively of broken angular masses of rock, the underlying, unbroken rock being entirely hidden from view. The contrast between the scraped and bare rock-surfaces further south, as in the vicinity of Reindeer Lake, and the undecayed, but broken and débris-covered surfaces in the north, is very marked.

Striæ.

As is shown on the accompanying map, most of the glacial striæ between Lake Athabasca and Doobaunt Lake point in a west-south-westerly, or westerly direction, but on Doobaunt Lake, and on the upper portion of the Telzoa River, there is an earlier set pointing southward. Between Doobaunt and Baker lakes the later striæ gradually swing round towards the north-west. Further east, on the course from Cumberland House, on the Saskatchewan River, to Kasba Lake, the striæ all point a little west of south, and no evidence could be found that at any time during the glacial period did the glacier move in any direction but that indicated by these striæ. General direction

On the rocks of the coast north of Churchill, all the striæ point more or less directly down into Hudson Bay, and the smoothly rounded landward slopes, the craggy broken cliffs facing seaward, the crescentic cross-fractures and boulder-trains, all show that the ice flowed towards Hudson Bay, and furnish strong evidence that it never moved in an opposite direction. The evidence collected in 1893 in regard to this eastward flow of the ice, was confirmed and strengthened by the additional facts obtained on portions of the same coast in 1894.

Possible exception.

The only observation which is at variance with this general result is the existence of an early set of striæ, pointing westward, on the rocks at Churchill. Whether these striæ were made by a glacier flowing from a centre near at hand, or at a distance, was not determined. They do not accord with the striæ attributed to the Labradorean glacier along Nelson River and further south, for while the west-pointing striæ at Churchill were earlier than those of the Keewatin glacier, those of the Nelson River and further south are clearly later.

Rounded hills at Churchill.

The rocky hills at Churchill are well rounded on almost every side, having been planed by glaciers moving in turn from the east, the south-west and the north. Even a casual observer could not but recognize the difference between these hills and the broken rocky elevations further north, with their strongly marked stoss and lee sides, nowhere showing any evidence of a glacier having approached or over-ridden them from the seaward side.

These seaward-pointing striæ may be seen on most of the rocks on Ferguson River, and on the shores of Chesterfield Inlet as far up as Baker Lake, at which place they overlie, and intersect the striæ pointing north-westward.

On the shores of Yath-kyed Lake, and on the banks of Kazan River upwards to Angikũni Lake, the main direction of striation is south-eastward, but there is a later, and apparently local, set pointing north-westward.

Observations around Great Slave Lake, down Back River and along the Arctic shore, as well as in the country between Cochrane and Kazan rivers and the west coast of Hudson Bay, are greatly needed to supplement the observations taken in this interior northern country. The information which we have attempted to set down in the present report, and to briefly outline here, seems to indicate clearly the following stages in the growth and decline of the Keewatin glacier :—

Three stages in the growth and decline of the Keewatin glacier.

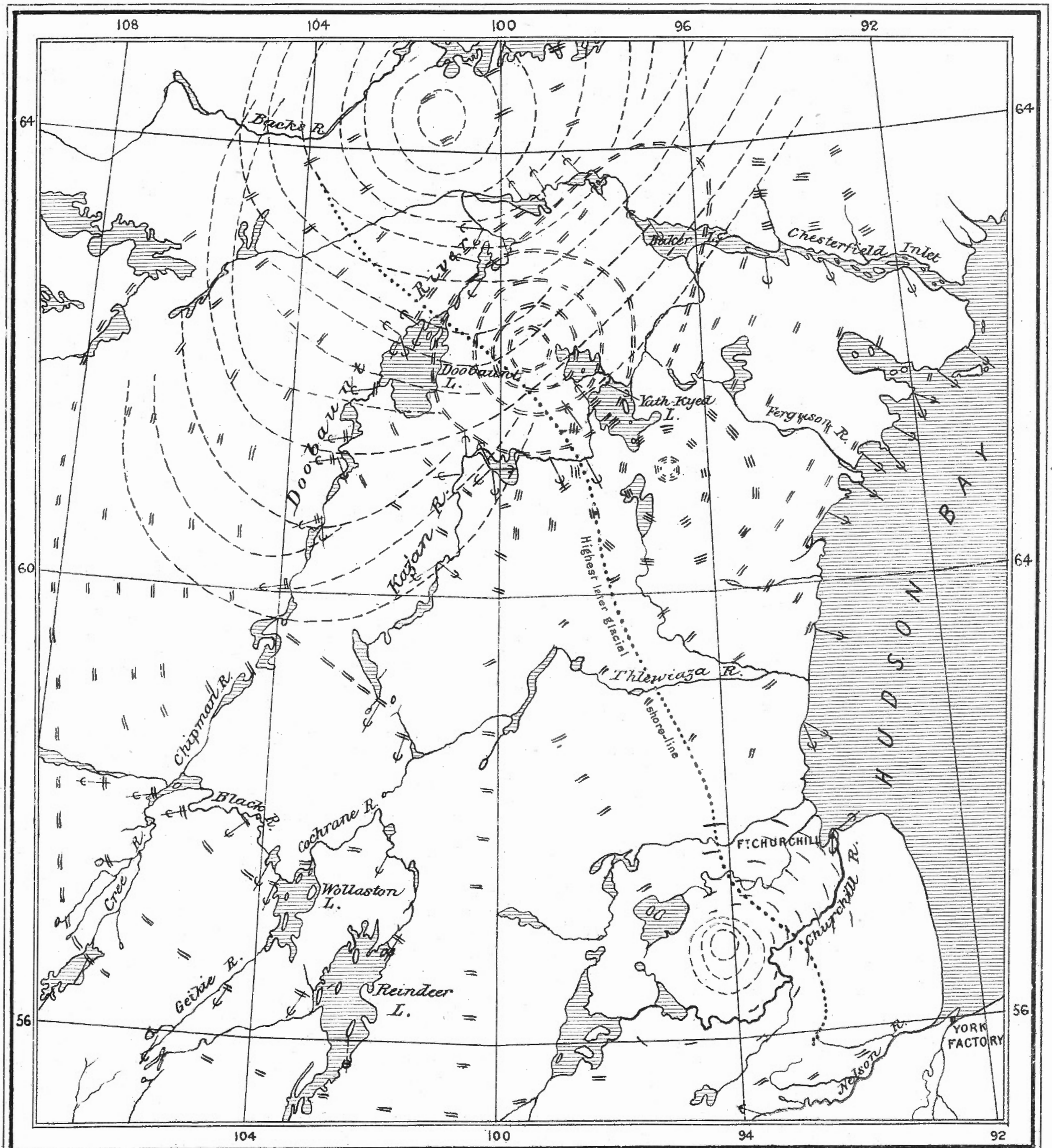
1st. A centre north-west or north of Doobaunt Lake, probably between the Telzoa and Back rivers, from which the ice flowed southward, at least as far as north latitude 60°, though it may have extended over the Great Plains, and have there formed the lower boulder-clay. It no doubt also spread outwards from the centre in other directions.

2nd. As the ice increased in thickness, and perhaps after a warmer period, the centre of distribution moved south-eastward until it rested

Geological Survey of Canada

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

1897



Accompanying Part F, Vol. IX, 1896.

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Diagram

showing three positions successively occupied by the

Centre of the Keewatin Glacier

over the country that is now almost surrounded by the Doobaunt and Kazan rivers below Doobaunt and Angikūni lakes. At this point the ice must have been of great thickness, for it flowed outwards in all directions, reaching, in the writer's opinion, to within a short distance of the base of the Rocky Mountains on the west and far into Minnesota, Dakota and Iowa on the south.

3rd. When the Keewatin glacier had greatly diminished in size, the centre of distribution moved still nearer to the sea-shore, and probably broke into several distinct glaciers. One of these was situated on the hills south-east of Yath-kyed Lake, while another seems to have been located north of Baker Lake.

The following is a list of the glacial striæ observed in 1893 and 1894, with the exception of those recorded in my previous report on the country between Athabasca Lake and Churchill River :— List of striæ.

List of Glacial Striæ.

	Direction.
Athabasca River :—	
Cascade Rapid	W.
Chipman River :—	
North end of Portage from Black Lake	S. 45° W.
Telzoa River :—	
Daly Lake, north side of Narrows	S. 80° W.
(1st set)	S. 60° W.
" latitude 60°	S. 85° W.
" island in northern expansion	S. 70° W.
(1st set)	S. 25° W.
" island two miles east of above island	S. 73° W,
" island near north-east end	S. 75° W.
" near north end	S. 75° W.
Hinde Lake, west shore	S. 80° W.
Midway between Boyd and Barlow lakes	S. 5° E.
Five miles above Barlow Lake	S. 80° W.
Barlow Lake, near south end	S. 80° W.
Cairn Point in Carey Lake	S. 85° W.
Carey Lake, four miles from its outlet	S. 85° W.
Carey Lake, outlet	S. 80° W.
(1st set)	S. 20° E.
Four miles below the outlet of Carey Lake	S. 85° W.
Two miles below the last	S. 88° W.
(1st set)	S. 20° E.
Markham Lake, west shore	S. 86° W.
Doobaunt Lake, at mouth of Telzoa River	S. 87° W.
" " five miles farther north	N. 80° W.
" " mouth of Sunset Creek	N. 80° W.
(1st set)	S. 30° W.
" " two miles east of north-west angle	S. 20° W.

Doobaunt Lake, north-west angle	(3rd set)	N. 50° W.
	(2nd set)	S. 20° E.
	(1st set)	S. 20° W.
" " north shore		N. 50° W.
" " " " two miles S.E. of last	(3rd set)	N. 40° W.
	(2nd set)	N. 60° W.
	(1st set)	S. 23° W.
" " point at Narrows, 3 miles farther east		N. 35° W.
Wharton Lake, quartzite hill	(2nd set)	N. 70° W.
	(1st set)	S. 33° W.
Lady Marjorie Lake, east shore		N. 60° W.
Nine miles below Lady Marjorie Lake	(2nd set)	N. 85° W.
	(1st set)	S. 25° W.
Aberdeen Lake, north shore		N. 35° W.
Between Aberdeen and Schultz Lakes		N. 28° W.
Schultz Lake, east end		N. 47° W.
Nine miles below Schultz Lake		N 47° W.
Eight miles above Baker Lake		N. 50° W.
Baker Lake, mouth of Prince River	(2nd set)	S. 29° E.
	(1st set)	N. 54° W.
" " nine miles east of Prince River		S.
" " bay east of Stone Tower		S. 13° W.
Chesterfield Inlet:—		
Mouth of Telzoa River	(3rd set)	S. 43° E.
	(general) (2nd set)	S. 3° E.
	(1st set)	S. 65° W.
Island off Flat Point		S. 17° W.
Seven miles west of Bold Point		S. 23° E.
Four " " "		S. 23° E.
Low Point		S. 17° E.
North shore in east longitude 93°		S. 17° E.
One mile east of Dangerous Point		S. 20° E.
Small island opposite Poston Point		S. 50° E.
Observation Point		S. 86° E.
Sturgeon River:—		
East side of Sturgeon Lake		S. 20° W.
Red Rock Portage		S. 25° W.
Island in Beaver Lake		S. 20° W.
Above Snake Portage		S. 10° W.
Leaf Portage		S. 15° W.
Birch Portage		S. 15° W.
Dog Portage		S. 10° E.
Portage above Pelican Lake		S. 25° W.
Pot-hole Portage	(2nd set)	S. 30° W.
	(1st set)	S. 15° W.
Reindeer River:—		
White Sand Falls		S. 17° W.
Rock Portage		S. 17° W.
Cochrane River:—		
Seven miles above Reindeer Lake		S. 35° W.
Eight " " " "		S. 30° W.
Latitude 58° 22′ 45″		S. 30° W.
Island in latitude 58° 26′ 30″		S. 13° W.
Island in Du Brochet Lake		S. 28° W.

Thlewiaza River :—
Granite hill beside Thebayazie River...... S. 18° W.
Near source of " " ...... S. 28° W.
Kazan River :—
Hill south-east of Kasba Lake...... S. 30° W.
North-east side of Ennadai Lake...... S. 40° W.
Hill below " " ...... (2nd set) S. 50° W.
(1st set) S. 65° E.
Eiyegiak ...... S. 80° W.
Angikūni Lake, west end of ...... (2nd set) N. 5° E.
(1st set) S. 75° W.
" " Enetah ...... S. 57° E.
" " island...... (3rd set) N. 30° W.
(2nd set) S. 50° W.
(1st set) S. 5° E.
" " island north of last ...... (4th set) N. 30° W.
(3rd set) S. 50° W.
(2nd set) S. 5° E.
(1st set) S. 85° E.
" " Granite Point near north end...... S. 80° E.
Pasamut's Falls...... S. 25° E.
Ten miles below Aūna...... S. 25° E.
Pallel-lua...... N, 35° W.
Yath-kyed Lake, Island in ...... N. 35° W.
" " point on west shore...... N. 30° W.
(1st set) S. 60° E.
" " point north of last ...... N. 33° W.
" near north-west angle ...... N. 35° W.
(1st set) S. 60° E.
Below Yath-kyed Lake...... S. 55° E.
Ferguson River :—
Ferguson Lake, north shore ...... S. 50° E.
" " south shore ...... S. 45° E.
Lake above Kaminuriak Lake ...... S. 53° E.
(1st set) S. 16° E.
Rapid above Kaminuriak Lake ...... S. 40° E.
Portage below " " ...... S. 25° E.
Above Quartzite Lake...... S. 15° E.
Quartzite Lake ...... S. 25° E.
400 yards portage below Quartzite Lake...... (2nd set) S. 17° E.
(1st set) S. 60° E.
Lowest portage ...... S. 35° E.
Nelson River :—
Gull Lake...... N. 70° W.
Seepiwisk Lake...... S. 68° W.
Hudson Bay shore :—
Mouth of Chesterfield Inlet ...... S. 55° E.
Opposite Fairway Island ...... S. 55° E.
Baker's Foreland ...... S. 50° E.
North of Rabbit Island ...... S. 21° E.
North shore of Ranken Inlet ...... S. 48° E.
Island in mouth of Ranken Inlet ...... S. 70° E.
(1st set) S. 38° E.
Cape Jones ...... S. 65° E.
(1st set) S. 15° E.

Point south of Corbett Inlet		S. 67° E.
North shore of Pistol Bay		S. 55° E.
Island in Pistol Bay		S. 53° E.
Whale Cove		S. 38° E.
Island in Mistake Bay		S. 42° E.
West shore of Mistake Bay		S. 42° E.
North shore of Dawson Inlet		S. 50° E.
Ten miles south-west of Wallace River		S. 60° E.
Latitude 60° 34°		S. 70° E.
Six miles south of Egg Island		S. 15° E.
Ten " " "		S. 60° E.
Churchill	(3rd set)	S.
	(2nd set)	N. 50° E.
	(1st set)	S. 80° W.

Till.

Whitish till.

The country from the "Pas" ridge, on the Saskatchewan River, to Beaver Lake, on Sturgeon River, is all more or less thickly underlain by a whitish stony till, consisting of a calcareous silt or rock-flour mixed with striated boulders of Palæozoic limestone, gneiss, hornblende-schist, etc.

Less abundant over the Archæan rocks.

North of Beaver Lake is a rocky country, where, as a rule, the stony till merely fills the depressions between the ridges of Laurentian granite and gneiss. This country, which is generally covered with a dense coniferous forest, extends as far northward as Reindeer Lake, north of which, to the north end of Reindeer Lake, the country consists of almost unwooded rocky hills and ridges,

Boulders numerous.

At the north end of Reindeer Lake, boulders again become very abundant, and thence northward to Schultz Lake the whole country is covered with a mantle of drift, consisting chiefly of boulders and apparently unstratified silt or rock-flour. Natural sections of these drift deposits are very scarce, for the ice protects the banks of the lakes and streams from the waves and currents, by piling against them compact walls of boulders, which resist eroding agencies almost as effectually as the solid rock itself. Vegetation is, however, rather scanty, and the clay surface is almost everywhere more or less exposed to view. The presence of boulders is a very dominant feature, and there may be barely sufficient rock-flour to fill the interspaces and bind the whole into a compact mass. In some places the silty matrix is absent and the surface then consists of a loose mass of boulders or rock fragments.

Undulating surface.

The surface of this till-covered country is usually gently undulating. Here and there these undulations rise into high regular drumlinoid hills, like those on the lower portion of Cochrane River, or into low drumlins like those south of Boyd Lake on Telzoa River, near Uliū on Kazan River, etc.

On the lower portion of Ferguson River many of the rocky hills are free from drift, and the extensive areas of broken angular rock-fragments are much less common than further west. The intervening plains between the rocky hills are, however, still thickly drift-covered. The rounded rocky shores of Chesterfield Inlet are remarkably bare and free from drift, but how far back from the shore this bare rocky country extends was not determined.

Shore of Hudson Bay.

The shore of Hudson Bay almost everywhere gave evidence of a thick deposit of drift. North of Wallace River, where the contour of the rocky surface would seem to be rather pronounced, the summits of the rocky hills are bare, but the depressions are filled with till, and shallow points of bouldery till extend seaward for long distances. South of Wallace River the rock surface is probably much more even, and the till-covered country extends as a more or less regular slope down under the water of the bay.

Direction of transportation of boulders.

The evidence furnished by the distribution of the drift, adds weight to the conclusions deduced from the observations on glacial striæ as to the direction and extent of the movements of the Keewatin glacier.

On the route from Reindeer to Theitaga lakes, the boulders seemed to consist exclusively of gneiss and other Laurentian rocks. As Kasba Lake is approached from the south, boulders of Huronian rocks become abundant—derived from the Huronian trough in the vicinity of that lake.

At the south end of Ennadai Lake, we found the first evidence of the transportation of material from the far north, in rounded pebbles of red sandstone and quartz-porphyry, similar to the Cambrian rocks that extend across the country from Doobaunt Lake to Baker Lake. At the north end of Daly Lake, and just beyond the north end of Ennadai Lake, striæ of the early glacier from the north and north-west were seen for the first time. From Ennadai Lake northward, boulders of Cambrian rocks became somewhat more common, until, between Angikūni Lake and the north point reached on Kazan River, the till is of a brick-red colour, on account of having been derived largely from these red Cambrian rocks.

On Ferguson River, boulders of red Cambrian rocks were also found all the way down to the shore of Hudson Bay, but no evidence could be found to show that the diabase rocks of the shore of Hudson Bay had ever been transported inland, though any traces of such evidence were carefully sought for.

Fragments of red Cambrian rocks were found all along the shore of Hudson Bay, diminishing in size and number to a few pebbles at

Churchill. With these were also a very few pebbles of white Palæozoic limestone, probably derived from outliers of Palæozoic rocks similar to the one on Nicholson Lake. Some of these pebbles have doubtless been carried from place to place along the shore by floating ice, for, in the autumn of 1893, we often saw pebbles and cobbles frozen in cakes of ice, and being carried along by them.

Moraines.

Common throughout the country.

Many rough stony ridges were observed at various places throughout this whole northern region, crossing, or extending beside, the lines of travel. Some of them were undoubtedly terminal moraines dumped at the foot of the Keewatin glacier, as it halted from time to time in its gradual recession towards the north. As a rule they are very irregular in contour, but lie roughly transverse to the general direction of striæ on the rocks beneath.

Between Saskatchewan and Churchill rivers.

The prominent morainic ridge, which was crossed in 1892 between Prince Albert and Green Lake, was again crossed in 1893 north of Vermilion River, on the trail from Edmonton to Athabasca Landing.

On Chipman River.

On Chipman River, between Chipman and Birch lakes, a rough stony morainic ridge crosses the river and blocks up the valley at the longest of the three portages. It consists of boulders of the surrounding Laurentian rock, imbedded in a gray rock-flour.

Along Telzoa River.

Near the south end of Boyd Lake, a rough stony morainic ridge runs S. 20° E., almost at right angles to the last set of glacial striæ in the vicinity, and to the long esker which there crosses the country.

Thence northward for seventy miles, to the north end of Carey Lake, the country often presents an exceedingly stony morainic appearance, though this is more particularly the case near the outlets of the lakes than elsewhere. For example, heavy morainic ridges cross the country at the north ends of both Barlow and Carey lakes.

Below Doobaunt Lake the moraines are obscured or modified by the more recent marine deposits. However, below Grant Lake, and along the west shore of Wharton Lake, there is an irregular stony ridge which would appear to have been a moraine, and the rough stony hills between Wharton and Lady Marjorie lakes are undoubtedly morainic.

Below the Forks of Doobaunt River no well defined moraines were recognized.

The "Pas."

The ridge on the Saskatchewan River at the "Pas," which is probably continuous with the ridge north of Lake Winnepegosis, is a moraine of the Keewatin glacier deposited after that glacier had retreated northwards from the lowlands of Manitoba, and probably before Lake Agassiz had been formed by the union of the fronts of the Labradorean glacier from the east and the Keewatin glacier from the north.

Near Frog portage.

An accumulation of till and boulders, probably morainic in character, skirts the south side of Churchill River in the vicinity of Frog Portage. It seems to have blocked up the channel of the early glacial stream that once flowed southward across the Lake of the Woods, and to have formed the large pot-holes at Pot-hole Portage.

On Cochrane River.

The rounded stony hills, a few miles north of the north end of Reindeer Lake, almost undoubtedly represent another great moraine, possibly smoothed and compacted by a slight re-advance of the glacier.

The next well-defined moraine is just north of the northern bend of Cochrane River, whose waters are diverted southward by a tract of very rough stony hills, resting on a northerly slope. North of this moraine lies Blue Lake, whose waters drain northward to the Thlewiaza River.

On Kazan River.

Kasba Lake lies on the summit of a steep slope, and the low sandy hills near its outlet are almost undoubtedly morainic in character.

Ennadai is also dammed back by a wide ridge of rough morainic hills, through which the Kazan River winds in an irregular and often broken channel.

Some of the stony hills around Angikūni and Yath-kyed lakes are undoubtedly morainic, but the rainy and stormy weather, and the necessity of constant travel, did not permit of their examination.

The hilly ridge between Kazan River and the head of Ferguson River is also probably morainic, though much finer material enters into the composition of the moraine here than is often the case elsewhere.

On Ferguson River.

A well-defined ridge of stony morainic hills, considerably modified by subsequent wave action, runs parallel to the shore of Hudson Bay near the mouth of the Ferguson River. Our last camp on this river was pitched in the snow at the foot of one of the prominent knolls on this ridge.

On Hudson Bay shore.

The shore of Hudson Bay north of Cape Esquimaux consists of high morainic hills and ridges of large boulders, giving the country a very rough sterile appearance, and again the lower boulder hills and ridges along the shore between north latitudes 59° and 60° are undoubtedly portions of a moraine of the glacier that flowed from the west downwards into the basin of Hudson Bay.

On the overland journey from Churchill to Norway House no moraines could be definitely recognized, but it is not at all unlikely that some of the hills near the headwaters of Owl River are of morainic origin.

Many more moraines than those here mentioned undoubtedly cross this great region, but these were the ones most clearly recognized from, the line of travel.

Eskers.

Conspicuous objects.

Eskers form some of the most conspicuous objects in the landscapes of the far north, where they rise in steeply sloping ovoidal hills, high above the surrounding plains, or extend in long narrow ridges, keeping their direct courses across hills and valleys alike, without regard to pre-existing surface slope or contour.

General character.

They occasionally rise to heights of from two to three hundred feet and are usually composed of well-rounded sand and gravel, though their summits may often be sprinkled with boulders. As a rule, the esker consists of a single ridge with steeply sloping sides, or perhaps with one or two low subsidiary ridges. But occasionally the single ridge is replaced by several high parallel ridges, between which are deep intervening depressions, often without outlet. In most, if not in all cases, these eskers would appear to have been deposited on the ground by running water in the beds of streams that flowed in icy valleys n gorges between walls of ice or in tunnels under the ice. Where the chasm or tunnel has been fairly persistent for a long time, the sand and gravel has been deposited evenly, and as the ice melted away from both sides a straight uniform ridge has been formed. But where the chasm or tunnel has been broken by huge masses of ice falling into it, the gravel and sand were deposited in several channels, and as the ice melted away these have formed parallel but often coalescing ridges.

Mode of formation.

That these eskers have usually been deposited on the ground, and not on a bed of ice in the bottom of the icy channel, would appear to be almost conclusively shown by the fact that most of them consist of a single main ridge, the middle line and crest of which does not seem to have been disturbed or broken since it was first deposited. If the gravel and sand had been deposited over a bed of ice, then, as the ice on both sides melted away, the sediment would have slid down to both sides of the central icy ridge, and two parallel ridges of gravel and sand would have been formed which would have been at varying distances from each other according to the height of the icy bed on which the sediment had been deposited. As the heights of these double ridges would depend on the amount of gravel, etc., at any one place in the original channel, they would rise and fall in keeping with the width, etc., of that channel, irrespective of the ground over which they are now running, instead of which the eskers usually have very smooth even crests, and they are almost always much higher over the lowlands than over the hills, thus tending to such an even surface as would have been formed by a running stream.

The conspicuous esker on the west shore of Hinde Lake, also presents strong confirmatory evidence pointing in the same direction. Red Hill is the south-western terminus of this esker, where the stream that formed it appears to have reached the edge of the ice sheet, and there to have built up a small fan-shaped delta. At the end of the esker is a steep slope of rounded gravel, which has remained almost undisturbed since it was deposited in the water that skirted the face of the glacier, and the two old beaches on this gravel slope are almost as fresh as if they had been formed yesterday. From the summit of this gravel slope, the esker extends at almost the same height north-eastward, as a long regular ridge, that has evidently remained unbroken since it was originally formed. Instances.

The shores of Selwyn Lake are largely composed of boulders and unassorted drift, perhaps morainic. With the hills of boulders are some long sandy eskers, running parallel to the glacial striæ, and some sandy islands, which may be broken eskers, or may represent small deltas formed at the mouths of superglacial streams, in the beds of which there had been no deposits of sand or gravel.

An esker, south of the narrows of Daly Lake, is a very pretty grass-covered sandy ridge, running S. 40° W. from some stony hills near the shore. Winding slightly, it rises over some rocky knolls seventy feet above the lake and thence continues an unknown distance inland. On Telzoa River.

Another esker, from fifty to seventy feet high, runs N. 75° E. as a single, or divided, sandy ridge, from the east bank of the river a short distance below Daly Lake.

Red Hill, on the west shore of Hinde Lake, is the south-western terminus of a long esker which extends an unknown distance towards the north-east. As stated above, its termination is marked by a steep bank of rounded water-worn gravel, while the ridge itself is here composed of several elongated overlapping sandy hills, 120 feet high, between which are deep depressions without outlet. The hill dips slightly towards the north-east, and thence continues as a long straight sandy ridge, through which the Telzoa River cuts, a short distance below Ptarmigan Rapid. This esker is clearly marked as it crosses the thinly wooded country, on account of being covered with fine tall white spruce.

A similar parallel sandy ridge, which may be designated White-spruce Esker, crosses the river a few miles further north. Where it is cut through by the river, it has a height of twenty-five feet.

Another esker, running N. 70° E., and S. 70° W., crosses the south end of Boyd Lake, forming a chain of islands across the lake, and a long straight ridge on either shore.

Some high sandy hills on the north shore of Doobaunt Lake may have formed part of a broken esker, but these are more probably ispatinows, such as are seen so well developed around Cree and Black lakes, and have been described by the author in his Report on the country between Athabasca Lake and Churchill River.

On Churchill River.

The first eskers seen in 1894 were on the north bank of the Churchill River, a short distance below Frog Portage. They consist of three oval pointed hills of stratified sand, rising to heights of sixty feet above the river, and trend S. 25° W., parallel to the glacial striæ on the surrounding rocks.

On Reindeer River.

The esker extending northward from White Sand Portage is much longer than those on Churchill River, but it is not impossible that it was formed by the same great glacial stream. The Indians, who resort to the banks of Burntwood River to trade, report that this esker can be followed for a long distance into the country towards the north-east.

On Cochrane River.

A magnificent esker was seen near Cochrane River. It consists of a long ridge of sand and fine gravel thinly wooded with large Banksian pine and white spruce. In some places, as where the river cuts through it, it is steep and narrow, but in other parts it is much wider, and is broken into little hills and ridges, giving it a very lumpy appearance. Its southern end was not seen, while towards the north it extends along the east bank of Cochrane River to the sandy plains south of the Blue Lake moraine. North of the moraine a similar sandy ridge, evidently formed in a continuation of the same drainage channel, runs along the west side of Blue Lake to Thanout Lake. The sand on the plains south of the moraine has undoubtedly been carried down from the north by a glacial stream and deposited as a fringe in front of the heavier morainic material, but the crest of the esker west of Blue Lake is lower than the level of the sand plain, and it is probable therefore that in this instance the sand of the esker was deposited in a stream with a bed, as well as with walls, of ice, and as the ice melted the sand slid into the ridges and hills that we now see.

Another narrow sandy esker forms the west bank of Thebayazie River for a short distance.

The high mammillated sandy ridge that crosses the middle of Kasba Lake is another fine example of an esker, which rises to a height of 180 feet above the lake. It was examined on the east side of the lake, but it extends across the lake in a direction S. 40° W., forming high sandy islands and another sandy ridge on the western shore. On Kazan River.

A similar esker forms the west shore of the deep bay at the south end of Ennadai Lake, rising at its highest to between 200 and 300 feet above the water. This esker projects as a long sand and gravel point out into the lake. In the distance, on the west shore of Ennadai Lake another similar sandy ridge was seen.

Similar eskers were seen on Kazan River running in the same direction as the last glacial striation—one at Sandy Lake, another above Kopanuak's Camp and a third below Hallo Lake. Below this no eskers were seen, and it is probable that none were formed so near the centre of glaciation.

On the shore of Hudson Bay, Cape Esquimaux, and the point to the south, are also eskers considerably modified by subsequent wave action. They consist of straight narrow ridges several miles in length running S. 70° E., parallel to the direction of movement of the Keewatin glacier. Their surfaces consist entirely of sand and gravel, while the scarped face of a terrace twenty feet high on the former point, shows an unstratified sandy till full of boulders, overlain by stratified sand. On the shore of Hudson Bay.

On the overland journey from Churchhill to Split Lake a lumpy sandy ridge, doubtless an esker, was seen north of Wasėgamow Lake, while a long and well defined esker was seen crossing the country in a direction S. 85° W and N. 85° E., between Mittitto River and Musogetaiwi Lake. On its south side are sand plains and hilly sand ridges. Between Churchill and Nelson rivers.

Extra-glacial Lakes.

The country explored during the seasons of 1893 and 1894 is not characterized by the number or extent of its extra-glacial lakes.

Hyper-Black Lake extended northward up Chipman River as far as Chipman Lake, on the north side of which are some rather extensive sandy deposits, formed at the mouth of a glacial stream that flowed into that lake from the north. Hyper-Black Lake.

Along the upper part of the Telzoa River, lake-shores are, as a rule, conspicuously absent, the only well-marked beaches seen being those on the south end of Red Hill, west of Hinde Lake. The extent of the lake by which these were formed was not determined, and it is probable that it was very short-lived.

Hyper-Doobaunt Lake.

On the sides of some hills north of Doobaunt Lake, sandy terraces were seen at an elevation of 240 feet above the present level of the water of the lake, or about 740 feet above sea-level. These are considered to have been formed in an extra-glacial lake, which covered the country in the vicinity of Doobaunt Lake. In accordance with the nomenclature adopted in a previous report, this lake may here be called Hyper-Doobaunt Lake.

If lake deposits have existed in the country near the sea-shore, they have been obscured by the later marine deposits.

Lake Agassiz.

On the line explored in 1894, the terrace on the side of the Pas Ridge, thirty feet above the Saskatchewan River, and the gravel ridge, forty feet higher, undoubtedly represent two ancient shore-lines of Lake Agassiz when that body of water extended southward towards the foot of the Pasquia Hills.

At the north end of Beaver Lake, twenty feet above the present level of the water, is a gravel ridge representing an old shore-line, probably of an earlier and higher stage of the lake itself towards the close of the glacial epoch. Similar low-level terraces occur along some of the quieter reaches of the Sturgeon River, on Churchill River above Reindeer River, and around the south end of Reindeer Lake.

Hyper-Kasba Lake.

An interesting series of ancient lake beaches occurs around the south end of Kasba Lake, clearly formed in an extra-glacial Hyper-Kasba Lake. Kasba Lake lies at an elevation of 1270 feet above the sea, and these beaches are respectively 50 150 and 200 feet above its surface. The highest one is rather weak and not very distinct, but the middle one is clear and well defined, but, though it is strong and distinct around the south end of the lake, I could see no signs of it on sides of the esker that crosses the middle of the lake. It is, therefore, probable that Hyper-Kasba Lake did not extend as far north as this esker, but that it lay at the foot of the Keewatin glacier shortly before the moraine was formed which now forms the stony ridges north-east of Kasba Lake.

No other lake deposits were recognized along the Kazan River north of Kasba Lake, though further exploration may prove that lakes did exist for short periods of time along the foot of the waning glacier or glaciers.

Marine Deposits.

Depression of the land.

At the close of the glacial epoch, or rather, after the Keewatin glacier had retired from most of the country west of Hudson Bay, the land stood several hundred feet below its present level, and the sea covered a wide belt of country which now slopes eastward or north-eastward towards Hudson Bay or the Arctic Ocean. The land then gradually rose, and the stages of its rise are marked by ancient beaches, terraces, sand-bars, etc. Dr. Robert Bell, of this Survey, believes that this elevation is still in progress around Hudson Bay*. Mr. A. P. Low has, however, adduced evidence to show that the land has ceased, or almost ceased, to rise around the southern portion of Hudson Bay†, and the writer, both in a previous part of this Report, and in a paper in the American Journal of Science for March, 1896, has expressed his belief that the land has reached a condition of comparative stability in the vicinity of Churchill.

In fact the conditions along the west coast of Hudson Bay are very similar to those in Labrador, in the valley of the Saint Lawrence, in the Maritime Provinces of Canada, and in the New England States, except that rock decay is very much less rapid in the northern than in the southern countries. Therefore the terraces, whether these are cut by the waves in the faces of the rocky hills, or are built along the shore, and the beaches of rounded gravel, are very much fresher in the northern country, and a geologist from the south might easily regard them as much younger than they really are.

Raised beaches on Telzoa River near Grant Lake.

On the Telzoa River, the highest abandoned sea-shores were seen in the vicinity of Grant Lake, a short distance below Doobaunt Lake. Grant Lake lies at an approximate elevation of 370 feet above the sea. Near its northern end is a sandy esker 270 feet high, the sides of which are particularly well suited to show any post-glacial shore-lines. Three terraces or old sea-beaches are well shown, the highest of which is 120 feet above Grant Lake, or 490 feet above the sea. As far as could be determined in the time at our disposal, this is the highest marine shore on the Telzoa River. If the above figures are correct, 490 feet would therefore represent the full extent of the rise of the land here since the close of the glacial epoch. The heights of Grant and other lakes are, however, only estimated, or determined by a few barometer readings, though they are probably correct to within a hundred feet.

At the Long Portage, near the west shore of Grant Lake, there is a distinct gravel beach seventy feet above the lake, or 440 feet above the sea.

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* Proofs of the rising of the Land around Hudson Bay. Am. Journ. Sci., vol. I., pp. 219-228, March, 1896. Report of Progress Geol. Surv. Can., 1877-78, pp. 25 C.C., and 33 C.

Ibid., 1878-79, p. 21 C.

†Report on Explorations in James Bay, by A. P. Low, Annual Report Geol. Surv. Can., vol. III., 1887, Part J, pp. 32-33.

Hill east of Wharton Lake

On the sides of the conspicuous hill of Huronian quartzite on the east shore of Wharton Lake, three ancient sea-beaches are strongly marked, at elevations of 130, 105 and 60 feet above the lake, or 430, 405 and 360 feet above the sea, the upper one being formed of well-rounded coarse gravel and small cobbles, while the two lower ones are of fine gravel and coarse red sand.

Diabase hills below Lady Marjorie Lake.

Corresponding beaches occur on the conspicuous hills of dark-green diabase below Lady Marjorie Lake, the highest of which is at an elevation of 440 feet above the sea, below which are four others, the lowest of which is at a height of 340 feet above the sea. On the south point of one of the hills these old shore-lines appear as five well cut notches, from which ridges of rounded gravel extend along the sides of the hill.

At the Forks, where the Doobaunt River is joined by the Thelew River, there is a wide sandy delta-plain, just below which is a sandy island 100 feet high, part of an ancient sand-bar, formed when the land stood about 260 feet below its present level.

Terraced hills near Aberdeen Lake.

Near the east end of Aberdeen Lake are some high well-terraced hills of conglomerate, on the sides of which a number of raised sea-beaches are particularly well marked. The highest beach (rather indistinct) is at the foot of a cliff 330 feet above the lake, or 460 feet above the sea. The next two are strong gravel beaches 300 and 230 feet above the lake, or 430 and 360 above the sea. The next 310 feet above the sea, is a terrace cut in the face of the hard conglomerate, with a beach of rounded gravel at its base. Below this are four other gravel terraces, respectively 280, 235 220 and 190 feet above the sea.

On a sandstone hill 400 feet high, at the east end of Schultz Lake the highest shore-line recognized was 260 feet up the hill, or 375 feet above sea-level.

A high beautifully terraced hill, similar to those just described rises on the north side of Baker Lake just east of the mouth of Prince River, but it was impossible to spare the time for its examination.

The above figures would seem to indicate a moderately regular rise of the land in Post-glacial time, in that portion of the country extending from Doobaunt Lake eastward to the head of Baker Lake.

Terraces on shore of Hudson Bay.

The rocky shores of Chesterfield Inlet, and of the whole of the north-western coast of Hudson Bay north of Wallace River, are marked with gravel beaches, sandy terraces, etc., down to the present high tide level, but none of the hills on the shore are sufficiently high to show the higher terraces, and thus to determine the extent of the elevation along the shore itself. Marble Island, which seems to rise high above the hills on the adjoining shore, would probably show all the higher beaches, but it has not yet been searched for such beaches.

On Kazan River, the higher marine shores were not so easily recognized as further west on the Telzoa River, for high pointed hills, which form such conspicuous features on the banks of the latter stream, and on the sides of which the ancient shores were readily traced, are not present on the banks of the Kazan.

At Aūnah, near the northern bend of the river, extensive plains of stratified sand begin to make their appearance, and extend more or less continuously all the way to Yath-kyed Lake. They have certainly been deposited near the sea-shore, and probably when the land was depressed almost or quite to its greatest extent.

On Ferguson River, all the way from Ferguson Lake to Hudson Bay, ancient marine shore-lines may everywhere be seen as scarps, terraces and gravel ridges, stretching in horizontal lines along the sides of the hills, or filling the depressions between rocky points.

High shore S.W. of Churchill.

On the overland journey southward from Churchill to Split Lake, the most distinct ancient sea-shore was that crossed on the third of December, a short distance north of the headwaters of Owl River, at an elevation of between 500 and 600 feet above sea-level. The passage from the broad wave-washed plain north-east of this ridge, to the rolling till covered country south-west of it, was very marked.

A similar high shore-line had been ascended and crossed in the winter of 1893, on the overland journey from York Factory to Oxford House, a short distance south of Fox River. Though in both places the ground was completely covered with several feet of snow, yet there can be little doubt that both points lie on the highest raised sea-beach west of the coast of Hudson Bay.

APPENDIX I.

CHIPPEWYAN NAMES OF PLACES IN THE COUNTRY HERE REPORTED ON.

These names were obtained at Churchill, in the autumn of 1894, from Deliazē′ and "Curly-head," with the assistance of George Oman, the resident interpreter :—

Nū-chō‘	Big Island.
Sheth-nă′-ne	Steep Hill.
Thē-chille-nă′ra-ai tua	Holes-in-the-stones Lake.
Dat-chă′re-kéthe tua	Eagle Lake.
Thlūl′-ain tua	Whitefish Lake.
Thē′-chō‘-gá tua	Big-stone Lake.
Thē′-rē-chē tua	Overflowing Lake.
Thai tua	Sand Lake.
Thin-telle tua	Ling Lake.
Thlew′i-aza tua	Small-fish Lake.
Thlew′i-aza dézé	Small-fish River.
I-then tua	Caribou Lake.
Nī-jan′-ilini tua	Boggy-ground Lake.
Ba-ral′-zō′a tua	Shoal Lake.
Edé-hon‘ tua	Horn Lake.
Thē′-tin-an tua	Seal-hole Lake.
Nū-el-tin′ tua	Frozen-island Lake.
Thá-anné dézé	Rocky-bank River.
Thá-anné tua	Rocky-bank Lake.
Thū-chōn-ilini tua	Big-pine-trees Lake.
Ethlé-īg′li	The Forks.
Et-thai-īre tua	Hawk-hill Lake.
Ta-tinne-ai tua	Deer-crossing Lake.
Edet′-thille dézé	Horns sticking along the bank, river
Thīl-tai tua	Horns sticking along the bank, lake
To‘-bo^{n} tua	Water-shore Lake.
Yath-kai-ed tua	Snow Lake.
Hō-yeth-yéze	Two little hills, with a river flowing between.
I-the-zen tua	Black-deerskin Lake.
E-ked-a-tan′-e	A small hill on another hill.
Kail-sheth	Willow Hill.

Twal-kai tua	Fat-fish Lake.
Thel-wel-kai tua	Snow-bird Lake.
Klok-seth	Big-grass Hill (south of Yath-kyed Lake).
Sas-ne-dē'ze-yethe	Bear-plucking Hill (just beyond the last).
Thā-ānné-yethe	.... (the next hill).
Gail-lī'nī dē'ze	Rabbit River.
Sa-bail-jē dē'ze	Sabailje's River.
Ka-zon-jēre tua	Long Lake.
Bes-kai tua	Knife Lake.
Des-ta-tha-thē-yethe	Hill between the two rivers.
Nū-gi-ā-za tua	White-island Lake.
Tes'-de-ūli tua	Floating-coals Lake.
Tū-tan-ne tua	Found Lake.
E-chū'-a tua	Fish (Pickerel?) Lake.
Bek-a-nū-klai tua	Many-islands Lake.
Thū-e-zon'-e tua *or* Thlū-e-zon tua	Trout Lake.
Thū-e-zon déze chēre	Mouth of Trout River.
En-na tua	Cree Lake.
De-nē' tua	Chippewyan Lake.
Thai-chō'-nū	Big Sandy Island.
Zon-kai tua	Shoal Lake.
Klō-ā-ze-we tua	Kloaze's Lake.
De-bē tua	Partridge (Ruffled Grouse) crop Lake.
Dē-nē-shan-i-li-ni	Moose Hill.
Kai tua	Willow Lake.
Tzan dé-ze-a-ze	Little Iron River.
Tzan dē'-ze	Iron River (Churchill River).
Ta-bil-kē tua	Net Lake.
I-then-déze	Reindeer River.

APPENDIX II.

VOCABULARY OF WORDS USED BY THE TRIBE OF INLAND ESKIMOS INHABITING THE BANKS OF KAZAN AND FERGUSON RIVERS.

Obtained from A′-yout, an Eskimo living on the upper part of the Kazan River. It was largely revised at Churchill by Powow, an Eskimo from the same district, with the assistance of the Rev. Jos. Lofthouse as interpreter,

The words are given in very much the same order as in J. W. Powell's "Introduction to the Study of the Indian Languages," and with some slight modifications the sounds of the letters are the same. The following is a list of the vowel sounds here used:—

a as in English	fat.	o " in English	pot.
ā " " "	far.	ō " " "	go.
â " " "	all.	u " " "	but.
e " " "	met.	ū as "oo" in "	fool.
ē " " "	they.	ai " in "	aisle.
i " " "	pin.	y " " "	year
ī " " "	marine.	ou " " "	out.

(1) Persons.

Man	āng′-ūt.
Woman	ār′-nak.
Elderly man	ō-tok′-kak.
Old woman	ār-nak-kwek-kak.
Young man	īn-nū-kūk′-tūk.
Boy	nū′-kā.
Girl	nai′-uk.
Infant	nū-tār′-ak.

(2) Parts of the Body.

Head	nī-ak′-kuk.
Hair	nut′-tek.
Grey hair	ka′-yuk.
Face	kī′-nak.
Forehead	kou.
Eye	ī′-ik.
Eyebrow	kab′-lūt.

Ear	hi-yū'-tik.
Nose	kaing'-ak.
Beard.	ūm-mik.
Mouth	kan'-yek.
Teeth	kī-ūt'-ti.
Tongue	ok'-ka.
Chin	tab-lū.
Neck	kon-i-lī'-ni-ak.
Body (trunk)...........	ka-te.guk.
Shoulder	nī'-gu-blū.
Back	kai-mer'-i-luk
Breast	ūm'-met.
Breast bone............	hak-kig'-gek.
Belly..................	ner-rok'-kak.
Arm.	tal'-yek.
Hand	ag'-gek.
Fingers	hī'-tam-ut.
Thumb	kōb'lū.
Leg	nī'-ū.
Thigh..................	kok-tō'-ak.
Leg below the knee.......	kan'-nak.
Foot	ī-ki-gek.
Toes...................	taip-in-in-ū-dik.
Marrow	pat'-chuk.

(3) Dress and Ornaments.

Hood	na'-ha.
Coat (outer deer-skin garment)................	tko-lī'-tok.
Trimming round the coat...	ag'-luk.
Shirt (inner deer-skin garment)	at-tī-yī.
Trousers	ka'-līk.
Gloves (with fingers)......	ad-gui-ut.
Boots	kam'-mi.
Deer skin blanket.........	kaip'-puk.

(4) Dwellings, Etc.

Camp or village	ig-lō.
Tent....................	tō-pek.
Fire....................	ōk'-ka.

Flame	ek-wā-la′.
Smoke	pū-yuk.
Smoke	ī-hi-uk.
Ashes	im-mē-an-nī-kō.
Câche	pe-rūl′-yā.
Track	tū-mī.
Iron	hâ′wik.
Copper or brass	ka-nū′-huk.
A sound	nā-ki-nim′-na.
A blow	a-nou′-yuk.
Sight	tak-kū-yuk.

(5) IMPLEMENTS.

Bow	pid-jik′-ī.
Fishing spear	kuk′-ki-wa.
Deer spear	u-puk-tō.
Head of deer spear	ū′-lū.
Handle of deer spear	ī′-pū.
Fishing hook	kar′-i-ō-kuk.
Fishing line of sinew	ī′-pī-ū-tuk.
Stick on which line is wound	ū-led′-gūt
Float for fishing net	puk-tak′-kut.
Knife	pī′-lout.
Knife (small penknife)	ō-kūt′-tak.
Snow knife	pan-nē′.
Pipe	pū-lū-yet′-ti.
Pipe stem	ī′-pō-ak.
Awl (for boring)	ī-kai-tak′.
Needle	mit-kut.
Canoe (for one man)	kai′-ak.
Wooden gunwale-piece of kaiak	ap-pum′-mak.
Double paddle	pou′-tik.
Boat	ū′-mi-ak.
Boat, large	ū-mi-ar′-yū-ak.
Boat, white man's	ka blū-nak-tho-ak.
Sail	tin-gin-er-ou-tuk.
Sledge	kam-ōd′-jik.
Deer skin line	hī′-ni-ak.
Plaited sinew line	pīl-er-ak.
Thread	en-na-lū′-ka.
Parchment	kai′-tin-kū-ni.

Cup	īm-mo-hū'-yak.
Spoon (musk ox horn)	ōu'-i-yū'-yak.
Kettle	hâ-wik.
Lid of kettle	ō'-ku-ak.

(6) Food.

Meat (of deer)	ū-yuk.
Dry meat	nip'-kū.
Fat	tūn'-nūk.
Boiled grain	kat'-che-wuk.

(7) Colours.

Black or blue	Ka-re-nek'-tō.
Red	ou-pa-luk'-tō.
White	ka-guk'-tō.

(8) Numerals.

1	a-tou'-i-ak.
2	mal'-rōk.
3	ping'-a-yū-ak.
4	hī-tă'-mut.
5	ted'-li-ma.
6	ar'-wing-e-gik.
7	mal'-ung-ik.
8	ping-a-hyū-ni-ik.
9	kū-ling-gūl'-u-ak-tak.
10	koul'-yik.
20	mal-rō-ad-gug'-gik.
30	ping-a-ho-ad-gu'-yik.
40	hī-tam'-ad-gu'-yik.
50	ted'-le-mat-ad-gu'-yik.
Half	nap'-puk.

(9) Divisions of Time.

Day	ū-blūt.
Night	ū-nū-ak.
Sunrise	he-kan-yek'-pōk.
Sunset	he-kan-rek'-pōk.
Noon	ka-wa-tan-u-a-tī'-wok.
Winter	ū'-ki-ōk.
Spring	ū-ping-rā'-ka.
Summer	ou'-i-a.

(10) Animals.

Reindeer	tūk′-tū.
Buck (deer)	pung′-ni-uk.
Doe	nō-ral′-lik.
Buck (young)	nū-ka-tū′-ak.
Fawn	nō′-kak.
Dog	kaip′-mik.
Fox (white)	ter-re-gū′-ne-ak.
Musk ox	ū-ming-muk.
Wolf	am-mār′-rō.
Wolverine	kāk′-wik.
Crane (brown)	nek′-to-al-li.
Diver (red-throated)	pai′-uk.
Duck	pū-lū-et′-ū-ak.
Goose	ting-ni-ak.
Gull	nou-yet′-yū-ak.
Loon	kak′-kou.
Merganser	a-ān′-yek.
Ptarmigan	pe-kū-lī′-a.
Wavy	kang′-uk.
Fish	ye-kal′-luk.
Ling (*Lota maculosa*)	tik-tal′-luk.
Pike (*Esox lucius*)	hyū′-lik.
Perch (?)	hū-lūk-pou′-i.
Sucker	ant′-ni-ak.
Lake trout	ich-chlō′-ra.
Trout (?) (large fish)	kek′-kī-wī-ak′-tō.
Whitefish (?)	an-ak′-luk.
Black fly	mē-lū′-i-ak.
Gad fly	ā′-lung′-i-yū.
Mosquito	kik-tō′-ri-ak.
Spider	nī-nī′-yō.

(11) Plants.

Tree	ne-pāk′-tuk.
Shrub (small black spruce)	kai′-uk-tūk.
Wood, fallen	tīp′-ya.
Wood, dry	tīp′-i-a-lūk.
" "	pal′-luk.
Willow	ōk′-pik.

Bearberry (*Arctostaphylos uva-ursi*)	a-tung-gou′-lik.
Labrador tea	nū-kăr′-rō.
Grass	ī′-wī.
Moss	ō-ă′-rū.
Lichen (black hair-like)	king-oú-yak.

(12) Geographic Terms, etc.

North	wâk-nyek-tok.
East	kā-nak-yek′-tok.
South	nig-yek′-tok.
West	ping-ak-yek′-tok.
River	kōg.
Rapid river	kōg′-ni-ak.
Rapid in river	kōg-nīk-′yū-ak.
Mouth of river	kă-tīn′-i-a.
Lake	kă-man′-yuk.
Small lake	kă-man-ou′-uk.
Very small lake or pond	te-her′-ok.
Bay	kang′-ek-lūk.
Shore	hig′-gī-a.
Point of land	nū′-ūk.
Island	ka-gek′-tok.
Portage	nap′-muk.
Hill	king′-a.
Pointed hill with stone on it.	ū-yăr′-ra-hūg′-lūk.
Stone placed on hill	in-nūk-kūk.
Stone or rock	ū-yăr′-ruk.

(13) Geographic Names.

Fort Churchill	ū-yar′-ri ig-lō.
Doobaunt Lake	tū′-li-ma-lū′-gyū-a kă-man′-yi.
Little Doobaunt Lake	tū′-li-ma-lū′gyū-et-na kă-man′-yi.
Big Lake	ang-gi-kū′-ni ka-man′-yi.
Yath-kyed Lake	hī-co-li′-gyū-a ka-man′-yi.
Child Lake	nū-tar′-a-wīt ka-man′yi.
Kamanuriak Lake	ka-man-yūr′-yū-ak.
Kazan River	īn′-nwi kōg.
Seal River	net-chil kōg.
Pallelluah	pal′-lel′-yū-a.

(14) Social Organization.

An Eskimo	īn-nwī.
Chief	ī-hyū-mat′-tok.
Trader	ī-hyū-ma-tēr′ok.
White man	kab-lū-na.

(15) Kinship.

Son	īr-ner′-ik.
Daughter	pa′-nik.
Father	at-ta′-ta.
Mother	an-nā′-na.
Wife	nū′-li-a.
Sister	nē′-yuk.
Twins	nū-kār′-a.
Grandchild	ok-kō′-ga.

(16) The Firmament.

Cloud	nū-ū′-ya.
Sky	al-la-kū′-ni.
Sun	hī-ak-kēn′-i-ak.
Moon	yat-ke′.
Stars	ū-blū-ri-ak.
Aurora	ak′-ka.
Hoar frost	hā-kū-ni.
Snow	ap′-pūt.
Ice	hī′-kō.
Rain	nī-pal′-lū.
Water	im′-mek.
Tide	pit′-tak.
Sea	tār′-rē-ō.
Wind	an-nōr′-rē.
Darkness	tā′-kū-ni.

(17) Pronouns, Adjectives, Adverbs, Etc.

I	u-wung′-a.
Thou	ig′-bi.
Small	mik′-ki-kū′-ni.
Large	ang′-gi-kū-ni.
Long	tā′-ki-kū-ni.
Short	nā′-hi-kū-ni.

Narrow	ik′-ik-i-kū′-ni.
Broad	i-kek′-to-kū′-ni.
Light..................	ok′-e-kū-ni.
Heavy.................	ok-u-mai′-i-kū-ni.
Near	kan′-i-kū-ni.
Far	o-má-hi-kū′-ni.
Flat...................	man′-i-kū′-ni.
Cold..................	ik′-ki.
"	ik′-ki-an-ni-kū-ni.
Warm	ik-ki-an-ē′-kū-ni.
Hot (water)............	ū′-na-kū-ni.
Good	pī-chi-ak.
Bad	pī-toú-i-kū-ni.
Lost..................	na-lūn′-i-kū-ni.
Broken	he-kō-met′-uk.
Departed..............	oug′-luk-pōk.
That	ted-ba.
Where.................	nā′-nī.
There	mā′-nī.
Where is it.............	nan-nim′-ne.
On this side of..........	mi-kā′-ni.
On that side of..........	o-ma-tā′-ni.
Today	ū-blū′-mi.
So....................	ta-man-nō.
There is none	nouk.
Plentiful	mai (in suffix).
Wanting (or no !)	nā′-ga (in suffix).

(18) Verbs.

To see	tak′-kō.
To sleep...............	hī-nik-tūk.
To portage	nap-muk-tō.
To travel..............	kak-mal′-tō.
To walk...............	pi-hūk′-tuk.
To run...............	ak-pā′-tō.
To talk	ok-kak′-tō.
To drink...............	im-ma-kyū′-ya.
To "	im-mek′-tō.
To stoop and drink........	hik-kī′-uk.
To dip up...............	kal-u-ing′-a.
To eat	ner-rā′-yuk.
To grasp...............	te-hō-yuk.

To brush off the snow......	ā-yek′-tōk.
To sneeze................	tá-ri-uk-to-kū-ni.
To cry..................	il-luk′-kū-ni.
To laugh................	kap-ma-tuk′-tō.
To be pleased............	koú-gak-tō.
To be displeased..........	an-nū-kū-ni.
To write................	ik-ke-rok′-tō.
To cook.................	ī-rē′-yuk.
To cut..................	kī-lēk′-tok.
To plane (wood)..........	hā-ner-á-mik.
To saw....	ū-lūt.
To splash................	mal′-lō.
To squeak...............	nī′-ko-lak-tō.
It is raining.............	nī-pal′-i-kū-ni.
It is snowing	kan-yi-kū-ni.
It is stormy (on the water).	at-kon-i-kū-ni.
It is lost	nou-gim-na.
It smells nice............	má-ma-kū-ni.
It smells unpleasant	ma-mai′-i-kū-ni.
I do not know............	a-mī′-a-huk.
Arise!.................	tō-pal-yer′-ik.
Go!....................	ún-gak-wok′-to.
Come!..................	kai′-uk.

(19) New Words.

Handkerchief........	kon-ji-hi-nē′-rūt.
Muffler.................	tap′-pi.
Paper	al-li-lē′-uk.
Buttons.................	han-nēr′-i-ak.
Tobacco.................	tīp′-le-tē′-rūt.
Rifle...................	am-me-hū-ek-ta-yū′-yuk.
Gun (single barrelled).....	kai-ūk-tē-tō.
" (double ").....	mal-rōl′-yī.
Gunpowder..............	ar′-yet.
Gun caps................	ik′-ni-uk.
Bullet..................	kar′-i-ok.
Biscuit.................	nek-lū-uk.
Bottle..................	kī-li-an-ā′-kut.
Fork....................	nī-ō-gī-tik.
Plate...................	pâ-wu-tuk.

APPENDIX III.

PLANTS (EXCLUSIVE OF ALGÆ AND FUNGI).

Collected by J. W. Tyrrell, C.E., D.L.S.

In 1893, along the line of route between Lake Athabasca and the west coast of Hudson Bay, and in 1885 at Ashe Inlet, on the north shore of Hudson Straits; with which is incorporated a small collection made by Miss Marjorie Lofthouse at Fort Churchill.

The species collected from the Barren Lands are marke;d *B* those from the forested country south of the Barren Lands, or in isolated groves of timber on the banks of the river, north of the general limit of the forest, are marked *W*. Any species collected both from the Woods and from the Barren Lands are marked *W.B.*, or *B. W.*, according to whether they are woodland species extending into the Barren Lands, or Arctic species extending south into the forest.

Determined by Professor John Macoun, M.A.

I. RANUNCULACEÆ.

1. *Anemone patens*, L., var. *Nuttalliana*, Gray.—*W.*
   Fort Chippewyan, Lake Athabasca, June 19.
2. *Anemone parviflora*, Michx.—*W.B.*
   North shore of Lake Athabasca. Limestone Island in Nicholson Lake, and the west shore of Hudson Bay at Fort Churchill.
3. *Anemone Richardsonii*, Hook.—*W.*
   Telzoa River, just below Daly Lake.
4. *Anemone multifida*, Poir.—*W.*
   Woodcock Portage, on Stone River.
5. *Ranunculus affinis*, R. Br.—*B.*
   Barlow Lake, Telzoa River. Telzoa River, between Schultz and Baker lakes. South shore of Chesterfield Inlet, near its mouth. Fort Churchill.
6. *Ranunculus Lapponicus*, L.—*B.*
   West shore of Doobaunt Lake, near the mouth of Telzoa River.
7. *Ranunculus hyperboreus*, Rottb.—*W.*
   Telzoa River, just below Daly Lake.

II. PAPAVERACEÆ.

8. *Papaver nudicaule*, L.—*B.*
   Telzoa River, between Schultz and Baker lakes. This species was also collected at Ashe Inlet, on the north shore of Hudson Straits, in 1885.

III. FUMARIACEÆ.

9. *Corydalis glauca*, Pursh.—*W.*
   North-west and north shores of Lake Athabasca. Esker near the Narrows of Daly Lake.
10. *Corydalis aurea*, Willd.—*W.*
    Rocky Island, on the north side of Lake Athabasca, west of Fond du Lac.

IV. CRUCIFERÆ.

11. *Cardamine pratensis*, L., var. *angustifolia.—B.*
    Island near the centre of Boyd Lake. Limestone Island in Nicholson Lake. Fort Churchill.
12. *Arabis lyrata*, L.—*W.*
    North shore of Lake Athabasca.
13. *Arabis humifusa*, var. *pubescens*, Wat.—*W.*
    North-west angle of Lake Athabasca. Esker near the Narrows of Daly Lake. This species had not previously been found west of Hudson Bay.
14. *Barbarea vulgaris*, R. Br.—*W.*
    Cracking Stone Point, north shore of Lake Athabasca. Red Hill, on the west shore of Hinde Lake.
15. *Sisymbrium humile*, C. A. Meyer.—*W.*
    Fort Chippewyan, Lake Athabasca.
16. *Cardamine digitata*, Rich.—*B.*
    Loudon Rapids, above Forks of Telzoa River. Mouth of Chesterfield Inlet. Not found elsewhere since it was collected by Sir John Richardson near the mouth of the Coppermine River.
17. *Draba hirta*, L.—*B.*
    Limestone Island, Nicholson Lake. Loudon Rapid, above the Forks of Telzoa River. Also at Ashe Inlet, on the north shore of Hudson Strait.
18. *Draba incana*, L.—*B.*
    Loudon Rapid, above the Forks of Telzoa River. Fort Churchill, on the west coast of Hudson Bay.
19. *Draba nemorosa*, L., var. *leiocarpa*, Lindb.—*W.*
    Fond du Lac, Lake Athabasca.
20. *Draba stellata*, Jacq.—*B.*
    North-west shore of Doobaunt Lake.
21. *Cochlearia officinalis*, L.—*B.*
    Mouth of Chesterfield Inlet.
22. *Eutrema Edwardsii*, R. Br.—*B.*
    North-west shore of Doobaunt Lake.
23. *Nasturtium palustre*, D.C.—*W.*
    Fond du Lac, Lake Athabasca.

V. VIOLACEÆ.

24. *Viola palustris*, L.—*W.*
    East and north shores of Carey Lake. These are the most northern localities in Canada where this species has been found.
25. *Viola canina*, L., var. *sylvestris*, Regel.--*W.*
    Fond du Lac, Lake Athabasca. South end of Daly Lake.

VI. CARYOPHYLLACEÆ.

26. *Silene acaulis*, L.—*B.*
    Doobaunt Lake, west shore. North end of Wharton Lake. Also at Ashe Inlet on Hudson Straits.
27. *Lychnis apetala*, L.—*B.*
    Mouth of Chesterfield Inlet.
28. *Lychnis affinis*, Vahl.—*B.*
    Doobaunt Lake, north-west shore.
29. *Arenaria lateriflora*, L.—*W.*
    Near the south end of Daly Lake.
30. *Arenaria peploides*, L.—*B.*
    Ashe Inlet, on the north side of Hudson Straits.
31. *Stellaria longipes*, Goldie.—*B. W.*
    Barlow Lake. Carey Lake. Wharton Lake. Doobaunt Lake, west shore. Loudon Rapids, above the Forks of Telzoa River. Fort Churchill.

32. *Stellaria longipes*, Goldie, var *læta*, Wats.
Barlow Lake and Limestone Island in Nicholson Lake.—*B.*

33. *Stellaria borealis*, Bigel.—*W.*
Red Hill, on the west shore of Hinde Lake.

34. *Cerastium alpinum*, L.—*B.*
Limestone Island in Nicholson Lake. Wharton Lake. Loudon Rapids, above the Forks of Telzoa River. Telzoa River, between Schultz and Baker lakes. Mouth of Chesterfield Inlet. Fort Churchill. Ashe Inlet, on the north side of Hudson Straits.

VII. GERANIACEÆ.

35. *Geranium Carolinianum*, L.—*W.*
North shore of Lake Athabasca, a short distance west of Fond du Lac.

VIII. SAPINDACEÆ.

36. *Acer spicatum*, Lam.—*W.*
Fort Chippewyan, Lake Athabasca. This is the most northerly locality in Canada from which this species has been recorded.

IX. LEGUMINOSÆ.

37. *Astragalus alpinus*, L.—*W.*
North shore of Lake Athabasca at Fond du Lac, and near Big Fowl Island. Esker near the Narrows of Daly Lake.

38. *Spiesia* (*Oxytropis*) *Belli*, Britt.—*B.*
Loudon Rapids, above the Forks of Telzoa River. Mouth of Chesterfield Inlet.
The only other locality from which this species has been collected is Digges Island, Hudson Bay, where it was found by Dr. Bell in 1884. It was described by Mr. Britton in 1894 from the specimens collected at the second and third of the above localities.

39. *Oxytropis campestris*, L., var. *cærulea*, Koch.—*B.*
Ashe Inlet, on the north shore of Hudson Straits.

40. *Oxytropis leucantha*, Pers.—*B.*
Telzoa River, between Schultz and Baker lakes. Mouth of Chesterfield Inlet. Fort Churchill.

41. *Hedysarum boreale*, Nutt.—*B.*
Loudon Rapids, above the Forks of Telzoa River.

42. *Hedysarum Mackenzii*, Richard, L.—*B. W.*
Fort Churchill. Ashe Inlet, on the north side of Hudson Straits.

X. ROSACEÆ.

43. *Prunus Pennsylvanica*, L.—*W.*
North-west angle of Lake Athabasca. Esker near Narrows of Daly Lake.

44. *Rubus chamæmorus*, L.—*W. B.*
Fort Churchill. Common in swampy places from Lake Athabasca northward to the edge of the woods. Grove on the north shore of Carey Lake, and at Loudon Rapids, near the Forks of Telzoa River. It was also found at Ashe Inlet, on the north side of Hudson Straits.

45. *Rubus articus*, L., var. *grandiflorus*, Ledeb.—*W.*
North shore of Lake Athabasca. Barlow Lake. North shore of Carey Lake. Fort Churchill.

46. *Rubus strigosus*, Michx.—*W.*
Banks of Stone River. In an isolated grove of white spruce on the north shore of Carey Lake. This would seem to have been an isolated locality, at some considerable distance north of its general northern limit.

47. *Dryas integrifolia*, Vahl.—B.

Carey Lake. Limestone Island in Nicholson Lake. West shore of Doobaunt Lake. Loudon Rapids above the Forks of Telzoa River. Fort Churchill. Ashe Inlet on the north shore of Hudson Straits.

48. *Fragaria Canadensis*, Michx.—*W.*

North shore of Lake Athabasca and Woodcock Portage on Stone River. This species, which has usually been confounded with *F. Virginiana*, was also collected in the same year by Miss Taylor at Fort Smith on Slave River.

49. *Potentilla Norvegica*, L.—*W.*

Woodcock Portage, on Stone River. Red Hill, on the west shore of Hinde Lake.

50. *Potentilla nivea*, L.—*B.*

Telzoa River, between Schultz and Baker lakes. Mouth of Chesterfield Inlet. Fort Churchill.

51. *Potentilla palustris*, Scop.—*W.*

Stony flats on the banks of Telzoa River, just below Daly Lake.

52. *Potentilla fruticosa*, L.—*W.*

North shore of Lake Athabasca, a little distance west of Fond du Lac.

53. *Potentilla nana*, Willd.—*B.*

Shore of Hudson Bay, north of Marble Island. Ashe Inlet, on the north shore of Hudson Straits.

54. *Potentilla tridentata*, Solander.—*W.*

Woodcock Portage, Stone River.

55. *Amelanchier alnifolia*, Nutt.—*W.*

North-west angle, Lake Athabasca.

XI. SAXIFRAGACEÆ.

56. *Saxifraga oppositifolia*, L.—*B.*

Telzoa River, between Schultz and Baker lakes. Mouth of Chesterfield Inlet. Ashe Inlet, on the north shore of Hudson Straits.

57. *Saxifraga cæspitosa*, L.—*B.*

Telzoa River, between Schultz and Baker lakes. Mouth of Chesterfield Inlet. Ashe Inlet.

58. *Saxifraga rivularis*, L.—*B.*

Loudon Rapids, above the Forks of Telzoa River. Ashe Inlet.

59. *Saxifraga cernua*, L.—*B.*

North-west shore of Doobaunt Lake. Loudon Rapids, above the Forks of Telzoa River. Telzoa River, between Schultz and Baker lakes. Mouth of Chesterfield Inlet. Fort Churchill.

60. *Saxifraga nivalis*, L.—*B.*

Mouth of Chesterfield Inlet.

61. *Saxifraga hieracifolia*, Waldst and Kit.—*B.*

North shore of Doobaunt Lake.

62. *Saxifraga punctata*, L.—*B.*

North-west shore of Doobaunt Lake.

This species had not previously been recorded east of the Rocky Mountains.

63. *Saxifraga Hirculus*, L.—*B.*

North-west shore of Doobaunt Lake.

64. *Saxifraga tricuspidata*, Retz —*B. W.*

Fort Chippewyan, Lake Athabasca. North shore of Carey Lake. Wharton Lake. Loudon Rapids, above the Forks of Telzoa River. Mouth of Chesterfield Inlet. Ashe Inlet.

65. *Chrysosplenium alternifolium*, L.—*B.*

Limestone Island, Nicholson Lake.

66. *Parnassia Kotzebuei*, Cham. and Schl.—*W.*

South end of Daly Lake.

67. *Parnassia palustris*, L.—*W.*
    Fort Churchill.
68. *Ribes oxyacanthoides*, L.—*W.*
    North shore of Lake Athabasca, near Fond du Lac.
69. *Ribes rubrum*, L.—*W.*
    Fort Chippewyan, Lake Athabasca.
70. *Ribes Hudsonianum*, Richards.—W.
    Fort Chippewyan, Lake Athabasca.
71. *Ribes prostratum*, L'Her.—*W.*
    North shore of Lake Athabasca. Esker near the Narrows of Daly Lake. East and north shores of Carey Lake.

XII. HALORAGEÆ.

72. *Hippuris vulgaris*, L.—*B.*
    Mouth of Chesterfield Inlet.
73. *Hippuris maritima*, L.—*B. W.*
    Red Hill, on the shore of Hinde Lake. Mouth of Chesterfield Inlet.

XIII. ONAGRACEÆ.

74. *Epilobium angustifolium*, L.—*W. B.*
    Esker near the Narrows of Daly Lake. Ashe Inlet, Hudson Straits. These localities probably mark the northern range of this species.
75. *Epilobium latifolium*, L.—*B.*
    West shore of Doobaunt Lake. Loudon Rapids above the Forks of Telzoa River, where the flowers were just appearing on Aug. 25. Fort Churchill. Ashe Inlet.
76. *Epilobium lineare*, Gray.—*B.*
    Red Hill, on the shore of Hinde Lake. Mouth of Chesterfield Inlet.

XIV. CORNACEÆ.

77. *Cornus Canadensis*, L.—*W.*
    North shore of Lake Athabasca. South end of Daly Lake.

XV. CAPRIFOLIACEÆ.

78. *Viburnum pauciflorum*, Pylaie.—*W.*
    North shore of Lake Athabasca. Esker near the Narrows of Daly Lake.
9. *Linnæa borealis*, Gronov.—*W.*
    Elizabeth Rapids, Stone River. Esker near the Narrows of Daly Lak North shore of Carey Lake. Fort Churchill.

XVI. RUBIACEÆ.

80. *Galium trifidum*, L.—*W.*
    Red Hill, on the shore of Hinde Lake.

XVII. COMPOSITÆ.

81. *Erigeron uniflorus*, L.—*B.*
    Loudon Rapids, above the Forks of Telzoa River.
82. *Erigeron eriocephalus*, J. Vahl.—*B.*
    North end of Wharton Lake.
83. *Antennaria alpina*, Gærtn.—*B.*
    West shore of Doobaunt Lake.
84. *Achillæa millefolium*, L., var. *nigrescens*, L.—*W.B.*
    Woodcock portage, Stone River. Fort Churchill. Ashe Inlet

85. *Matricaria inodora*, L., var. *nana*, Hook.—*W.*
Fort Churchill.

86. *Artemisia borealis*, Pall., var. *Wormskioldii*, Bess.—*B. W.*
Telzoa River, just below Daly Lake, and east end of Aberdeen Lake.

87. *Petasites palmata*, Gray.—*W.*
Fond du Lac, Lake Athabasca.

88. *Petasites sagittata*, Gray.—*B.*
Limestone Island, Nicholson Lake. Ashe Inlet, Hudson Straits.

89. *Arnica alpina*, Olin.—*B. W.*
North shore of Lake Athabasca. Esker near Narrows of Daly Lake. West shore of Doobaunt Lake. Loudon Rapids, above the Forks of Telzoa River. Fort Churchill. Ashe Inlet.

90. *Senecio palustris*, Hook., var. *congesta*, Hook.—*B.*
West shore of Doobaunt Lake. Fort Churchill. Ashe Inlet.

91. *Senecio aureus*, L., var. *borealis*, Tor. and Gr.—*B.*
Limestone Island in Nicholson Lake.

92. *Senecio aureus*, L., var. *balsamitæ*, Tor. and Gr.—*W.*
Fort Churchill.

93. *Sausssurea alpina*, Hook.—*B.*
North end of Wharton Lake.

94. *Taraxacum officinale*, Weber, var. *alpinum*, Koch.—*B.*
Loudon Rapids, above the Forks of Telzoa River. Mouth of Chesterfield Inlet. Fort Churchill.

XVIII CAMPANULACEÆ.

95. *Campanula uniflora*, L.—*B.*
Loudon Rapids, above the Forks of Telzoa River.

XIX VACCINIACEÆ.

96. *Vaccinium Canadense*, Kalm.—*W.*
South end of Daly Lake.

97. *Vaccinium uliginosum*, L.—*W. B.*
North shore of Lake Athabasca. Telzoa River, just below Daly Lake. Carey Lake. Doobaunt Lake. Loudon Rapid, above Forks of Telzoa River. Fort Churchill.

98. *Vaccinium Vitis-Idæa*, L.—*W. B.*
North shore of Lake Athabasca. Daly Lake. Doobaunt Lake. Loudon Rapids, above the Forks of Telzoa River. Fort Churchill.
While both this and the preceding species extend for a considerable distance into the Barren Lands, the bushes are small and bear very little fruit.

99. *Oxycoccus vulgaris*, Pursh. — *W.*
Esker near the middle of Daly Lake, and stony banks of Telzoa River just below the lake.

XX. ERICACEÆ.

100. *Arctostaphylos alpina*, Spreng.—*B. W.*
Island near the middle of Boyd Lake. Telzoa River, between Schultz and Baker lakes. Mouth of Chesterfield Inlet. Fort Churchill. Ashe Inlet, Hudson Straits.
(In 1894 the most southern locality at which this species was observed was on the hill south of Kasba Lake. In 1896 it was seen in the swamp at Cross Portage, north of Seepiwisk Lake, Nelson River.—J.B.T.)

101. *Arctostaphylos Uva-ursi*, Spreng.—*W.*
North to the edge of Barren Lands.

102. *Cassandra calyculata*, Don.—*W.*
North-west shore, Lake Athabasca. South end of Selwyn Lake.

103. *Cassiope tetragona*, Don.—*B.*
Shores of Doobaunt Lake. Telzoa River, between Schultz and Baker lakes. Mouth of Chesterfield Inlet. This is one of the plants most commonly used for fuel by those travelling in the Barren Lands.

104. *Andromeda polifolia*, L.—*W.B.*
North shore of Athabasca Lake. South end of Selwyn Lake. Esker near the middle of Daly Lake. West shore of Doobaunt Lake. Fort Churchill.

105. *Loiseleuria procumbens*, Desv.—*B.*
Boyd Lake.

106. *Bryanthus taxifolius*, Gray.—*B.*
Loudon Rapids, above Forks of Telzoa River.

107. *Kalmia glauca*. Ait.—*W.*
Fond du lac, Lake Athabasca. Esker near middle of Daly Lake.

108. *Ledum latifolium*, Ait.—*W.*
North shore of Lake Athabasca. Daly Lake. Farther north it is replaced by the next following species.

109. *Ledum palustre*, L.—*B. W.*
South end of Daly Lake. Carey Lake. Shores of Doobaunt Lake. Wharton Lake. Loudon Rapids, above Forks of Telzoa River. Mouth of Chesterfield Inlet. Fort Churchill.

110. *Rhodendron Lapponicum*, Wahl.—*B.*
Limestone Island, Nicholson Lake. Shores of Doobaunt Lake. Fort Churchill.

111. *Pyrola minor*, L.—*W.*
Red Hill, on the shore of Hinde Lake.

112. *Pyrola secunda*, L., var. *pumila*, Gray.—*W.B.*
North shore of Carey Lake. Loudon Rapids, above the Forks of Telzoa River. This is the most northern point at which this species was observed.

113. *Pyrola rotundifolia*, L., var. *pumila*, Hook.—*B. W.*
North shore of Lake Athabasca. Carey Lake. Wharton Lake. Loudon Rapids on Telzoa River. Fort Churchill. Ashe Inlet.

XXI. PLUMBAGINACEÆ.

114. *Armeria vulgaris*, Willd.—*B.*
West shore of Doobaunt Lake. Loudon Rapids above the Forks of Telzoa River. Mouth of Chesterfield Inlet.

XXII. PRIMULACEÆ.

115. *Primula Mistassinica*, Michx.—*W.*
North shore of Lake Athabasca. Fort Churchill.

116. *Trientalis Americana*, Pursh.—*W.*
Elizabeth Falls, Stone River.

Androsace septentrionalis, L.—*W.*
Fort Churchill.

XXIII. GENTIANACEÆ.

118. *Menyanthes trifoliata*, L.—*W.*
Woodcock Portage, Stone River.

XXIV. HYDROPHYLLACEÆ.

119. *Phacelia Franklinii*, Gray.—*W.*
North shore of Lake Athabasca. Woodcock Portage on Stone River.

XXV. SCROPHULARIACEÆ.

120. *Castilleia pallida*, Kunth.—*B.*

Limestone Island in Nicholson Lake. Shore of Doobaunt Lake. Loudon Rapids, above the Forks of Telzoa River.

121. *Pedicularis Lapponica*, L.—*B.*

Mouth of Chesterfield Inlet. Ashe Inlet, on Hudson Straits.

122. *Pedicularis euphrasioides*, Stephan.—*B. W.*

Esher near the middle of Daly Lake. North shore of Carey Lake. Loudon Rapids, above the Forks of Telzoa River. Fort Churchill.

123. *Pedicularis hirsuta*, L.—*B.*

Limestone Island in Nicholson Lake. West shore of Doobaunt Lake. Loudon Rapids.

124. *Pedicularis flammea.*—*B.*

Limestone Island in Nicholson Lake.

125. *Pedicularis capitata*, Adams.—*B.*

East shore of Carey Lake.

126. *Bartsia alpina*, L.—*W.*

Fort Churchill.

XXVI. LENTIBULARIACEÆ.

127. *Pinguicula villosa*, L.—*W.*

Daly Lake. Boyd Lake.

128. *Pinguicula vulgaris*, L.—*W.*

Carey Lake. Fort Churchill.

XXVII. POLYGONACEÆ.

129. *Polygonum viviparum*, L.—*B.*

Limestone Island in Nicholson Lake. West shore of Doobaunt Lake. Loudon Rapids, above the Forks of Telzoa River.

These are among the most northern localities at which these species has been found in Canada.

130. *Oxyria digyna*, Campdera.—*B.*

Mouth of Chesterfield Inlet.
Ashe Inlet on the north shore of Hudson Straits.

XXVIII. MYRICACEÆ.

131. *Myrica Gale*, L.—*W.*

North-west angle of Lake Athabasca.

XXIX. CUPULIFERÆ.

132. *Betula papyrifera*, Michx.—*W.*

North shore of Lake Athabasca.
Daly Lake.

The Indians make their canoes from the bark of this tree. Trees sufficiently large for canoes were seen as far north as the north end of Selwyn Lake, and the northern bend of Cochrane River. From these places northward it gradually decreases in size, until it disappears at about the northern limit of the forest.—J. B. T.

133. *Betula pumila*, L.

Red Hill on the west shore of Hinde Lake.
Boyd Lake.

134. *Betula glandulosa*, Michx.

Daly Lake.
Loudon Rapids, above the Forks of Telzoa River.
Doobaunt River, between Schultz and Baker lakes.

Fairly common, as a small shrub on the Barren Lands as far north as Ferguson River.—J.B.T.

135. *Alnus viridis*, DC.—*W.*

Carey Lake. Quartzite Lake, on Ferguson River.

XXX SALICACEÆ.

136. *Salix petiolaris*, Smith.—*W.*
North-west shore, Lake Athabasca.

137. *Salix desertorum*, Rich.—*W.*
North shore of Lake Athabasca.

138. *Salix Brownii*, Bebb.—*W.B.*
North shore of Lake Athabasca.
North-west shore of Doobaunt Lake.
Ashe Inlet, Hudson Straits.

139. *Salix Richardsonii*, Hook.—*B.*
Mouth of Chesterfield Inlet.
Not previously recorded from the vicinity of Hudson Bay.

140. *Salix reticulata*, L.—*B.*
Limestone Island in Nicholson Lake.
Loudon Rapids, above the Forks of Telzoa River.

141. *Salix herbacea*, L.—*W.B.*
Esker near the middle of Daly Lake.
Mouth of Chesterfield Inlet.
Ashe Inlet, on the north side of Hudson Straits.

142. *Salix rostrata*, Rich.—*W.*
North shore of Lake Athabasca.
Elizabeth Rapids, Stone River.

143. *Salix speciosa*, Hook and Arn.—*B.*
Mouth of Chesterfield Inlet.

144. *Salix glauca*, L., var. *villosa*, And.—*B.*
Doobaunt River, between Schultz and Baker lakes.

145. *Salix phyllicifolia*, L.—*B.*
Shore of Doobaunt Lake.
Doobaunt River, between Schultz and Baker lakes.
Mouth of Chesterfield Inlet.

146. *Salix balsamifera*, Barratt.—*W.*
West shore of Daly Lake.
This species was not before known to occur north of the Saskatchewan River.

147. *Populus balsamifera*, L.—*W.*
North shore of Lake Athabasca.
Limbs, believed to be of this species, were found lying on the sand at the Forks of the Telzoa River, having drifted down the West Branch to that place.

148. *Populus tremuloides*, Michx.—*W.*
North shore of Lake Athabasca.
Esker near the narrows of Daly Lake.
The latter locality is the northern limit of the tree in this longitude. On the head waters of the Thlewiaza River it was found to range as far north as an Esker in latitude 60°. A few small trees were also observed on the raised beaches near Fort Churchill.—J.B.T.

XXXI. EMPETRACEÆ.

149. *Empetrum nigrum*, L.—*W.B.*
Daly Lake.
Hinde Lake.
Carey Lake.
Loudon Rapids on Doobaunt River.
Mouth of Chesterfield Inlet.
Ashe Inlet on Hudson Straits.
Very little fruit was found on the bushes north of the edge of the Barren Lands.

XXXII. CONIFERÆ.

150. *Juniperus communis*, L.—*W.*

Fort Chippewyan, Lake Athabasca.
Esker near the middle of Daly Lake.
North shore of Carey Lake.

155. *Juniperus Sabina*, L., var. *procumbens*, Pursh.—*W.*

Fort Chippewyan, Lake Athabasca.

152. *Pinus Banksiana*, Lambert.—*W.*

On dry sandy or rocky slopes as far north as the north end of Selwyn (and Theitaga) lakes.

153. *Picea nigra*, Link.—*W.B.*

North shore of Lake Athabasca.
Telzoa River, just below Daly Lake.
This species occurs in scattered grooves down the Telzoa River to Doobaunt Lake (and down the Kazan River to Angikuni Lake, while one isolated grove was seen on a sandy flat not far above Yath-kyed Lake). On the shore of Hudson Bay it reaches its northern limit at the mouth of Nelson River. The most northern examples are spreading shrubs, in the middle of which may be a small upright stem four or five feet high.—J.B.T.

154. *Picea alba*, Link.—*W.B.*

North shore of Lake Athabasca.
The sandy eskers near Hinde and Boyd lakes were thinly covered with fine large trees of this species. Groves of large trees were also growing on the wet, but well drained, flats or slopes beside the Telzoa River down to within a short distance of Doobaunt Lake. Many large drifted trunks were also found at the Forks below this lake. On the Kazan River this species was not noticed north of Ennadaï Lake. Its northern limit on the shore of Hudson Bay is at Little Seal River, north of Fort Churchill, where it replaces the preceding species in the wet swamps near the shore.—J.B.T.

155. *Larix Americana*, Michx.—*W.B.*

Telzoa River, as far north as Doobaunt Lake.
Kazan River, as far north as the grove of Black Spruce above Yath-kyed Lake, it being the larger tree of the two.
On the shore of Hudson Bay as far north as the mouth of Little Seal River, associated with white spruce.—J.B.T.

XXXIII. LILIACEÆ.

156. *Smilacina trifolia*, Desf.—*W.*

Esker near middle of Daly Lake.

157. *Maianthemum Canadense*, Desf.—*W.*

North shore of Lake Athabasca.

158. *Allium Schœnoprasum*, L.—*W.*

North shore of Lake Athabasca.

159. *Tofieldia borealis*, Wahl.—*W.B.*

Barlow Lake.
Loudon Rapids, above the Forks of Telzoa River.
Fort Churchill.

XXXIV. ORCHIDACEÆ.

160. *Orchis rotundifolia*, Pursh.—*W.*

Fort Churchill.

XXXV. JUNCACEÆ.

161. *Luzula spadicea*, D.C., var. *melanocarpa*, Meyer.—*B.*

Island near the middle of Boyd Lake.

162. *Luzula campestris*, Desv.—*B.*

Island near the middle of Boyd Lake.

163. *Luzula campestris*, Desv., var. *vulgaris*, Hook.—*B.*

West shore of Doobaunt Lake.

XXXVI. CYPERACEÆ.

164. *Scirpus cæspitosus*, L.—*B.*
Island near the middle of Boyd Lake.

165. *Eriophorum polystachyon*, L.—*W.B.*
West shore of Hinde Lake.
Island near the middle of Boyd Lake.
Limestone Island in Nicholson Lake.
West shore of Doobaunt Lake.
Ashe Inlet on Hudson Straits.

166. *Eriophorum vaginatum*, L.—*W.B.*
Esker near the middle of Daly Lake.

167. *Eriophorum capitatum*, Host.—*B.*
Ashe Inlet, on Hudson Straits.

168. *Carex rariflora*, Smith.—*B.*
Loudon Rapids, above the Forks of Telzoa River.

169. *Carex canescens*, L., var. *alpicola*, Wahl.—*W.*
Telzoa River, just below Daly Lake.
Boyd Lake.

170. *Carex misandra*, R. Br.—*W.B.*
West shore of Hinde Lake.
Mouth of Chesterfield Inlet.

171. *Carex aquatilis*, Wahl.—*W.*
West shore of Hinde Lake.

172. *Carex vulgaris*, Fries., var. *hyperborea*, Boott.—*W.*
Daly Lake. Hinde Lake.
Boyd Lake.

173. *Carex Magellanica*, Lam.—*W.*
Esker near the middle of Daly Lake.

174. *Carex saxatilis*, L.—*W.*
Hinde Lake. Barlow Lake.

175. *Carex rotundata*, Wahl.—*B.*
Mouth of Chesterfield Inlet.

XXXVII. GRAMINEÆ.

176. *Hierochloa alpina*, R. & S.—*B.*
West shore of Doobaunt Lake.
Loudon Rapids above the Forks of Telzoa River.
Mouth of Chesterfield Inlet.

177. *Arctagrostis latifolia*, Griseb.—*W.B.*
West shore of Hinde Lake.
Loudon Rapids, above the Forks of Telzoa River.

178. *Arctophila Laestadii*, Rupt.—*W.*
West shore of Hinde Lake.

179. *Elymus arenarius*, L.—*W.*
Black Lake on Stone River.

180. *Elymus mollis*, Trin.—*B.*
Doobaunt River, between Schultz and Baker lakes.
Mouth of Chesterfield Inlet.

181. *Calamagrostis Langsdorffii*, Kunth.—*W.*
Black Lake on Stone River.
Esker near the middle of Daly Lake.
Telzoa River just below Daly Lake.

182. *Calamagrostis Canadensis*, Hook.—*B.*
Limestone Island in Nicholson Lake.

183. *Poa alpina*, L.—*B.*
Loudon Rapids, above the Forks of Telzoa River.

184. *Poa angustata*, R. Br.—*B.*
Boyd Lake.

185. *Poa cenisia*, All.—*B.*
Limestone Island in Nicholson Lake.
London Rapids, above the Forks of Telzoa River.

186. *Trisetum subspicatum*, Beauv.—*W.*
Esker near the middle of Daly Lake.

XXXVIII. EQUISETACEÆ.

187. *Equisetum sylvaticum*, L.—*W.*
Esker near the middle of Daly Lake.

XL. FILICES.

188. *Polypodium vulgare*, L.—*W.*
North shore of Lake Athabasca.

189. *Phegopteris Dryopteris*, Fee.—*B.*
Island near the middle of Boyd Lake.

190. *Aspidium fragrans*, Swartz.—*W. B.*
Daly Lake. Carey Lake.
Doobaunt River, between Schultz and Baker lakes.
Mouth of Chesterfield Inlet.

191. *Cystopteris fragilis*, Bernh.—*B.*
Limestone Island in Nicholson Lake.
Mouth of Chesterfield Inlet.

192. *Woodsia Ilvensis*, R. Br.—*W.*
North shore of Lake Athabasca.
Grove of white spruce on the north shore of Carey Lake.

XLI. LYCOPODIACEÆ.

193. *Lycopodium annotinum*, L.—*W.*
Cracking-stone Point, Lake Athabasca.
North shore of Carey Lake.

194. *Lycopodium annotinum*, L., var. *alpestre*, Hartm.—*W.*
Telzoa River, below Daly Lake.

195. *Lycopodium complanatum*, L.—*W.*
West shore of Hinde Lake.

196. *Lycopodium Selago*, L.—*B.*
West shore of Doobaunt Lake.
Ashe Inlet on Hudson Straits.

XLII. MUSCI.

197. *Sphagnum fuscum*, var. *pallescens*, Warnst.—*W.*
In swamp on the banks of Telzoa River, just below Daly Lake.

198. *Sphagnum tenellum*, var. *rubellum*, Warnst.—*W.*
Telzoa River, just below Daly Lake.

199. *Sphagnum acutifolium*, Russ. & Warnst.—*W.*
Telzoa River, just below Daly Lake.

200. *Dicranum elongatum*, Schwaegr.—*W.*
North end of Barlow Lake.

201. *Dicranum congestum*, Bird.—*B.*
West shore of Doobaunt Lake, at the mouth of Telzoa River.

202. *Dicranum fuscescens*, Turn.—*B.*
West shore of Doobaunt Lake, at the mouth of Telzoa River.

203. *Dicranum Bergeri*, Bland.—*W.*
West shore of Hinde Lake.
204. *Aulacomnium palustre*, Schwaegr.—*B.*
West shore of Doobaunt Lake, at the mouth of Telzoa River.
Ashe Inlet on Hudson Straits.
205. *Polytrichum strictum*, Banks.—*B.*
West shore of Doobaunt Lake, at the mouth of Telzoa River.
206. *Webera nutans*, Hedw.—*B.*
West shore of Doobaunt Lake, at the mouth of Telzoa River. Ashe Inlet on Hudson Straits.
207. *Hypnum exannulatum*, Guemb.—*B.*
West shore of Doobaunt Lake, at the mouth of Telzoa River.
208. *Hylocomium Schreberi*, Willd.—*W.*
Telzoa River, just below Daly Lake.
209. *Hylocomium splendens*, Schimp River.—*B.*
West shore of Doobaunt Lake, at the mouth of Telzoa River.

XLIII. HEPATICÆ.

210. *Ptilidium ciliare*, Dum.—*B.*
West shore of Doobaunt Lake.

XLIV. LICHENES.

211. *Cetraria aculeata*, Fr.—*B.*
West shore of Doobaunt Lake.
212. *Cetraria arctica*, Hook.—*B.*
River bank between Nicholson and Doobaunt lakes.
213. *Cetraria Islandica*, Arch.—*W. B.*
Daly Lake. Hill at the north end of Barlow Lake.
214. *Cetraria Islandica*, Ach., var. *Delisœi*, Bor.—*W.*
Telzoa River, just below Daly Lake.
215. *Cetraria Richardsonii*, Hook.—*B.*
West shore of Doobaunt Lake.
216. *Cetraria cucullata*, Ach.—*B.*
North-west angle of Doobaunt Lake.
217. *Cetraria juniperina*, Ach., var. *Pinastii*, Ach.—*W.*
Telzoa River, just below Daly Lake.
218. *Cetraria nivalis*, Ach.—*W. B.*
Telzoa River, just below Daly Lake.
North end of Barlow Lake.
Ashe Inlet on Hudson Straits.
219. *Alectoria jubata*, L., var. *implexa*, Fr.—*W.*
West shore of Hinde Lake.
220. *Alectoria divergens*, Nyl.—*W.*
Telzoa River, just below Daly Lake,
221. *Alectoria ochroleuca*, Nyl., var. (a) *rigida*, Fr.—*B.*
North end of Barlow Lake.
West shore of Doobaunt Lake.
222. *Parmelia physodes*, Ach.—*W.*
Telzoa River, just below Daly Lake.
223. *Parmelia conspersa*, Ach.—*W.*
Telzoa River, just below Daly Lake.
224. *Umbilicaria Muhlenbergii*, Tucherm.—*W.*
Telzoa River, just below Daly Lake.

225. *Nephroma arcticum*, Fr.—*W.*
West shore of Hinde Lake.
226. *Lecanora tartarea*, Ach.—*W.*
Telzoa River, just below Daly Lake.
227. *Stereocaulon Despreauxii*, Nyl.—*W.*
Telzoa River, just below Daly Lake.
228. *Cladonia decorticata*, Floerk.—*W.*
North end of Barlow Lake.
229. *Cladonia gracilis*, Fr., var. *elongata*, Fr.—*W. B.*
Telzoa River, just below Daly Lake.
West shore of Doobaunt Lake.
230. *Cladonia rangiferina*, Hoffm.—*W.*
Telzoa River, just below Daly Lake.
North shore of Barlow Lake.
231. *Cladonia rangiferina*, Hoffm., var. *sylvatica*, L.—*W.*
Telzoa River, just below Daly Lake.
232. *Cladonia cornucopioides*, Fr.—*W.*
Telzoa River, just below Daly Lake.
233. *Bomyces aeruginosus*, D.C.—*W.*
Telzoa River, just below Daly Lake.

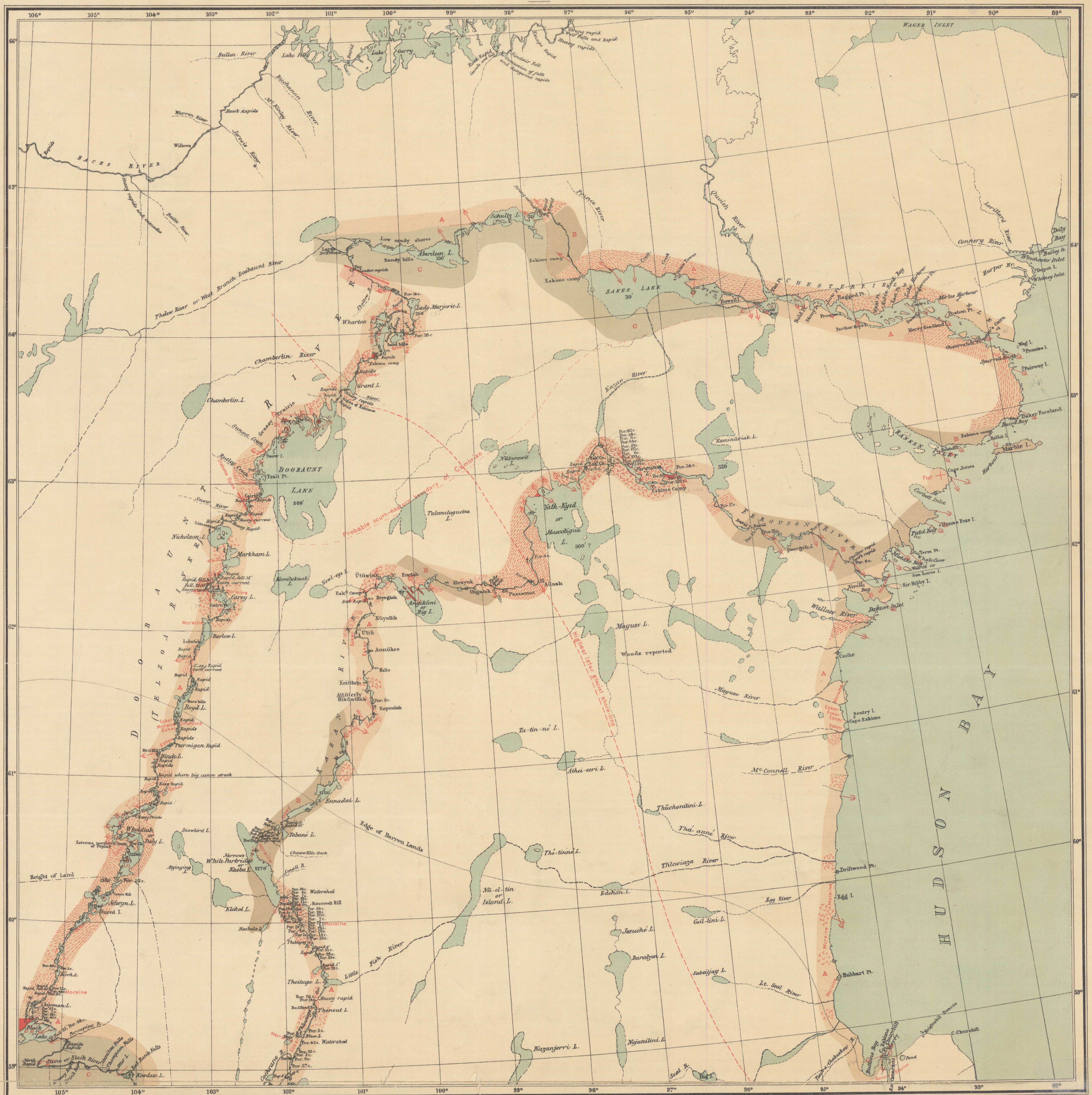
Doobaunt & Kazan Rivers &c.

5.1.5
A, Geol.

Geological Survey of Canada

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

1897



Legend

- C — Cambrian { Athabasca sandstone and conglomerate
- B — Huronian
- A — Laurentian (granitoid gneisses)
- A — Massive granitic rocks
- Quartz-porphyry and andesite (associated with Cambrian)
- Di. Dia. Ga. — Diorite, diabase, gabbro, etc.
- Glacial striæ
- 690' — Height above sea
- Por. 5 c. — Portages (length in chains)
- Clump of trees
- Eskimo camp
- Latitude station

J. White, Chief Draughtsman
Compiled and drawn for photo-lithography
by C. O. Senécal, C.E.

MAP
of
DOOBAUNT and KAZAN RIVERS and NORTHWEST COAST of HUDSON BAY

To accompany Report by J. Burr Tyrrell, M.A.

Natural Scale: — $\frac{1}{1,584,000}$

Scale 25 miles to 1 inch

10 0 10 20 30 40 50 60 70

Accompanying Part F, Vol. IX (New Series), 1896

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Doobaunt and Kazan Rivers
5-1-5
A. Geol.

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

REPORT

ON THE GEOLOGY

OF THE

FRENCH RIVER SHEET

ONTARIO

BY

ROBERT BELL, M.D., LL.D., F.R.S.

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

No. 627

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

Director Geological Survey of Canada.

SIR,—I beg to submit herewith my report on the French River region to accompany Map-sheet 125, showing the geology and geography of that part of Ontario.

I have the honour to be, Sir,

Your obedient servant,

ROBERT BELL.

OTTAWA, 3rd May, 1897.

NOTE.—*The bearings given throughout this report refer to the true meridian.*

REPORT ON THE GEOLOGY

OF

THE FRENCH RIVER SHEET.

By Robert Bell, M.D., LL.D., F.R.S.

This sheet (number 125 of the regular series) represents the country around the north end of Georgian Bay. The geology of this region has been worked out at intervals during many years by the writer and some other members of the Geological Survey, to be mentioned further on, and the object of this report is to condense all the information ascertained up to the present time and to state it as clearly as possible in few words. The geological facts are so fully represented upon the map itself as to render lengthy descriptions unnecessary. The sheet has the same dimensions and is upon the same scale as the others of the series, namely $\frac{1}{253,440}$ or 4 miles to 1 inch. It adjoins the Sudbury sheet on its north side and, like it, embraces an area of 72 miles from east to west by 48 miles from north to south or 3,456 square miles. The north-west corner is in the township of Hallam, the north-east at the western extremity of Lake Nipissing, the south-east at Shawanaga Bay and the south-west near the south-eastern extremity of Grand Manitoulin Island. For the sake of brevity in the following descriptions, the word "sheet" will be used for the ground which it covers.

Object of this report.

Area covered by map.

Mr. A. E. Barlow, M.A., who had been with me in the field in previous years continued to be my professional assistant in 1891, and we had also during that season the services of Messrs. A. M. Campbell, H. H. Walker, B.A.Sc., W. G. Miller, M.A., H. G. Skill and R. W. Brock. The three gentlemen last named assisted me again in 1892.

Assistants.

The topography is based upon the latest admiralty charts and the surveys by the Crown Lands Department, but considerable portions are from surveys made by the late Alexander Murray of the Geological Survey and by myself and assistants.

Topography.

The geology of different parts of Sheet 125 had been investigated to some extent by the late Mr. Alexander Murray, Assistant Pro-

Geology.

vincial Geologist, in 1847, 1855, 1856 and 1857 and by myself in 1859, 1865, 1876 and 1886. In 1860 both Mr. Murray and I visited the Cloche Peninsula and vicinity and spent some days in examining the lowest unaltered rocks of that neighbourhood with a view to ascertaining their age and their relation to the Sault Ste. Marie sandstones. Some of the results of that work are mentioned in the Geology of Canada, (1863), but no annual report for that year was published. Our attention in later years was therefore directed to adding details and filling up gaps in the geology of the area within the boundaries of the sheet, as well as to studying more carefully the geological structure and the relations to one another of both the larger and smaller divisions of the rocks.

Necessary surveys.

Considerable time was taken up in making the topographical surveys referred to in the summary reports for 1891 and 1892, which were indispensable in the construction of a sufficiently accurate and detailed map for publication. The topographical surveys which had previously been made within the sheet where those of the Whitefish and French rivers by the late Mr. Alexander Murray, the admiralty surveys by Captains Bayfield and Boulton and those by the Crown Lands Department, the last-mentioned consisting of outlines of townships along the northern edge of the sheet, the subdivisions of three townships, the greater part of which are included in the eastern part of the sheet, and of two others shown in part at the western edge. The topogragraphical surveys made by myself and assistants included Bay of Islands * and McGregor Bay with their irregular peninsulas and inlets and numerous islands†, Collins Inlet, several lakes connected with Whitefish and French rivers, both branches of the Ma-zin-in-a-zing (Pictured-water) River, the chain of lakes on its western branch, Tyson or Pai-pin-a-goshing Lake, on its eastern branch, Mitchi-zin-ishing (Big-fence) River and its chain of lakes, Trout Lake and other lakes in its vicinity, besides numerous minor lakes and streams in various parts of the sheet.

Admiralty charts.

Township surveys.

Dr. Bell's surveys.

The Killarney Belt of Red Granite.

Killarney granite belt.

The division between the Huronian and Laurentian rocks of our sheet has a general north-easterly course, but lying between the former and the gneisses to the south-eastward is a belt of red granite,

*This is the large bay into which Whitefish River discharges and which having had no name prior to my survey was called Bay of Islands for convenience of reference. See Summary Report for 1891, page 22.

†About 220 islands were located and outlined in Bay of Islands and about 240 in McGregor Bay.

which may for convenience be designated the Killarney belt, extending from Killarney Bay north-eastward to Three-mile Lake. It begins at the eastern extremity of Badgeley Island, where there is a small area of the granite in contact with the quartzites, and it includes the greater part of George Island. Behind Killarney village it has a breadth of about one mile and a half and appears to attain its maximum width opposite to the western entrance of Collins Inlet, where it is nearly three miles; but it soon diminishes to the north-eastward and appears to average only about one mile for the greater part of the remainder of its course to Three-mile Lake where it terminates in a point.

This belt of granite is apparently of intrusive origin and of later date than the quartzites. The occurrence of the quartzite (elsewhere described in this report) along its south-eastern side from George Island to Collins Inlet indicates that it should come within the Huronian area. At Killarney village it shows an approach to lamination towards the edges of the mass. Here it has a medium texture and is composed of reddish felspar and bluish-white quartz with a little hornblende, which however, is often wanting. Excepting at the sides it has a massive homogeneous structure, but in a few instances a single reddish or yellowish-green shaly streak, an inch or two in thickness, was observed running in a north-easterly direction with a dip to the south-eastward of about 50°. Towards each side, the grain of the rock begins to assume a sort of parallelism or a gneissoid structure (See Report of Geological Survey for 1876, page 208.)

Origin and age.

Incipient lamination.

Along its north-western side the granite belt is in contact with the Huronian quartzites or the schists which are here occasionally associated with them. The boundary between them leaves the east side of Killarney Bay at an island in the western part of section 29 of Rutherford township and runs with a general bearing of N. 60° E. (ast.) till it reaches Three-mile Lake, a distance of twenty-three miles from the extremity of the belt at Badgeley Island. This boundary marks part of the line of the great break which is elsewhere more fully described in this report and which, further to the north-eastward, forms the division between the Laurentian and Huronian systems.

Quartzite boundary.

The actual contact of the rocks on either side of this break may be seen in many places on its course all the way from Badgeley Island to Three-mile Lake. Along this line the rocks everywhere give evidence of great disturbance. Huge portions as well as many of moderate size which have been separated from both sides have become mingled

Disturbance along contact.

together and intermixed with the finer débris, all being cemented into a coarse breccia. Protruding masses and branches of the granite penetrate the quartzite for short distances and large masses of the quartzites have become entirely or partially separated from the parent rock and incorporated in the granite. Some good examples of this condition may be seen in the northern part of Crooked Lake. On the west side of the inlet of this lake, a semi-detached mass of white quartzite penetrates quarter of a mile into the granite. Continuing north-eastward, the line of fault traverses two points in Brush-camp Lake, the next higher one to Crooked Lake, and here the contact-breccia is particularly well seen. The quartzite near the break has become whitened, its granular character obliterated and a hyaline lustre has been imparted to it.

Detached mass of quartzite.

Contact of granite.

On Brush-camp Lake and the lower part of Three-mile Lake, the Huronian strata abut against the granite on the other side of the dislocation and they have been altered not only at the contact, but for some distance back from it. The principal rock on the north-west side in this vicinity is a stratified arkose and it has been altered into gneiss and mica-schist.

Dislocation.

Near the middle of Three-mile Lake the almost vertical Huronian beds, striking in an east-south-easterly direction, come almost at right angles against the Laurentian gneiss, there running north-east, without the intervention of the granite belt, which apparently terminates here.

The south-east side of the Killarney belt of granite rests against the Laurentian gneiss except in the interval from the southern point of George Island to the western entrance of Collins Inlet, when a narrow belt of partially altered, fine grained, brittle, red and sometimes gray quartzite intervenes between the granite and the water of Georgian Bay. This quartzite is much divided into small triangular and rhombohedral blocks by innumerable joint-planes running in every direction which give to its surface an extremely rugged aspect. In addition to the division-planes, strongly marked, straight and sometimes deep trench-like cuts run through these rocks. Their course corresponds with the general strike, but their origin is not very apparent.

Red and gray quartzite.

Approaching the western entrance of Collins Inlet, the strike of the quartzite is N. 75° E., while that of the gneiss to the eastward has a very uniform strike of N. 40° E. with a south-easterly dip of 60°. The existence of this quartzite between the granite and the Laurentian gneiss would indicate that the former is intruded within the Huronian rocks and may be classed with them, as mentioned by the writer in his report for 1876, page 208. Further to the north-eastward, or where the granite of the Killarney belt comes into contact with the gneiss which prevails to the eastward, it is not always separated from the latter by a very distinct boundary. The two rocks in some places pass into each other more or less gradually. Still a dividing line may be drawn between them with sufficient accuracy for the purposes of geographical geology. This line leaves the western part of Collins Inlet, as represented on the accompanying sheet, with a north-eastward course and after touching the western bay of West Lake, it crosses the outlet bay of Brush Lake and reaches the east side of Three-mile Lake, where the granite belt appears to terminate, as already stated.

Contact of gneiss and granite.

Leaving the central part of Three-mile Lake, the boundary line between the Huronian quartzites, schists, etc., and the Laurentian gneiss, curves to the northward and passes about one mile east of Lake Panache. It continues with a bearing a little east of north for about ten miles beyond Lake Panache when it resumes its former general course of N. 60° E. to Sturgeon River, as represented on the Sudbury sheet.

Boundary between Laurentian and Huronian.

The Laurentian Rocks of the Sheet.

The Huronian rocks of the north-western corner of the sheet form part of the great belt of this system which has been traced from Lake Superior to Lake Mistassini. This belt is flanked on both sides by Laurentian rocks, but those on the one side appear to belong to a different part of the system from those on the other. The rocks along the north-west side, which, however, do not come within the sheet, may, for the purpose of this report, be considered as belonging to the lower division, while those on the south-east side resemble the Grenville series which occurs along the north side of the lower Ottawa and is considered as belonging to the upper division. They consist of red and gray mica- and hornblende-gneisses in beds which can be traced with regularity for considerable distances, together with coarse hornblende and mica-schists and bands of quartz-rock with schistose partings. No limestones have yet been found among these rocks, within the boundaries of the sheet, but in the Parry Sound district to the eastward, among similar strata, the writer has traced five bands of crystalline limestone like those of the Grenville series.

Two divisions of Laurentian.

Resemblance to the Grenville series.

In order to identify more clearly the position among the Laurentian rocks to which those represented upon this map belong, the following note as to the general difference between the two divisions referred to may be appropriate in this place. What is here assumed to be the lower division is characterized by a great uniformity in the nature of its rocks over large areas. They consist principally of highly crystalline red and gray hornblende- and mica-gneisses of a solid homogeneous character or with only a rudely laminated structure, generally much disturbed and varying rapidly on the strike so that no particular band can be traced very far. They are composed mostly of quartz and felspar, the hornblende and mica seldom forming any considerable proportion. Economic minerals are almost entirely absent and the number of mineral species found in this division is small, whereas, the gneisses and other rocks of the upper division are less disturbed and contorted and have a stratigraphical arrangement like that of altered sediments. They generally possess considerable regularity in their structural arrangement and in some regions include long and thick masses or beds of crystalline limestone, quartz-rock and stratified as well as massive labradorite. Massive and somewhat banded pyroxene rocks are also present in some regions instead of the hornblende rocks of the older division. About seventy distinct species of minerals have been found among the rocks of the upper division in various parts of Canada and among the economic minerals of the upper series of the Laurentian rocks may be mentioned, graphite, apatite, mica, serpentine and limestone marbles, limestones suitable for building and calcining, felspar for porcelain, porphyries and other ornamental stones, pyrite, sulphates of barium and strontium, asbestus, crysotile, gneiss and granite for building and ores of iron, copper, lead, etc.

Character of the lower division.

Characters of the upper division.

On the map, which shows only the upper division of the Laurentian rocks, or those lying south-east of the great Huronian belt, the strike of the gneiss is everywhere indicated by the broken red lines and from these it may be seen that in the western part of the area represented, its prevailing direction is north-eastward, while towards the east side of the sheet the general course is south-eastward. Throughout the whole region the gneisses are of the typical upper Laurentian varieties. They are evenly stratified and regularly arranged in anticlinal and synclinal forms according to the structural laws governing stratified rocks, as shown by their contours in plan. The average angles of dip are not high and in some localities they approach the horizontal. As a rule, the stratification is not disturbed or contorted but runs straight and evenly for considerable distances, so that, as far as their structure goes, these gneisses have the characters of altered sedimentary deposits. The reddish and grayish shades are represented in varying proportions in different localities and they frequently alternate with each other,

Regularity of stratification.

both as to thin beds and thick sheets. All along the east-and-west shore of Georgian Bay, from the western part of Collins Inlet to the eastern mouth of French River, the gneisses are remarkable for the regularity of their strike. From the former locality to the western mouth of French River the strike is almost everywhere N. 40° E. and the dip S. E. at an angle of 60°.

Lower channels of French River.

The French River is noted for its straight reticulating rocky channels which may be said to be unique in the geography of Canada. Its lower channels traverse a rocky delta-shaped area, fifteen miles broad at the coast. The upward course of these channels is from north-east to north. They form three groups, each of which unites into one channel a short distance up and the three main channels thus formed all fall into an east-and-west one at seven miles from the coast. All the channels except this transverse one are excavated in beds of gneiss which everywhere strike parallel to them. The long east-and-west channels are transverse to the strike in the lower part of French River and they appear to follow either lines of crushing accompanied possibly by dislocation, which occur at intervals parallel to the system of jointing in these rocks, or they are situated upon groups of parallel joints occurring close together and running for long distances. Prior to the glacial epoch these lines permitted the deep penetration of the surface water and the decay of the rock through a long period of time, and during that epoch the decomposed rock was easily removed and thus the existing channels were formed. They are unlike ordinary river-courses and are in reality only long and very narrow lakes, with rapids or chutes of a few feet at considerable distances apart.

Origin of channels.

Relation of topography to geology.

From the mouths of French River, south-eastward, all along the coast of Georgian Bay, the rocks are almost continuously exposed, so that the relation between the geological structure and the configuration of the shore is well illustrated. The strikes of the gneisses are brought out in strong relief, owing to the greater or less amount of decay and subsequent glacial erosion which the different strata have undergone. This circumstance is graphically demonstrated by the improved charts of this coast recently completed by Captain Boulton of the British Hydrographic Department. In the report of the writer for 1876, page 195, it is stated in regard to this coast that "locally the run of the stratification is often indicated by the form or direction of the points and bays, the larger islands and the chains of smaller ones. The curving outlines of the islands, channels and inlets opposite to Penetanguishene, the twisted appearance of Parry Island and of the channel on its south-east side, as well as the singular straightness of Partridge Bay, the Long Inlet, the points on the west side of Parry Island and about Shibaishkong Island all correspond with the local strike of the rocks and are due to the effects of denudation which has formed channels along the course of the more yielding strata, and left ridges or higher ground where the rocks resisted decay and erosion. Along this shore there is, however, a class of channels and inlets due to another cause, namely the existence of dykes of trap and breccia, and of granite veins and also of parallel joints or cracks, along which the rocks have been rendered more decomposable; or these latter may have acted merely as starting points or guiding lines for the action of glaciers or other denuding agencies which constantly enlarged and deepened the depressions, once they had been commenced. The channels and inlets of this class usually run nearly east and west and have steep sides, while those which follow the stratification have usually some other course and are not so abrupt."

Channels due to dykes.

Among the distinctly stratified and regularly arranged gneissic rocks of the lower parts of the French River, coarse mica- and hornblende-schists and evenly bedded quartz-rocks occur also in considerable bands. Examples of the former may be seen along the north-eastward continuation of the Middle Outlet and of the latter in township 43.

Bedded quartz-rocks.

Quartz veins.

In the Laurentian area south of the Huronian belt, veins of quartz were observed in many places running in different directions, but they were all of a vitreous character or of the kind which miners call "hungry" and none of them were observed to carry promising quantities of metallic ores.

Granite veins.

Coarsely crystalline veins of red and nearly white granite, having various courses, are not uncommon among the mica- and hornblende-schists and the schistose gneisses in the region about the mouths of the French River, but such veins appear to be more rare at a greater distance inland from Lake Huron.

Granite area.

Between the western and middle outlets of French River, there is an area of coarse dull olive-gray granite, which has a breadth of about two miles on the lake-shore, and it probably runs inland for about four miles.

THE LAURENTIAN ROCKS NORTH-WEST OF THE HURONIAN BELT.

North-west of the great Huronian belt the Laurentian rocks, as already explained, are considered to belong to the older division of the system. They form part of the great body of the series and extend to an indefinite distance to the north-westward. A considerable, but varying breadth, bordering on this side of the Huronian belt, consists mostly of non-foliated granitic rock, but those merge into the foliated varieties which prevail at greater distances in a north-westerly direction from this belt. Reddish granite-like rocks border these Huronian strata all the way from Lake Wahnapiti to the township of Cascaden. But notwithstanding this outward granitic appearance, on closer examination the textural arrangement of the component minerals is more like that of a quartz-diorite and they are certainly of eruptive origin. The late Professor George H. Williams examined, under the microscope, a thin slice of a fine grained variety of these rocks from Kin-ni-wabic Lake in the township of Levack and pronounced it micropegmatite and undoubtedly eruptive.

Foliated and eruptive granites.

Red hornblende-granite is largely developed and appears to be continuous all the way from the Sudbury district, where it is shown on Sheet 130, westward to the Mississagi River, and it probably extends still further west.

Great extent of granite.

HURONIAN.—QUARTZITES.

It was stated in my report in the Annual Report of 1890-91 and again in my summary report for 1891, that the Huronian rocks of the north-western part of Sheet 125 have a general synclinal structure, and that the quartzite ridges forming the long peninsulas to the north-west of Killarney are on the southern side of this geological basin, while those of the Cloche Mountains form the opposite side. The investigations of 1892 seem to have demonstrated the correctness of this view. The large islands in McGregor Bay would lie about the centre of this trough. Along the southern side of the general synclinal structure are several subordinate folds which appear to be intimately connected with the peculiarities of the topography of this region.

Synclinal structure of quartzites.

The Cloche Mountains consist of two principal ridges of quartzites, which, running parallel to each other at an average distance of one mile apart, have a course almost due east, all the way from the western edge of the sheet to the township of Goschen. The outermost or more northern of these ridges, continues its eastern course across this township to Three-mile Lake, where it abuts against the granite at the line of the great dislocation; while the quartzites of the inner or southern ridge are apparently folded sharply upon themselves in getting round he eastern end of the trough on the south side of Lake David. Their

Two quartzite ridges.

continuation on the southern side of the fold runs south-westward towards the north side of Trout Lake. In attempting to work out the structure in this neighbourhood, we were guided to some extent by means of a belt of sea-green quartzite on the northern flank of the outer ridge and by belts of different shades of green occurring in other parts of the series.

Quartzite ranges of points.

The quartzite ranges of McGregor and Frazer points, lie at about the same distance apart as the two ridges of the Cloche Mountains and they may perhaps represent the same belts on the opposite side of the main syncline. They are, however, separated by a belt of gray sericite schist, out of which Narrow Bay has been excavated, and instead of being the equivalents of the two ridges of the Cloche Mountains, as just stated to be probable, they may both belong to one band on the opposite sides of a subordinate syncline with the sericite schist resting in it.

Trout Lake region.

On the south side of Trout Lake the quartzites rise into comparatively high peaks and perpendicular cliffs. The strike is here from S. 75° to 80° E. and the dip northward at angles from 85° to 90°. This lake, and also the smaller ones and the streams between it and the head of Narrow Bay, lie in a continuation of the depression occupied by the latter, which, as already stated, has been excavated in a wide belt of gray sericite schist. A narrow margin of the schist, striking nearly east-and-west, skirts the north shore of Trout Lake. The low ground between this sheet of water and Ka-ka-kise Lake appears to owe its origin to a continuation of this broad band of schist.

Lines of dislocation

There appears to be some evidence that a dislocation at about right angles to the general strike crosses this valley in a north-westerly direction, following nearly the course of the outlet and the lowest bay of Sturgeon Lake, which are at right angles to that of the main body of the lake. The line of the great north-east and south-west dislocation, which, in this vicinity, separates the quartzites from the granite to the south of them, enters the west end of Lake George and passes out at its eastern extremity, where it may be seen at the little rapid between the lake and the large marsh just above it. It strikes the south shore of Ka-ka-kise Lake half a mile from its outlet and leaves it at the eastern extremity, from which it follows the foot of the bold quartzite hills, here called the Killarney Mountains, north-eastward to Brush or Brush-camp Lake.

Structure of the quartzite bands.

Between Trout Lake and Brush Lake, the pure quartzites are very largely developed. The outline of their structure seems to be in the form of a section of a double convex lens with a length of ten miles, in a direction nearly parallel with the northern boundary of the granite to the south. These rocks may represent a great thickening of the quartzites of the outer ridge on the south side of the general synclinal trough, or they may be a distinct addition to them, lying stratigraphically lower in the series. On the other hand, the lens-shaped outline referred to, may be owing to another subordinate trough with nearly perpendicular dips, so that the total thickness of its beds may be only half the width of the lens, which is three miles. If it be a synclinal trough, then the main body of Sturgeon Lake and the smaller lakes in the mountains to the east of it would lie along its axis. They are surrounded on both sides by high quartzite hills, which curve round in the form described and constitute the most elevated ground in this part of the country. North Peak, one of the points in the range forming the north side of the lens, rises to an elevation of 1180 feet above Lake Huron or 1762 feet above the sea, being thus, so far as known, one of the highest summits in the province of Ontario, and only about 200 feet lower than the Niagara plateau in the township of Osprey.

Thickness of quartzites.

The addition of the quartzites of the lens just described to those of the general syncline gives us here the greatest development of these rocks to be found in the Lake Huron region. A straight line drawn north-northwest over the hills from Ka-ka-kise Lake on the south side of the great lens, would pass nearly at right angles across six miles of quartzites, with only a few schistose bands, all standing nearly on edge. North of the lens just described, this line crosses the eastern part of the main syncline which is contiguous with it, so that if the former be a synclinal trough as supposed, the actual volume of the strata would be doubled in both cases and the real thickness of the quartzites would be only half the above measurement, namely three miles, or 15,840 feet.

Syncline in quartzites.

Ridges and bosses of quartzite protrude through the horizontal Silurian limestones of Great and Little Cloche Islands and Cloche Peninsula. Between Trout Lake and Great Cloche Island the structure of the older rocks is apparently in the form of an elongated basin or trough running nearly east-and-west, with almost vertical dips. The eastern extremity of this trough appears to be near the outlet of Sturgeon Lake and the outliers of quartzite which come up through the Silurian strata to the westward of McGregor Point, seem to lie along the westward continuation of its axis. These exposures appear to occur in the general course of the axis of the syncline of Narrow Bay and they probably make their appearance along this line on account of the local thickening due to the folding of the belts in getting round the synclinal axis. The western part of McGregor Point is crossed diagonally by some of the inner quartzite bands of the syncline, while the eastern part of Narrow Bay would appear to lie near the central line of the trough.

Anticline and syncline.

If the foregoing interpretation of the geological structure of this region be correct, Frazer Bay would lie upon an anticline, the axis of which would run up the south side of the bay and diagonally through the north-eastern part of Badgeley Point, while Badgeley, Centre and Partridge islands would belong to the south side of another narrow synclinal trough, with Heywood Island lying in the course of its axis to the westward. The quartzite ridge which runs westward from the head of Sheguiandah Bay on Grand Manitoulin Island, may belong to this syncline or it may form part of the next structural fold to the southward.

Area between Bay of Islands and McGregor Bay.

Quartzites occur, but not continuously, along the northern sides of Great Cloche Island and of Cloche Peninsula and they have served to protect the more yielding Silurian rocks, that flank them on the south, from erosion during the glacial period. The quartzites extend eastward from Cloche Peninsula along the south shore of the northern peninsula of the Indian reserve which lies between Bay of Islands and McGregor Bay. The commonest rocks of the points and numerous islands of the bays just named are light coloured quartzites, probably belonging to a number of different bands ; but greywackes, sericitic and other schists, conglomerates, breccias, dolomites, greenstones and other Huronian rocks, also form a considerable proportion of the strata over the whole area which includes these two bays.

Greenstones.

The greenstones, associated with the quartzites, which form so prominent a feature of the Huronian rocks of the Sudbury sheet, become less conspicuous among the corresponding quartzites shown on the present sheet immediately to the south. Those which exist within the limits of this sheet are more largely developed in the tract on the south side of Lake Panache than elsewhere. Here they occur in the form of belts running east-and-west, one of which measures eight miles and another five miles in length. Along the south shore of the channel between Bear Lake and Walker Lake and from Van Winkle Lake to the west side of Leech Lake there is an uneven belt of ordinary

Greenstone belts.

greenstone. Another belt of this rock appears to be continuous from Cat Lake to the western part of Murray Lake. The large island in the southern part of Bear Lake consists of the same rock and there are also various other small areas of greenstone in this part of the sheet. Some areas of this rock occur on Lake Panache, a short distance northward of this district, as shown on the Sudbury sheet. A few occurrences of greenstone on Bay of Islands and McGregor Bay are mentioned in this report in connection with the geology of that part of the sheet.

Greenstone patches.

The Arkose Series.

McGregor Bay region.

In the space between the Cloche Mountains and the range which runs eastward from McGregor Point to Sturgeon Lake, including Bay of Islands, McGregor Bay and the land thence eastward to the junction of the two chains, the rocks belong to a local division of the Huronian which may for present convenience be called the arkose series, with its associated rocks. Structurally this area would appear to occupy the central part of the synclinal form between the above-mentioned conspicuous quartzite ranges. Although various forms of arkose or greywacke are the prevailing rocks within this space, there are in different parts of it considerable quantities of gray quartzites and fine quartz-conglomerates, mixed agglomerates and breccias, sericitic and micaceous schists, impure dolomites and eruptive greenstones.

Band of sericite-schist.

The sericite-schist is most conspicuously developed as a strong east-and-west band running through the northern parts of Bay of Islands and McGregor Bay. Dolomites and agglomerates are found in a parallel zone not far to the south of this band, while quartzites are most strongly developed along the centre of the arkose area including the southern part of the Indian peninsula north of Birch Island. The greenstones are in greatest force on the south-eastern sides of both Bay of Islands and McGregor Bay and on the islands about three miles east of Birch Island.

Associated rocks.

Character of arkose.

The rock above referred to as arkose or greywacke, resembles sandstone in some respects, but it does not usually occur in well defined beds with parallel faces, but rather in heavy bands traversed by joint-planes or a rudimentary sort of cleavage. It breaks readily and may be easily bruised or scratched, showing that it is largely composed of materials softer than quartz. The colour in fresh fracture is usually some shade of ash-gray, but the weathered surfaces may be stained to various shades. When closely examined it is found to consist of comminuted granitic débris mingled with many small and some larger angular and rounded fragments of the granite from which it has been derived. These fragments are usually of the same character and consist of red or gray binary granite or quartz-felspar rock of medium texture. Fragments of other crystalline rocks are also occasionally incorporated in the arkose. On microscopic examination the finer matrix of this rock is found to consist of somewhat rounded grains of quartz and more angular ones of felspar, with a filling of fine sericite and some dark amorphous mineral.

Origin of arkose.

As to the origin of these rocks, the thick unstratified and brecciated greywacke or arkose may represent consolidated masses of volcanic ashes or mud with stones, which were thrown upon the land or into shallow water, while the stratified varieties may have consisted of similar ejectamenta thrown into deeper water where they became arranged into layers as we find them. Some of these rocks whether stratified or otherwise may represent volcanic products which were originally thrown into the sea in a molten or heated condition and became broken up and almost completely disintegrated.

Reversion to granite.

A study of the different phases of the greywackes and their associated rocks in this region, would appear to prove that the former constituted the crude material from which both the quartzites and clay-slates were derived by the modifying and separating action of water. Again, by the action of time, pressure, heat and other metamorphosing agents upon different varieties of greywacke, some of our granites, syenites, gneisses and possibly other crystalline rocks were probably formed. In the Sudbury district, many instances were noted where the more massive greywackes exhibited a proneness to revert to granite again, while some of the stratified varieties showed different stages of their passage into gneiss.

Near the western bay of Lake Evelyn a rock allied to arkose has assumed the appearance of red granite, although on microscopic examination it proves to be of clastic origin.

Eastward ending of quartzites.

In the township of Goschen, the heavy quartzite bands in getting round the main anticlinal axis, which has a general north-easterly bearing, have a deeply notched arrangement, as shown upon the map, owing to subordinate flexures and in the "bays" thus formed and flanked by the solid white quartzite, other rocks come to the surface. Some of these resemble sandstones, others arkose, while schistose rocks, mostly micaceous, also occur.

Clay-Slates and Slate-Conglomerates.

These rocks do not form a large proportion of the Huronian series within this sheet. Solid and slatey argillites are found along Long Lake, an expansion of Whitefish River, and slate-conglomerates occur in considerable force on both sides of Bear Lake and between Cat and Leech lakes. Around the south-western part of Bear Lake and also along its eastern side much of the conglomerate is very darkly coloured. The pebbles are unevenly distributed and frequently occur closely aggregated in groups or "clouds" with smaller numbers between them. Clay-slates and conglomerates.

In the continuation of the Huronian belt to the north-westward of the present sheet, the clay-slates are intimately associated with the quartzites. Both appear to have been derived from the materials of arkose or disintegrated granite by the modifying action of water, which has separated the quartz grains from the clayey portion and deposited them in separate places at the same time, so that in a general way they may be regarded as contemporaneous. In some localities, as on the Montreal River, the two rocks may be seen interstratified with each other. Association of slates and quartzites.

Huronian Limestones.

Bluish-gray or dove-coloured impure magnesian limestones occur on several of the islands along the southern side of the sericite belt in the northern part of Bay of Islands. They may not form parts of a continuous band, but they appear to be confined to a horizon parallel to the sericite belt. A few spots of similar limestone were found among the islands in other parts of this bay. Huronian limestone horizon.

A finely crystalline limestone occurs among the Huronian rocks in the north-western part of the township of Rutherford. The locality is upon the slope of the hill about 100 yards back from the north shore of Lamirandière Bay at a distance of about half a mile from its narrow entrance. The limestone "has a vertical attitude and runs about N. 70° W. at the part examined. Its total thickness is about 75 feet, of which the 25 feet along the northern side consists of a single solid band of nearly white finely crystalline limestone, clouded with light greenish and grayish patches. The remaining 50 feet are mixed with shaly patches of hornblende, together with a little shining granular magnetic iron ore. Adjoining the limestone on the north side is a band, only a few feet in thickness, of dark smoke-coloured chert-rock, ribboned with streaks of a dull red colour. It breaks easily with a Limestone of Lamirandière Bay. Chert-rock.

fine conchoidal fracture and appears to be identical with a rock which was used by the mound-builders for making some of their arrow-heads. This is followed to the northward by a dark-coloured dioritic conglomerate in which the pebbles are mostly small and generally widely scattered, and further on by a very dark-gray soft massive-looking micaceous schist, most of which is full of small pebbles. Measured from the limestone band, a thickness of from 100 to 200 feet of these rocks is exposed."*

Conglomrates.

Limestones of Lake Panache

A short distance northward of the sheet, several exposures of impure gray limestones occur among the Huronian rocks of Lake Panache. Some specimens of these limestones were ascertained by Dr. T. S. Hunt to contain about fifty per cent of carbonate of lime.

Relations between Topography and Geology.

Origin of geographical features.

The base rocks are so largely exposed in the region covered by our map that an opportunity is furnished for studying the dependence of the topography upon the geology. The effects of cleavage and bedding, fissures and joints, rock-crushing, dislocations, intrusive dykes, etc., on the production of geographical features are here so well marked as to make it worth calling attention to some points in connection with this subject. In any part of the district we may select, it will be found that the joints, fissures and dislocations, generally run in two sets intersecting each other at large angles, but those of either set are parallel to each other. Usually one set is more strongly marked than the other and exercises an important influence in the decay and disintegration of the rocks, and this in its turn affects the contours of hill and valley and determines the positions of streams, inland lakes and of the inlets, etc., of Georgian Bay.

Lines of Erosion.

Channels along dykes.

The dykes which traverse both the Laurentian and Huronian rocks of the district and the fissures and lines of crushing which occur more particularly in the former, have given birth to some of the more striking features of the map. The greenstone dykes cutting these rocks are often remarkable for their persistence in length, even when of no great thickness. Sometimes these dykes run parallel to one another in groups and in such cases they are apt to produce marked effects on the topography. Large dykes are more coarsely crystalline than small

*Report of Progress, Geol. Surv. Can., 1876-77 p. 209.

ones and they have decomposed more rapidly along their centres than towards the sides. Their decay and erosion have given origin to the channels of many inlets, long narrow lakes and straight sections of river in various parts of the Archæan regions of Canada, and, as already mentioned, examples of these are to be found within the limits of the present sheet.

East-and-West Inlets and Channels.

E. and W. inlets of Georgian Bay.

A striking feature in the character of the shore-line of Georgian Bay in this sheet is the straight east-and-west channels, such as Collins Inlet, Key Inlet, and Byng Inlet, which have been excavated in the gneiss independently of its strike or dip. The straight channel, having nearly the same course, which separates George Island from the mainland at Killarney has been similarly excavated in granite and quartzite. In the direct bearing westward of the Killarney Channel, a notch is cut through Badgeley Point almost to the level of the lake and the low neck of land which here intervenes between Killarney and Frazer bays is called Rat Portage. Here eleven parallel dykes of greenstone occur in the breadth of a quarter of a mile. A dyke of greenstone parallel to Killarney Channel traverses the granite which forms its south wall. Some of the dykes which occur on the islands off the entrance to Narrow Bay, and again in the bays on the opposite sides of the southern part of Cloche Peninsula, appear to be the continuation of the Rat Portage set. The physical depression following the course of this belt of dykes is no doubt in some way connected with it.

Collins' Inlet.

Collins Inlet was found to follow one or more dykes, accompanied by a fracture, the inequalities in which are filled by a friable brown breccia. The bottom of the inlet probably lies upon one or more dykes of greenstone, patches of which may be seen adhering to the walls and filling angles and fissures in them at numerous places on both sides. Along the south side of the eastern part of this inlet a friable brown breccia very much like that occurring at the head of Byng* Inlet may be seen near the level of the lake. It appears to fill a space between the walls of a dislocation following the course of the arm itself. The existence of this inlet is therefore probably due to the rock-decay which took place along both this break and the dyke or the closely parallel dykes above referred to.

Key Inlet.

Key Inlet is upon the course of a large diabase dyke, while Byng Inlet lies upon a geological break in which soft breccia,

* Report of Progress, Geol. Surv. Can., 1876-77 p. 202.

like that of Collins Inlet, also occurs. The dykes would suffer deep decay in pre-glacial times and the great fractures referred to would also facilitate the disintegration of the adjacent rocks along their course, thus allowing of their subsequent easy erosion by glacial action. A line of deeper water, following in the same direction, marks the continuation of these rock-channels in the bottom of the lake. The rocky sides of Collins and Key inlets instead of sloping gently to the water like the shore in other parts of the lake, in this quarter are marked by long perpendicular, but not high, walls which cut across the strike of the gneiss at any angle.

Cambro-Silurian and Silurian Rocks.

Cambro-Silurian.

The eastern part of Grand Manitoulin Island and the islands of the La Cloche group which come within Sheet 125, consist of unaltered fossiliferous rocks belonging to the Silurian (Ordovician and Silurian). They are quite undisturbed and dip slightly to the southward, the rate being estimated at about 40 feet to the mile. Further details as to some aspects of the geology of Grand Manitoulin Island are given by the writer in the Report of the Geological Survey for 1865. His Report for 1866 refers to the westerly part of the same island, and to Cockburn, Drummond and St. Joseph Islands.

Report for 1865.

Chazy (?) Formation.

Chazy formation.

The lowest beds of the unaltered rocks are exposed in the northern parts of Great Cloche Island and in Cloche Peninsula. They consist of from 50 to 100 feet or perhaps more, of reddish and chocolate coloured calcareous marls with greenish layers and mottlings, together with some beds of fine-grained white and reddish sandstones. These rocks have yielded no fossils by which their precise age can be determined, but they underlie the limestones of the Trenton group and may be Chazy. Overlying the marls and interstratifying the upper portion of them are beds of hard, compact, dark-gray magnesian limestone which weather to various yellowish and reddish shades.

The Trenton Group.

Trenton group.

Between the hard beds, just referred to, and the summit of the Trenton formation proper, at Little Current, there must be a thickness of nearly 300 feet. This consists of rather thinly bedded lumpy and uneven-surfaced gray limestones, with many thin shaly beds and partings interstratifying them. A considerable number of rather poorly preserved fossils have been collected from these beds. These belong to the Black River and Birdseye formations of the Trenton group. The upper beds of the group, consisting of gray limestone, are seen in the south bank of the channel at Little Current and near the level of Lake Huron at the northern extremity of Strawberry Island. At these localities they are overlain by the black bituminous shales of the Utica formation. The breadth of those limestones at right angles to the strike in this part of the sheet is eight miles. If the average dip be 40 feet to the mile, as assumed, the total thickness of the Trenton group would here be about 320 feet. Resting on the flanks of the quartzite-ridges of Badgeley Point and island and of Centre, Partridge and Heywood islands, are numerous patches and margins of gray limestone containing Black River fossils and dipping at various angles form the quartzite centres into the lake. The northern half of the peninsula between Manitouaning and Smith bays and the adjacent islands on its north-east side and also Squaw Island consist of limestones belonging to the Trenton group.

Little Current

Limestone patches.

Utica Formation.

The black shales of this formation are found at the surface on the high ground in the village of Little Current. They cover the whole of Strawberry Island except the northern extremity. Small patches of this rock occur in Sheguendah village and on Heywood Island. They cross the peninsula between Manitouaning and Smith bays and form a small area at the extremity of Cape Smith. The thickness of the formation on Manitoulin Island is estimated at 60 feet.

Utica formation

Hudson River Formation.

Hudson River strata are largely developed in the township of Sheguendah and also in the area lying between Manitouaning Bay, Smith Bay, James Bay and the head of South Bay. In this region they consist mostly of bluish-gray and drab marls and shales, interstratified with thin layers of limestone and fine-grained sandstones, with a thirty or forty foot band of rather thinly bedded grey limestone at the top. The whole thickness of the formation at Cape Smith is 300 feet, but it diminishes to the westward and may not exceed 250 feet to the south of Little Current. Lonely, Club and Rabbit islands also consist of Hudson River strata.

Hudson River formation.

Clinton Formation.

Clinton formation.

The Medina formation which is so well developed between Lake Ontario and Georgian Bay does not extend to Manitoulin Island. Resting on the Hudson River strata are a set of magnesian limestones which are usually thinly bedded, somewhat hard and argillaceous and gray and purplish drab in colour, but in some parts they are buff-coloured and occasionally they are heavy-bedded. An example of the last-mentioned condition is to be seen at Gibraltar Rock at the south end of Manitouaning Bay which appears to consist of a lenticular thickening of the formation. The isolated plateau or table-land extending from Mocassets Landing half way to Smith Bay and the ridge of high ground to the north of James Bay are included in this formation. But its largest area within the sheet lies between James Bay and the Niagara escarpment which runs westward across the peninsula from Tamarac Cove to South Bay. These limestones have a thickness of about 150 feet and between them and the base of the Niagara formation there is a band of red marl with green layers and mottlings which, although only twenty-seven feet thick, is very persistent. Its geological position corresponds with that of the "iron ore band" of the Clinton formation.

Niagara Formation.

Niagara formation.

The southern portion of the peninsula between South Bay and the eastern side of Manitoulin Island belongs to the Niagara formation, which has here a thickness of about 405 feet. It consists principally of heavy-bedded, light-gray, light bluish-gray and buff dolomites. Good fossils are rare, although much of the rock is made up of comminuted fragments of organic remains. The thicker beds are rendered somewhat porous by the numerous small cavities left between these fragments. Most of the beds show a crystalline character on fresh fracture.

Guelph formation.

A break or ravine, running north-westward from Tamarac Cove, separates the north-easterly part of this Niagara plateau from the main body of the formation and it thus becomes an outlier as shewn upon the maps. On the south end of Fitzwilliam Island and on the eastern part of the south shore of Manitoulin Island there is a thickness of about 100 feet of heavy-bedded, coarsely spongy, gray and buff dolomite, which contains a few fossils like those of the Guelph formation.

General Section.

A vertical section from the mainland along the western border of the sheet, somewhat produced to the south, would show the following thickness for each of the successive formations from the base upward· Section across Manitoulin Island.

	Feet
Chocolate marls and fine sandstones (Chazy ?)..	100
Trenton group..........................	320
Utica formation.........................	60
Hudson River formation.................	250
Clinton formation.................... ...	177
Niagara formation.......................	405
Guelph formation (?).....................	100
Total thickness..........	1412

Surface Geology.

Glaciation.—The region covered by the sheet everywhere bears evidence of having undergone severe glaciation, which had been preceded by long-continued atmospheric decay of the solid rocks. The Laurentian area has been worn down to a comparatively low and even surface, while the great quartzite bands stand out as high and bold ridges, having resisted alike the preglacial erosion and the wearing action of the heavy land ice. On Manitoulin Island, the successive Cambro-Silurian strata which have a nearly horizontal attitude, have been brought out in bold relief by the denuding agency of the ancient glaciers, so that when the island is viewed from the eastward, the north-facing escarpments of the successive formations may be seen like so many volumes partially overriding one another. Glaciation.

Glacial Striæ.—As elsewhere in the country northward of Lake Huron, the striæ on the mountain tops and the higher levels in general, run more nearly due south than in the valleys or on lower ground. From Bay of Islands to the mouth of French River, the course of the striæ is from S. 35° W. to S. 45° W., and the same course prevails from the lake-shore northward to Lake Panache and Tyson Lake. But there are some exceptions, evidently due to the contour of the surface. At Killarney village the course is S. 35° W., but at the west end of the channel, one mile distant, it is S. 25° W. On the north-west flank of the high quartzite ridge, on the north side of Sturgeon Lake, the course is S. 60° W. or nearly parallel to that of the ridge itself. Around Trout Lake and thence southward to French River, the direction varies Glacial striæ in different localities from S. 10° W. to S. 35° W., and it would average S. 15° W. From the western mouth of French River to Byng Inlet, it ranges from S. to S. 40° W., but generally approximates to the latter. On Manitoulin Island, the ice grooves are seen only where the surface consists of firm limestone rock. All over the eastern part of the island they run about S. 40° W., but this gradually changes as we go west till near the opposite extremity it has become S. 10° W.

Pot-holes.

Pot-holes.—Large pot-holes are conspicuous along the north sides of Collins Inlet, the Key and Byng Inlet. Scattered examples may also be seen near the level of Lake Huron, on the north side of Bay of Islands, on Whitefish River and on the lakes connected with it. A large and deep one occurs at the short carrying-place which has always been known as the Pot-hole portage, at the west end of the northern expansion of McGregor Bay. Large pot-holes are also said to have been found in the middle outlets of French River, and in some places between Byng Inlet and the south-east corner of the sheet. On the top of Gibraltar Rock, at the southern extremity of Manitouaning Bay, many large and small pot-holes have been bored in the surface of the level limestone rock. Before this rocky surface had been swept by fire, clumps of small trees and single trunks might have been seen growing out of these holes, their roots being embedded in the black soil with which they were partly filled. Great perpendicular nitches, like longitudinal sections of cylinders are excavated in the walls of some ravines which occur in the upper part of Gibraltar Rock.

Gibraltar Rock.

Superficial deposits.

Superficial Deposits.—Both the Archæan and the Palæozoic regions of the sheet may be characterized as rocky, more than half the area being destitute of soil fit for cultivation. The superficial deposits are nowhere deep or extensive. Some deposits of fine sand occur on the southern slope of the great quartzite ridge on the north side of Bay of Islands. Below the first fall in ascending the Whitefish River, the banks consists of gravel, sand and sandy clay. Behind the village of Wekwemikong two ancient shore-lines have been formed partly by gravel and partly by the wearing away of the Hudson River strata. The clayey banks in the township of Shiguiandah, south of Little Current, consist of Hudson River marls, softened superficially by long exposure to the atmosphere. In shallow places among some of the islands near the north shore of Lake Huron a stiff reddish clay occurs which is seldom seen above high water mark. This may some day prove useful for puddling or other purposes in a section of country where such clay is scarce. Along the Mitchi-zin-ish-ing River from Tyson's settlement to Lake George, clay occurs under the surface sand of the valley.

Economic Minerals.

Limestones for Building, Granite, Marble.—The Silurian rocks of Manitoulin and Fitzwilliam islands afford a variety of good stones for ordinary building purposes and some kinds suitable for heavy structures The latter may be looked for among the thickly bedded buff-coloured dolomites of the Clinton formation and the gray dolomites of the upper part of the Niagara. The Guelph formation, which appears to be represented by the highest rocks in the southern parts of these islands, is heavy-bedded and would yield stone of large dimensions, but of a porous character. The red granite of George Island is of a pleasing red colour, and has generally a medium texture, but in parts it is fine-grained. In the north-western part of the island, the expos ures rise to a good height for quarrying, and, as far as can be judged without actual trial, it could be got out in large blocks. Some part of the Huronian crystalline limestone exposed on the northern side of Lamirandière Bay, referred to in a previous part of this report, may be found suitable for working as marble.

Building stones, granite, marble.

Clays.—Some of the clayey shales of the Hudson River and Clinton formations on Manitoulin Island may be found suitable for making fire-clay or for the manufacture of pottery. The occurrence of stiff clay near the water-level along the north side of Lake Huron has been already referred to.

Clays.

Shell Marl.—This substance is found under a few of the limited peaty swamps and marshes and also under some of the smaller lakes or their dried-up sites on Manitoulin Island. Where the soil already contains so much carbonate of lime as does that of this island, these marls will not be required as fertilizers, but they may prove useful in the manufacture of hydraulic cement.

Shell marl.

Lime.—The limestones of Manitoulin Island appear to be all dolomitic, except those of the Trenton group and some of the beds in the Hudson River formation. Both the dolomites and the pure limestones have been calcined for use by the farmers in the various parts of the island where they occur and have been found to yield excellent lime. The purer portions of the Huronian limestones of Lamirandière Bay would no doubt also answer for this purpose.

Lime.

Hydraulic Cement.—Some of the yellow-weathering bands of the Black River formation and also some of the thinly bedded portions of the Clinton look as if they could be converted into hydraulic cement, for which there is an increasing demand in Canada, especially for making granolithic foot pavements.

Hydraulic cement.

Bitumens.

Bitumens.—The bituminous black shale of the Utica formation of Cape Smith, the peninsula between Smith and Manitouaning bays and Strawberry Island, would yield about 3 per cent of oil on distillation, but at the present prices, it could not be manufactured at a profit. Some years ago, wells were sunk for petroleum at Cape Smith and at Bass Lake behind Shiguindah and small quantities were said to have been obtained. Surface indications of petroleum were stated to have been observed many years ago on the south side of Shiguindah Bay. In 1846, the late Mr. Alexander Murray brought a specimen of bituminiferous limestone from Manitoulin Island, which would be well suited for making asphalt pavements. The locality was not stated, but the writer has been informed that such a rock occurs a short distance westward from South Bay Mouth.

Quartzite for glass-making.

Quartzite for Glass-making.—The white quartzites of McGregor, Frazer and Badgeley points and their adjacent islands, as well as of the high ridge on the north side of Bay of Islands, would furnish inexhaustible quantities of pure material for making glass. As these rocks occur on the immediate shore of Lake Huron, at numerous convenient places for shipping, they are likely to be utilized sooner or later for this purpose.

Iron ore.

Iron Ore.—Small deposits or pockets of apparently good hæmatite have been found in a few places among the Huronian quartzites. One of these, on the north-western side of Sturgeon Lake, near its western extremity, had been opened to a small extent, but abandoned some years ago. From all that could be seen at the surface, the occurrence was of limited extent.

Copper ore.

Copper Ore.—At the Wallace Mine near the mouth of Whitefish River, which was opened in 1847, but soon abandoned, copper-pyrites occurs in a quartz vein. Another vein, only a few inches wide, containing copper-glance occurs at the portage across a narrow part of McGregor Point, four miles and a-half from its extremity. Small quantities of copper-pyrites were found in a quartz vein near the north side of Cross Lake on the Whitefish River and in other veins in various places among the Huronian rocks in the north-western part of the sheet, but none of these occurrences gave promise of economic value.

Nickel.

Nickel.—The existence of nickel in the country north of Lake Huron, where the metal has since been produced in such large quantities in the

First discovery.

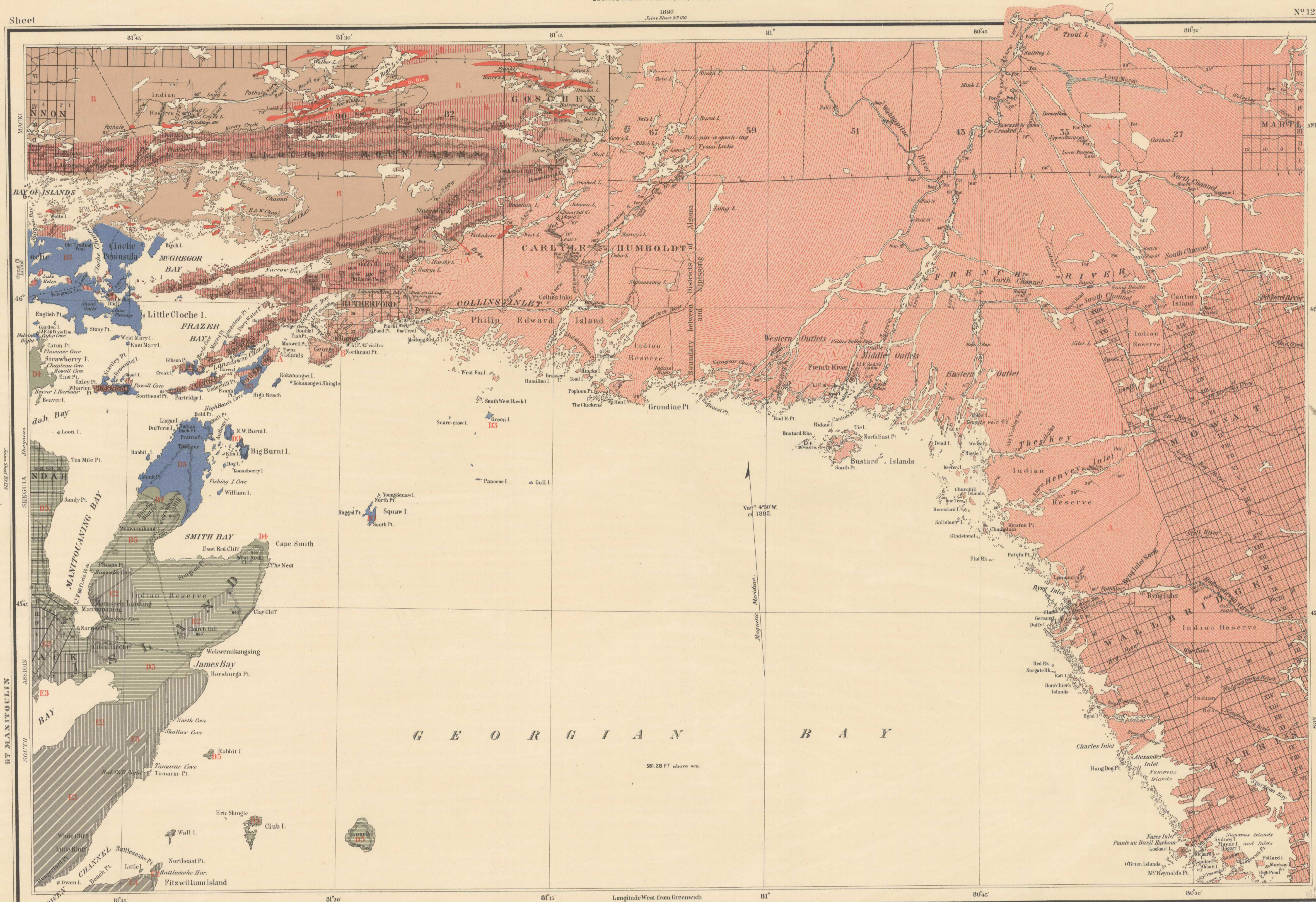
Sudbury mining district, was first made known by the late Mr. Alexander Murray, Assistant Provincial Geologist, in 1848, from a specimen he collected at the Wallace Mine, which had been opened the previous year. The ore was found by Dr. Hunt's analysis to contain 8·26 per cent of nickel, but Mr. Murray says, "as two-fifths of the specimens consisted of earthy material which might readily be separated by dressing, the quantity of nickel in the pure ore which this would represent, would equal nearly 14 per cent." Dr. Hunt also discovered the presence of nickel in greenstone which had been brought the same year by Mr. Murray from a locality not far from the site of the present town of Sudbury.

French River sheet
5.1.7
A, Geol.
1897

Geological Survey of Canada

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

Sheet 1897 No. 125



Legend

Silurian

- E3 — *Niagara*
- E2 — *Clinton*

Cambro-Silurian

- D5 — *Hudson River*
- D4 — *Utica*
- D3 — *Trenton and Black River*

Huronian

- B — *Quartzite*
- B — *Sericite-, chlorite-, hornblende- and arkose-schists, clay-slates, greywackes, quartzite bands and dolomites*

Laurentian

- A — *Diorite-gneiss and granite-gneiss*
- A — *Granite*

- Di, Dia — *Diorite and diabase*

- 70° *Strike and dip*
- *Vertical dip*
- *Glacial striæ*
- 736' *Heights above sea level*
- ♀ *Copper*
- Ni *Nickel*

DESCRIPTIVE NOTES.

LAURENTIAN

The Laurentian rocks of this sheet consist of red and grey mica- and hornblende-gneisses in even and regular beds, together with coarse hornblende- and mica-schists and bands of quartz-rock with schistose partings. They dip usually at angles of medium inclination. In the western part of the sheet, the prevailing strike is N.E., while towards the eastern part it is N.W., and there appears to be an anticlinal and synclinal arrangement throughout. An area of coarse, dull olive-grey granite occurs between the western and middle outlets of French River. Some greenstone dykes, having approximate east-and-west directions, traverse the gneiss and appear to have been connected with the origin of the depressions in which lie the east-and-west fiords, such as Collins inlet, The Key and Byng Inlet.

Limestones have not been found among the Laurentian rocks within the sheet, but in the Parry Sound District, not far to the eastward, five bands of crystalline limestone have been traced.

HURONIAN AND IRRUPTIVE.

The irruptive rocks are, for the most part, associated with the Huronian areas, and consist of the belt of red granite running from Badgeley island to Three-mile Lake, twenty-three miles in length with a maximum breadth of three miles together with some belts of diabase and diorite between the east end of Lake Panache and Howry Creek, running parallel with the general stratification

The most conspicuous feature of the Huronian system within the map, is the whitish quartzite, great ridges of which enter the west side of the sheet and extend due east to Three-mile Lake, whence they run south-west to Lake Huron, forming the high points between McGregor and Killarney bays. Between these two arms of the quartzite, and northward, the most abundant rock is ash-coloured greywacke, which is associated with varying proportions of quartzites, quartz-conglomerates, agglomerates, breccias, sericite- and mica-schists impure dolomites and the irruptive greenstones above mentioned. The whole series, including the quartzites, dips at high angles. The strike is indicated at frequent intervals on the map.

CAMBRO-SILURIAN AND SILURIAN.

The Cambro-Silurian and Silurian rocks of Grand Manitoulin, La Cloche and other islands, consist of unaltered fossiliferous strata, with a southward dip of about 40 feet to the mile. The following section is taken across La Cloche, Grand Manitoulin and Fitzwilliam islands along the western edge of the sheet. The order is ascending :—

		FEET.
1.	Chocolate-coloured marls with some fine sandstones, possibly Chazy -	100
2.	Trenton group, grey limestones with shaly and marly beds - - -	320
3.	Utica ; black bituminous shale - -	60
4.	Hudson River; bluish-grey and drab marls and shales interstratified with thin layers of limestone and fine-grained sandstones, with 30 or 40 feet of grey limestone at the top - - (Medina ; wanting.)	250
5	Clinton ; drab, buff and purplish magnesian limestones, about 150 feet, followed by red marl beds at summit, very persistent but only 27 feet thick, equivalent of the "Iron Ore Band" -	177
6.	Niagara ; thick and thin-bedded, dark and light grey and buff dolomites. The thick and light-coloured beds prevail, and are usually porous and crystalline, although largely composed of fragmental organic remains - -	405
7	Guelph (?); some of the highest beds on the south end of Fitzwilliam island and the south-eastern portion of Manitoulin island may belong to this formation. They consist of coarse spongy, grey and buff dolomites - - -	100
		1412

ECONOMIC MATERIALS

The Silurian rocks furnish good building stones, and their various dolomites and limestones have been found to burn into good lime. Rocks apparently suitable for hydraulic cement occur in the Clinton and Trenton formations. The Utica bituminous shales would yield oil and gas. The Huronian white quartzites afford inexhaustible quantities of excellent material for glass making. The red granite of George Islands is well suited for monuments and is a good and handsome building stone. It is easy of access and can be obtained in large blocks. Nickel and copper ores occur at the Wallace Mine on the north side of Bay of islands, and iron and copper ores have been found at a few places among the Huronian quartzites.

J. White, Chief Draughtsman
A. S. Cochrane and C. O. Sénécal, Draughtsmen

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PROVINCE OF ONTARIO
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Geologically surveyed by R. Bell

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SOURCES OF INFORMATION

Surveys by A. Murray, R. Bell and A. E. Barlow, Geological Survey
Charts of Hydrographic Survey of Canada
Plans of surveys of Crown Lands Dept. of Ontario

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Photo. by A. P. Low, 1896.

VALLEY OF THE WIACHOUAN RIVER, NEAR ITS OUTLET, RICHMOND GULF.

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

REPORT

ON A

TRAVERSE OF THE NORTHERN PART

OF THE

LABRADOR PENINSULA

FROM

RICHMOND GULF TO UNGAVA BAY

BY

A. P. LOW, B. AP. SC.

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

No. 657.

To

G. M. Dawson, C.M.G. LL.D., F.R.S.,

Director Geological Survey of Canada.

Sir,—I herewith beg to submit my Report on a traverse of the northern portion of the Labrador Peninsula between Hudson Bay and Ungava Bay, made during the summer of 1896.

I am, sir,

Your obedient servant,

A. P. LOW.

Ottawa, 12th January, 1898.

Note.—*The bearings throughout this report refer to the true meridian.*

REPORT

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BY

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Introductory.

The present report is based on the observations and measurements made during the summer of 1896, on a line of traverse carried across the north-western part of the Labrador Peninsula, from Richmond Gulf on the east coast of Hudson Bay to the mouth of the Koksoak River at Ungava Bay, supplemented by subsequent examinations of the rock specimens in the office.

This work may be considered as supplementary to the Report on the Labrador Peninsula, which included the results of the explorations of 1892, 1893, 1894 and 1895 in that region, and the surveys made in 1896 have been added to the map published with that report.* Map.

Acknowledgments are here made to Mr. C. C. Chipman, Commissioner of the Hudson's Bay Company, for a circular letter to the officers in charge of posts along the route travelled, and to the following gentlemen at those posts: Messrs. Wm. Broughton, Miles Spencer, Duncan Mathewson, A. Nicholson, D. Gillies, J. A. Wilson, S. P. Ross, J. Ford and R. Ford, and also to Capt. A. Gray of the Hudson's Bay Company's steamship *Erik*, for their generous hospitality and efficient aid, to which the success of the exploration is largely due. Further acknowledgments are made to Messrs. Nicholson, Gillies, Boucher, J. Ford, Guy and Swafield, for gifts of bird skins, bird eggs, Acknowledgments.

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* The line of traverse here described is shown upon the north-west sheet (No. 587) of the map accompanying the report above-mentioned, being Part L, Annual Report, Geol. Surv. Can., vol. VIII. (N.S,), 1895.

and articles of Eskimo manufacture, for the museum, and also for valuable information concerning the natives and natural history of the region.

Assistants.

Mr. G. A. Young acted as my assistant and carried on the surveys, kept the meteorological observations, and helped in the general work of the expedition in a most efficient and satisfactory manner. Mr. W. Spreadborough was attached as collector of plants and natural history specimens, and succeeded in making large collections of this kind, besides performing other duties incident to such a trip. The remainder of the permanent party consisted of three canoe-men, and these were supplemented by extra canoe-men and guides from time to time, as required.

Previous traverses of route.

The route followed between Hudson Bay and Ungava Bay was first passed over in 1824 by Dr. Mendry, when sent by the Hudson's Bay Company from Moose Factory to establish a trading post at the mouth of the Koksoak River. The only known record of his trip is a rough map of his journey, from which a copy was taken at Moose Factory in 1887; since then the original map has been lost.

In 1885, the Rev. J. Peck, of the Church Mission Society, crossed by the same route and subsequently wrote a short account of his trip which was printed in a publication of the Society. A survey from Richmond Gulf, seventy-five miles inland, to the outlet of Clearwater Lake, was made by the writer in 1887, an account of the journey appearing in the report of that season's work.*

Journey to Commencement of Exploration.

To reach the point of departure of the exploration, far up the east coast of Hudson Bay, the party left Ottawa on May 27th, and proceeded by the Canadian Pacific Railway to Missinaibi station, situated near the head of the Michipicoten River, which flows into Lake Superior. Here the outfit and provisions were loaded into two large Peterborough canoes and a large bark canoe manned by four Indians, who were temporarily engaged to assist in the transport to Moose factory. From Missinaibi station the route led through Dog and Crooked lakes to the height-of-land separating the head-waters of Michipicoten from the Missinaibi branch of the Moose River. Having crossed the watershed Missinaibi Lake was followed northward to its outlet, and the river was descended to Moose Factory near its mouth in the south-western part of James Bay. This part of the route has been fully described by Dr. Bell,† and it need only be stated here

Missinaibi to Moose.

* Annual Report, Geol. Surv. Can., vol. III. (N.S.), pp. 55-60 J.

† Report of Progress, Geol. Surv., Can., 1877-78, Part C.

that it is the easiest and shortest route from the railway to Hudson Bay, being in all about 350 miles. Rapids and falls necessitate some twenty-five portages, of which the longest is more than two miles, but most are comparatively short, ranging in length from 50 to 400 yards. The last portage is about 150 miles above the mouth of the river, and below it the stream passes from the undulating country underlain by Laurentian and Huronian rocks, to a much flatter country where nearly horizontal beds of Silurian and Devonian limestone are masked beneath a considerable thickness of stratified clay and sand. These deposits of drift thin out towards James Bay, so that for upwards of fifty miles from the mouth of the river, the land does not reach an elevation of one hundred feet above the sea. This great plain was covered with large spruce trees and remnants of the forest are still found in patches along the banks or on the islands, but elsewhere it has been burnt and its place taken by a thick growth of small aspen and white birch. Much of the plain would undoubtedly make fine agricultural land and the climate is sufficiently temperate to allow the successful growth of hardy cereal and root crops, as these are now grown at Moose Factory, which is less favourably situated than the country further away from the influence of the cold waters of James Bay. A drawback to settlement exists in the swampy nature of large areas having a heavy clay subsoil, but this might easily be overcome in many places by drainage to the rivers, and a large tract of country made fit to support a considerable population when it is rendered accessible by railways.

Flat country along Lower Moose.

A delay of a week at Moose Factory was occasioned by the repairs necessary to the large Collingwood fishing-boat belonging to the Survey which had been stored there in 1892. The boat was loaded with two tons of provisions and outfit, and carried the two large wooden canoes on deck, besides a crew of six men, and consequently was rather low in the water for safety or comfort. The trip up Hudson Bay lasted from the 14th to the 29th of June, and the course followed was across Hannah Bay to Point Comfort, thence north-east passing to the east of Charlton and Strutton islands to the east coast of Cape Hope, whence the coast was followed to Richmond Gulf.

Voyage in Hudson Bay

Stops were made at several places, including Fort George, Great Whale River and Little Whale River, to examine the rocks in order to extend the knowledge of the geology of the coast, which had been, in part, previously examined and reported on by Dr. Bell in 1877,* and by the writer in 1887 and 1888. A description of the coast and islands is

* Report of Progress, Geol. Surv. Can., 1877–78, pp. 11-19 c.

Observations *en route.*

given in previous reports, and it is only necessary to mention that the south and east coasts of James Bay are generally low, with a wide margin of swampy land above high tide, while between high and low water mark wide mud flats sometimes extend for miles. As the coast is followed northward the flat swampy land is broken by rocky ridges; these increase in height and number, so that in the vicinity of Cape Jones the areas of rock exceed those of swamp and drift. The shore is broken by long irregular points, and in many places is fringed with islands that extend several miles from the mainland; they are rocky or formed of drift. A chain of large islands lies parallel to the coast and about a third of the way across James Bay. These are composed of sand, clay and boulders, representing the higher parts of a terminal moraine of an ice-sheet from the Labrador side.

Coast north of Cape Jones.

Beyond Cape Jones the character of the coast changes. The rocky hills are continuous and rise directly from the shore, with, in places, a narrow margin of terraced drift on their flanks. The scattered islands of James Bay give place to a regular chain formed from the bedded rocks of the Manitounuck series of Dr. Bell.* These rocks also occur in patches along the coast to the south of Great Whale River, and continuously so to the northward of that stream. As the rocks dip seaward, the islands present abrupt cliffs on their landward sides and slope more gently with the bedding in the opposite direction. The chain of islands commences immediately north of Cape Jones, and with only a few breaks continues northward to Portland Promontory, a distance of over 300 miles, or considerably beyond the limit of this report.

Vegetation.

The coast and inner islands of James Bay are covered with thick growths of small black spruce and larch, along with white spruce, balsam fir, aspen and balsam poplar and white birch; the outer islands are nearly treeless. To the northward of Cape Jones, the trees become dwarfed and confined to the lower slopes and valleys, and as the coast is followed northward the forest becomes scanty, so that in the vicinity of Richmond Gulf, dwarfed black spruce and larch only are found in protected gullies, leaving the greater part of the coast quite bare.

At Great Whale River, an Indian who had crossed to Fort Chimo with Mr. Peck in 1885, was engaged as guide, but, contrary to the accepted idea, he had, in the course of eleven years, forgotten all that he knew about the route, and proved useless in that capacity.

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* Report of Progress Geol. Surv. Can., 1877-78, pp. 11-16 c.

Country Between Hudson Bay and Clearwater Lake.

Richmond Gulf.

Richmond Gulf, or more properly "Gulf Lake," is a triangular body of salt water, widest at the southern end, where it measures nineteen miles from east to west, while its greatest length is twenty-three miles from north to south. It is separated on the east side from Hudson Bay by a high narrow ridge of Cambrian rocks, capped with trap, which rises in cliffs from 500 to 1200 feet above the water. A deep narrow break in the ridge near the south-west angle of the lake, (or gulf) affords a connection between the sea and the lake. The average rise and fall of the tide in this part of Hudson Bay is about six feet, and is sufficient to cause a tremendous rush of water in and out through the narrow channel, which is about two miles long and less than 300 yards wide in its narrowest part. The difference between high and low water in the lake is about twenty inches. The south and east shores are rounded hills of Laurentian granite, from 500 to 1000 feet high, flanked by upturned beds of Cambrian rocks and trap. The expanse of the lake is broken by a number of large, high islands formed from the same upturned beds dipping west.

Trees.

Along the outer coast in the vicinity, stunted black spruce and larch grow in clumps only in the low protected gullies, but around the margin of the lake the trees grow thickly everywhere, and on its eastern side they rise nearly to the summits of the hills, showing that the climate is more moderate away from the cold waters of Hudson Bay.

Clearwater River.

The Clearwater River, a large stream discharging Clearwater Lake, flows through a deep, narrow gorge near the south-east angle, into Gulf Lake, and about two miles to the eastward another stream called the Wiachouan falls in. The mouth of this river was reached on July 1st, and after discharging the boat, which was then sent in charge of two Eskimos to Great Whale River, the outfit and provisions were rearranged for portaging inland. The Wiachouan has a fall of 315 feet just above where it reaches the salt water. This was passed by a portage two miles and a quarter long that rises 500 feet to the summit of a rocky ridge and then descends to the stream immediately above the fall. One mile above, a fall of 55 feet necessitated another portage of quarter of a mile, with a very steep rise at its lower end. The river above this, for twelve miles, to where the route leaves it, is about forty yards wide, and winds through a valley nearly half a mile wide walled in with rounded Laurentian hills that rise from 300 to 500 feet above it. The valley is well wooded with small spruce and larch, the upper sides and tops of the hills being partly bare.

Portages on Wiachouan.

Reach the plateau level.

The route left the river on its north side, by a portage that rose in a mile and a quarter to a small stream nearly on a level with the surrounding country, or about 750 feet above sea-level. Five short portages were made along the stream, where it connects as many small lakes, and then a portage of 1000 yards was crossed to a lake drained by another tributary of the Wiachouan. The route followed this stream due east eleven miles, through three lakes of two, one and a half and seven miles long, respectively, connected by portages of 175 and 750 yards. The route then turned north and passed over four portages of 90, 220, 375 and 500 yards, connecting short lake-traverses to a large lake drained by a branch of the Clearwater.

Return to Clearwater valley.

This lake is five miles and a half long and has a number of deep bays at both ends. A portage of a third of a mile, led from its east end to the small stream discharging it, which was followed northward two miles, and there left on the north side by a portage up a steep hill and then one mile over a barren plain to the Clearwater River.

The river was ascended four miles and a half to an expansion called Stillwater Lake, passing on the way five short rapids where half-loads were tracked up. The lake is seven miles long and averages half a mile in width; at its head there is a heavy rapid passed by a portage of 300 yards. The current above is sluggish for two miles, to where the stream branches into three parts, all outlets of Clearwater Lake. The eastern and smallest stream was followed for a mile and a quarter, when a narrow neck was crossed into the middle branch at the head of a long rapid, about one mile below where it flows out of the lake. Clearwater Lake was not reached until July 11th owing to the large quantity of supplies to be carried over the numerous portages.

Character of country.

The country between Richmond Gulf and Clearwater Lake has a great sameness of character and consists of a plateau rising abruptly from the coast to a general elevation of 750 feet. Its surface is broken by rounded ridges of granitic hills that rise from 100 to 400 feet above the general level, while the valleys between the ridges are filled with lakes, generally long and narrow, those of each valley being connected by short rapids. The largest rivers, like the Clearwater, have deep valleys cut below the general level of the plateau, but these only extend a few miles inland, so that beyond fifty miles from the coast all the water-courses are but little below the level of the plateau. About one half of the plateau is barren, the trees being confined to the margins of lakes and the lower lands of the valleys. The forest is wholly composed of black spruce and larch, the former constituting about ninety per cent of the whole. The trees are small, slim and grow close together on the lower grounds, but on the higher they are separated by open glades. The largest trees never exceed twelve inches in diameter three feet from the ground, nor are they ever more than thirty feet high.

The small streams and lakes are well stocked with trout and white-fish. In the Clearwater, large brook- and lake-trout are plentiful, especially in the rapids below the lakes. The barren-ground caribou is not abundant in this region, and in summer is not often met with, being at that season in the barrens farther north. Willow ptarmigan were found everywhere in great numbers, but other feathered game is scarce. A few families of wandering Indians inhabit this area and the frequent standing poles of their wigwams showed where they had camped along the route. Fish and game.

Clearwater Lake.

The exploration of the shore-line of Clearwater Lake occupied our time from the 12th to the 20th of July, much delay being caused by wind and rough water.

Clearwater Lake is a large and beautiful body of water, whose greatest length from south-east to north-west is forty-five miles. From its north-west end the main body of the lake is nearly twenty miles across, it then narrows to about half that width and continues so to the head of the south-east bay. The shore-line is very irregular, being broken by rocky points into numerous bays of various forms, some of which are quite long; they are most numerous along the north-west and southern shores, and these portions of the lake are fringed with many rocky islands, some of them large. Islands are also found along the other shores, but are not nearly so numerous. Besides the fringe along shore, the middle of the lake is occupied by several large and high islands that extend into and nearly block the entrance of the south-east bay. The main outlet of the lake is near its south-west corner, where several large islands divide it into three channels, as already mentioned. Another outlet leaves the head of a narrow bay some four miles west, and this stream does not join the main discharge for more than twenty miles; still another outlet is said to flow from the head of a long narrow bay that stretches westward from the north-west corner of the main lake. The streams flowing into the lake are all small and unimportant; the largest is called Noonish River, and enters at the north-east corner, while another large brook flows into Clearwater Lake.

Surrounding country.

the head of the south-east bay. The water is remarkably clear, deep and cool, and is abundantly stocked with large lake- and brook-trout, whitefish and suckers. The surrounding country is formed of rounded Laurentian hills that rise from 200 to 500 feet above the lake. Only two hills exceed 500 feet in altitude, and they are but little higher; one, called Burnt Hill, is situated near the mouth of the north-west bay, the other, or Berry Hill, is on the north side, about ten miles east of Burnt Hill. From the summit of the latter, the east end of Seal Lake may be seen some twenty miles to the northward. The hills are highest around the western and southern portions of the lake, the land becoming lower and flatter to the north and east, especially about the south-east bay, where large areas are flat and swampy. The forest is similar in size, growth and distribution to that already described, the trees about the south-east bay being somewhat larger and the woods continuous over the low areas.

Country Between Clearwater and Seal Lakes.

Clearwater Lake to Seal Lake.

The canoe-route from Clearwater Lake to Seal Lake, ascended the Noonish River due east, for fifteen miles, through small lake-expansions connected by three rapids, to a small lake at its head. The rapids are too shallow for canoes and were passed by portages of 1000, 600 and 50 yards respectively. From the lake a portage of 500 yards led over a ridge to a narrow southern bay of Seal Lake.

The country surrounding the route is similar to that last described, with low partly barren hills rising from 100 to 300 feet on both sides of the valley. A new feature is the quantity of stratified sand arranged in ridges along the valley. These ridges are uniform in height, about fifty feet above the water, and look like terraces, but on examination are seen to be sharp and narrow and are probably eskers formed by a glacial river flowing westward. A continuation of the ridges was seen on the southern bay of Seal Lake about three miles from where it joins the main body, and there they form long narrow points stretching out from the west shore.

Seal Lake.

Exploration of Seal Lake.

The time between July 24th and August 3rd, was spent on Seal Lake, but owing to a succession of strong gales for several days, the lake was too rough for canoes, and consequently there was only sufficient time to carry a survey-line from the southern bay to the head of the north-east bay. From this survey, supplemented by

Photo. by A. P. Low, 1896.

VIEW OF SEAL LAKE, FIVE MILES EAST OF NARROWS, LOOKING EAST.

information obtained from Indians, the lake was found to be more than fifty miles long, while it varied in breadth from half a mile to five miles. Its western end is about twenty miles directly north of Berry Mountain on Clearwater Lake, where it discharges by the Nastapoka River, a large stream flowing into Hudson Bay forty-five miles north of Richmond Gulf. The southern bay on the Clearwater route is six miles long and is broken by a number of smaller irregular bays on both sides.

Thirteen miles east of its mouth, the main lake narrows to less than 300 yards for a short distance and has a strong current that practically joins two lakes. To the eastward of the narrows the breadth varies from one to two miles, for six miles, the lake then dividing into long narrow bays, one running a little south of east, the other nearly north-east. The east bay was not explored but is said to have about the same length as the south-east one, or about sixteen miles. The north-east bay subdivides about two miles from its mouth, the main bay continuing north-east, the other running nearly west for some ten miles. The surface of the lake is partly broken by islands, many of those in the western part being large and high. In the eastern part, the islands are generally small and rocky, but there is a chain of them along the north shore formed of sand, the remains of esker ridges. The water has a brownish tinge and is not nearly so clear as in the last great lake; in many places it is quite shallow.

Long bays.

Islands.

The name is derived from the seals living in its waters, which are either the common harbour seal (*Phoca vitulina*) or a closely allied species. The harbour seal is known to travel overland for considerable distances, but its presence in this lake nearly a hundred miles from salt-water at an elevation of nearly 800 feet above the sea, can hardly be due to its migration up such a rough stream as the Nastapoka. Another way in which it might have reached the lake was during the subsidence of the land at the close of the glacial period, when the lake was nearer sea-level than at present by more than 600 feet, and when the deep bay extended inland up the present valley of the Nastapoka to or near the outlet of the lake, with such conditions it would be easy for seals to reach the lake, and having found it full of fish they probably lost the inclination to return to the sea. Three seals were seen in the lake, and the Indians kill annually more than thirty, showing that the animal breeds freely in the fresh water.

Seals inhabiting the lake.

The same rolling semi-barren country was found about Seal Lake, with rounded rocky hills rising from 100 to 300 feet above its surface; the trees are similar to, but smaller than, those about Clearwater Lake.

Character of country.

Barren-ground caribou were seen plentifully on the island and about the shores of the lake.

Cross the watershed.

Seal Lake was left on August 4th, by a small stream called Buzzard Brook, which flows into the head of the north-east bay at the foot of a prominent, steep hill. The brook flows from the north-east in a valley from 100 to 1000 yards wide. It is a succession of small lakes joined by rapids, which were passed by four short portages in the seven miles to the height of land separating the Nastapoka from the head-waters of the Stillwater branch of the Koksoak. The height-of-land portage is fifty yards long and passes through a low boulder-strewn gully to Shem Lake.

The drift becomes much thicker as the watershed is approached and is thrown into irregular sharp hummocks from 50 to 150 feet high, covered with many large boulders and angular masses of rock. The sandy esker-ridges continue from Seal Lake up the valley to and beyond the height-of-land.

Upper Stillwater River.

Shem Lake.

Shem Lake is seven miles and a half long from the portage to its discharge at its north-east end ; it varies from a quarter to one mile wide and occupies a continuation of the valley followed from Seal Lake. The country surrounding the lake rises from 100 to 200 feet, with gently sloping hills masked by a thick mantle of drift through which the rocks appear only on the summits. The drift is largely composed of angular blocks and boulders, and it is evidently little travelled. The lake discharges by a large brook which falls twenty-five feet in a quarter of a mile below the outlet ; it is then joined by a northern stream of equal size, and the combined stream is called the Natuakami or Stillwater River.

Shem Lake to Natuakami Lake.

From Shem Lake to Natuakami Lake, fifty-four miles lower down stream, the character of the river and surrounding country changes so little that the whole may be included in one description a bewildering detail of rapids and changes of course. The stream between the lakes flows in a general north-east direction. With numerous minor bends, it first flows nearly north-east for thirty-four miles, then turns gradually towards north for twelve miles and finally north-east for eight miles.

The main stream is joined by tributaries at frequent intervals, mostly from the northward, the largest flow in at the eighth, eighteenth, twenty-sixth, thirty-fifth and forty-seventh miles below Shem Lake ;

the last is the only important stream, and has been named Russel River. It flows through a deep northern valley and joins the Stillwater by a fall of ten feet. It is somewhat smaller than the main stream which above the junction flows with a rapid current in a shallow channel about 150 yards wide. The level of Natuakami Lake is 370 feet below that of Shem Lake and the river between the lakes is almost a continuous rapid without any direct falls, the total number of rapids is sixty-four, or more than one per mile. They are all very shallow, greatly obstructed with boulders and dangerous to descend with canoes.

River valley and plateau.

The country does not slope with the river, and consequently the bottom of the valley for several miles above Natuakami Lake is about 700 feet below the general level of the surrounding region. The valley varies from a quarter of a mile to a mile in width, and small black spruce and larch grow on the low bottoms and nearly to the summits of its rocky walls. The river is not well supplied with fish, only a few trout and suckers being taken with net and hook. Barren-ground caribou were plentiful on the sandy islands above Natuakami Lake, but were scarce along the upper part of the river where they probably confined themselves to the barren upper hills to escape the tormenting swarms of flies met with in the valley.

The country above the valley is formed of rounded ridges of bare granite hills without soil or trees, fire having destroyed every vestige of vegetable growth.

Natuakami Lake.

Natuakami Lake.

Natuakami Lake occupies a broadened portion of the valley and is only an expansion of the river without current. It is fifteen miles long and varies from a quarter of a mile to three miles in width. The water is generally shallow and at the head of the lake there is a delta of low sandy islands three miles long, formed from detritus brought down by the river. These barren, wind-swept islands are a favourite resort for caribou in fly time. The sides of the valley rise gently and do not obtain an elevation of 500 feet above the lake within from five to ten miles of the shores, leaving wide areas of swamp and bottom lands on both sides, where small black spruce and larch grow thickly except where removed by fire.

Indians.

A number of Indians were found here engaged in killing caribou; they reported that the lake is well stocked with trout, whitefish and suckers, and that a few salmon are taken in the nets, but that the greater number of salmon ascend the Kenogamistuk branch to spawn. A number of small salmon were taken between Natuakami Lake and the junction of the Kenogamistuk on the way down stream.

Lower Stillwater River.

Natuakami Lake to Kenogamistuk.

The distance from Natuakami Lake to the junction of the Kenogamistuk is thirty-seven miles, and the general course of the river is about east-north-east, the stream forming a light curve on the south side of that course. The river leaves the lake at its east end, where, for two miles, it is broken into shallow rapids, with a fall of twenty-five feet. Small islands and shingle bars divide the stream into several channels, all very shallow and greatly obstructed with boulders which form the bottom at the rapids, no rock being seen in place in the bottom at these or other rapids further down stream, showing that the present bed of the river is probably a new one, considerably above the level of its pre-glacial bed. The valley at the outlet of the lake narrows to about half a mile, and lower down varies from half a mile to one mile across. The steep rocky walls rise from 400 to 1000 feet above the river. The stream averages a quarter of a mile in width, and the interval between the shores and the sides of the valley is occupied by low swamps resting upon clay soil. Terraces up to 160 feet above the level of the river were observed almost continuously on both sides of the valley from the outlet of the lake, and probably mark the level of the sea during the period of post-glacial subsidence. The terraces were not seen above Natuakami Lake, but this was probably due to the lack of drift upon the rocky walls of the valley there, as the clays extend about eight miles above the lake, to the foot of the heavy rapids of the upper river.

Larger trees.

The trees in the valley below Natuakami Lake are larger than any met with in crossing from Hudson Bay, and a few small balsam fir and balsam poplar were noted, along with the black spruce and larch.

Current of river.

Below the outlet rapid, there is an interval of five miles of quiet water, followed by two miles and a half of rapids, with a descent of thirty feet, where the channel is again broken by bouldery islands, while the low muddy shores of the stretch above, give place to high banks of rounded boulders. Then follows eleven miles of even current at a rate of about three miles an hour, the river flowing in a shallow channel from a quarter to half a mile wide, obstructed by many sand bars; the banks are low and muddy, with swamps or long narrow lakes between the river and the sides of the valley, which are from

Photo. by A. P. Low, 1896.

STILLWATER RIVER, LOOKING WEST, TEN MILES ABOVE NATUAKAMI LAKE.

one to two miles apart. The slopes rise from 800 to 1000 feet and are flanked by terraces, the high-level terrace (200 feet) being very persistent, and in places having its upper part and top formed of packed boulders. The lower terraces are seen only in the gullies of small tributaries and never rise more than 50 feet above the river. Terraces.

The quiet water is followed by fourteen miles of heavy rapids connected by stretches of swift water, extending to the junction of the Kenogamistuk, the total fall being 65 feet. The stream varies from 200 to 400 yards in width with banks from ten to thirty feet high, composed of tightly packed boulders which form points jutting a short distance into the stream. Eddies occur below the points and are of great assistance in ascending with canoes. The hills are somewhat higher and more rugged, often terminating in sharp points due rather to the weathering of the granite than to lack of glaciation.

A short distance above the Kenogamistuk, a large stream called the Lookout River flows in from the northward. It is broken into several channels at its mouth by low shingly shoals, over which it falls in steep shallow rapids. About a mile up the river passes out of a deep narrow gorge, at the mouth of which are two well-marked terraces 100 and 250 feet high. The poles of a number of Indian tents were standing on both terraces, where the natives live during the autumn while keeping watch for herds of caribou that cross the river in the vicinity. Lookout River.

Kenogamistuk River.

The Kenogamistuk is a much larger stream than the Stillwater, being at its mouth more than a mile wide, but as it is greatly obstructed with sand and gravel bars, the width of the combined channels would be about half a mile only. The channels are shallow, but the current is very strong and the volume of water great. The river was ascended five miles from its mouth, to where a large tributary flows in with tremendous rapids through a narrow gorge from the south-east. As the stream was ascended its channel was found to contract and the deeper water became more rapid so that for half a mile below the branch, its width was about 200 yards and the rapids quite unnavigable. From a hill near by, the valley of the main stream was seen stretching for several miles to the south-west and down it the river poured in a continuous heavy rapid for more than six miles. The valley varies from one to two miles in width, and the rocky walls rise from 600 to 1000 feet above the stream. The banks of the river are usually steep and often show sections of contorted, Kenogamistuk.

bedded clay, gravel and shingle. The high-level terrace (250 feet) is well marked on both sides of the valley.

Upper waters.

According to the Indians who hunt along the Kenogamistuk, the river is almost a continuous rapid from its mouth to the first forks some forty or fifty miles above, the forks being situated about thirty miles directly south of Natuakami Lake. The western branch is much the smaller and rises in a large lake near the head waters of Little Whale River; the larger branch flows from the southward for a considerable distance from where it again branches, the western branch rising near the head of Great Whale River, the southern branch draining several large lakes not far to the northward of Nichicun and Lake Kaniapiskau.

Larch River.

Kenogamistuk to Kaniapiskau.

From the junction of the Stillwater and Kenogamistuk the combined stream is called the Larch River for sixty-six miles, to where it is joined by the Kaniapiskau, the general course for this distance being nearly east-northeast. The course is north-east for twenty-five miles below the Kenogamistuk. As the valley here is from two to four miles wide and the river from 400 to 1000 yards across, there is a considerable interval of flat swampy land between the shore and the sides of the valley. The hills continue rugged and slightly lower than those previously described. A good view of the country surrounding the river was obtained from the summit of a sharp peak of granite 890 feet above the water, on the north side of the valley about two miles below the forks. The country is more broken than the uplands about Natuakami Lake, being deeply cut by the ravines of small streams leading down to the river. The depressions are dotted with small lakes and ponds, and the whole upper surface is devoid of trees, the vegetation being confined to small willows and arctic shrubs. The clay banks of the river slope gently from the water to heights ranging from twenty to forty feet. The shores are generally sandy with frequent bouldery points; the channel is shallow and obstructed with long sand bars and shoals over and between which the river flows with a uniform current of about four miles an hour. The valley closes in to less than a mile towards the end of the course, and the river also narrows and breaks into heavy rapids for the next eight miles, with a total fall of 60 feet, the general course of the stream being south. Along the first five miles, the rapids are very heavy, the river being hemmed in between low banks of huge boulders so that its breadth varies from 100 to 200 yards only. The channel widens by

Character of country.

degrees along the lower three miles, and the rapids gradually change into a swift unbroken current flowing in a shallow channel. Two large streams join the river from the northward, the upper, called Young River, comes in with a tremendous rush over huge boulders about the middle of the course; the other, or Junction River, falling in at the lower end, and taking its name from the fact that its valley appears to mark the junction of the Cambrian rocks with the granites. The surrounding country is somewhat lower, but more rocky and broken than that last described. Terraces at elevations of 30, 60, 100, 150 and 200 feet were observed in many places. Tributaries from the north

The course of the main stream below Junction River is south-east for ten miles, then east for nine miles, north-east for nine miles, and finally east for eight miles to its junction with the Kaniapiskau. The river varies from a quarter to a third of a mile wide along the three upper courses, and flows with a swift, even current broken only by shallow rapids at the sixth and fourteenth mile. The banks are high and scarped in places, when they show sections of stratified clay, but in most places they have a gentle slope, and between the frequent bouldery points are covered with a thick tangle of willows that extends from the water to the edge of the trees some sixty feet above the river. Larch River below Junction River.

The aspect of the country changes with the change of the rock, the unequal granite hills giving place to regular ridges of stratified rock, which have a gradual slope towards the east coinciding with the dip of the strata while presenting steep cliffs toward the west. These ridges vary from 200 to 500 feet in height above the river, along the western part, but as the Kaniapiskau is approached they become higher and about the junction with that stream some are 1000 feet high. The valley immediately below Junction River widens out until the hills forming its sides are from five to ten miles apart, the space between being occupied by a flat plain elevated about sixty feet above the river. As this plain is underlain by clay, its surface is usually very swampy and is covered with deep *Sphagnum* moss, through which a passage from the river to the hills can be made only with great difficulty. All the tributaries have deep gullies cut into the clay. The trees are the same as those last described, being confined to black spruce, larch, balsam fir, white spruce and balsam poplar; they are all small and of no commercial value. The spruce, larch and fir grow thickly on the plain and lower parts of the hills, of which the summits are barren. Change in aspect of country.

The river is very rapid along the last course of eight miles above the Kaniapiskau, having a fall of forty feet. It narrows to about 300 Confluence with Kaniapiskau.

yards and rushes along in a much narrower valley than formerly, between high banks of clay faced with boulders, to the forks. The Kaniapiskau is the longest and largest branch of the Koksoak River, and takes its rise in Summit Lake in north latitude 53°, out of which the Manicuagan River also flows southward to the Gulf of St. Lawrence, thus forming a continuous waterway from Ungava Bay, southward across the centre of Labrador to the St. Lawrence. The Kaniapiskau was explored from Lake Kaniapiskau downwards in 1893, and a description of it is given in my report on the Labrador Peninsula.* Where it joins the Larch River it is about half a mile wide, with a strong current and shallow channel.

Koksoak River.

Koksoak River.

The united stream below the junction of the Larch and Kaniapiskau is called the Koksoak, an Eskimo word signifying "big river." The river averages about half a mile in width for six miles below the forks, and flows with a swift current in a shallow channel. The banks are low and either strewn with boulders, or sandy. The hills on the sides of the valley are from one to two miles apart, and are arranged in sharp ridges whose axes are nearly at right angles to the river. These ridges rise from 500 to 800 feet above the water and have steep cliffs on their south-west sides.

The course of the river is north-east for the next twenty-five miles, and its channel varies from half a mile to a mile and a half in width, being obstructed by large islands of sand and gravel covered with a thick growth of willows. The banks vary from ten to thirty feet in height and are formed of sand with a bouldery shore. The valley is from one to three miles wide and rises in low sandy terraces to the flanks of the rocky hills, which are formed of schist, gneiss and granite instead of the shale, limestone and trap of the former courses. The hills become lower as the river is descended, and although formed of different rocks they still preserve the characteristic westward facing cliffs and vary from 300 to 500 feet in height. The channel contracts to about half a mile at the lower end of the course with rocky shores, islands and reefs that break the stream into heavy rapids for a mile. The tide effects the river to the foot of this rapid.

Rapid at head of tide.

The course is nearly east for eighteen miles from the rapid to Highfall Creek, a small river falling in from the southward. Along this course the banks are generally high and rocky and the south shore is

*Annual Report, Geol. Surv. Can., vol. VIII. (N.S.), pp. 107-123 L.

an almost continuous rock-exposure. The channel is about a mile wide and is broken by many low islands of sand and boulders. The hills on the south side rise in many places directly from the river, but are only from 50 to 200 feet high; on the north side there is usually wide sandy terraces between the river and the rocky hills behind.

Below High-fall Creek.

From the mouth of High-fall Creek the course of the river changes to north-east for ten miles; the stream widens to nearly two miles and the low hills retreat, leaving a wide interval of swampy land on both sides. The shores are flat, and when the tide is low extensive mud-flats are laid bare on both sides. Eight miles below High-fall Creek the shores again become high and rocky, and the river is obstructed by several large rocky islands that divide it into a number of channels through which the water rushes in or out according to the state of the tide.

Lower part of river.

The next and last course of the river is nearly north-northeast for thirty-two miles, to its mouth in the south-west part of Ungava Bay. Along this course the channel is deep and with the exception of a few rocky islands along the shore and a large one, called McKay Island, twenty miles above the mouth, no obstructions to navigation occur. The current varies from four to seven miles an hour up or down with the rise and fall of the tide, which at the mouth of the river ordinarily rises more than thirty feet, while exceptional spring tides have been known to rise sixty feet above low-water mark. The shores of this lower part are high, irregular and rocky, and at low-water the numerous small bays are filled with mud. The banks usually rise directly from the water into bare rocky hills from 200 to 400 feet high, but in places terraces occur on their flanks up to 200 feet above the present water-level. The river averages about a mile and a half in width, but nine miles above its mouth it narrows to less than half a mile across, for nearly two miles.

Vegetation.

The trees in the valley below the Kaniapiskau are all small, and consist nearly exclusively of black spruce and larch, with only a few clumps of balsam poplar on the low sandy islands of the upper reaches. The trees cover the bottom lands and grow about half way up the hill-sides about the Forks, but as the stream is descended they become smaller and are only found on the lower parts, and finally die out about fifteen miles above the mouth of the river, the only remaining vegetation being small arctic willows, birches and shrubs.

Completion of survey.

The survey was completed to the end of the north point at the mouth of the river on the 5th of September, after which the river was ascended thirty miles to Fort Chimo, to await the departure of the

Hudson's Bay Company's steamship *Erik*, in which the party was conveyed to Rigolet, on the Atlantic coast, and from there to Quebec in a schooner.

Fort Chimo.

Fort Chimo is the most northerly post of the Hudson's Bay Company in Labrador, being situated in North Latitude 50° 08′ or just inside the tree limit. The fort is located on a low terrace on the south bank, facing a small cove and opposite the highest safe anchorage for sea-going ships. The post consists of about a dozen small buildings, the greater number of which are made from imported lumber, as the trees of the region are too short and small to be of much use for building. The permanent inhabitants are the usual officers and servants of such a post, and these with their Eskimo wives and children number about twenty-five persons in all.

Indian trade.

Trade is carried on with the northern Indians, who live about the tributaries of the Koksoak, and with the Eskimo along the coast of Ungava Bay and Hudson Strait as far west as Cape Wolstenholm. The total number of Indians trading at and dependent on Fort Chimo is about one hundred and fifty. They belong to the Nascaupee tribe, and speak a dialect of the Cree or Algonkin language. They are a poor, degraded people, without thrift or forethought, and as a rule, very lazy. Being caribou hunters they can hardly be induced to trap fur-bearing animals. They depend wholly on the herds of barren-ground caribou for their food and clothing, and sell a certain number of caribou skins not required for their own use, with a few furs, to the Hudson's Bay Company for powder, shot, tea, sugar and tobacco, which comprise all their necessaries of life. Foxes, both white and the varieties of the red species, form their principal fur hunt, but otters are also taken, and in early spring they made excursions southward into the wooded country for martens.

Eskimo trade.

The Eskimos trading at Fort Chimo are about 140 families, or 700 persons in all; but less than half of these visit the post, as the more northern families send in their furs by a few able-bodied men who travel with dogs on the ice along the coast to and from the post in the spring. The Eskimo trade is chiefly in deer, seal, fox, white bear, wolf, and wolverine skins, walrus ivory, seal and porpoise oil.

Fisheries.

The Hudson's Bay Company also engages in the salmon and porpoise fisheries along the lower Koksoak and in the Whale River to the south and Leaf River to the northward. In 1896 the salmon fishery was poor, the catch being far below the average, and only equal to half the catch of the previous year. The porpoise fishery is small and would be abandoned if it did not give employment to the Eskimo during the summer season.

CLIMATE.

The climate of the region embraced in this report totally unfits it for agricultural purposes. At Fort Chimo, lettuce, radishes, and a few small turnips are grown with a great deal of care and attention.

Opening of rivers.

The rivers break up in the interior about the first week in June, but the ice does not leave the larger lakes before the end of that month. The snow of the previous winter remains in all sheltered gullies fronting the north throughout July. During the day the temperature often rises to 70° F., but the nights are always cold, and severe frosts are common throughout July and August; ice a quarter of an inch thick having been noted during the night of August 8th. Snow falls about the middle of September, and by the end of the month the ground is permanently covered, and the small ponds are frozen over; the rivers being closed by the middle of October. The following are the mean temperatures from three readings daily taken at 6 a.m. noon and 9 p.m. July, 50·7 F.; August, 54·1 F.; September (1 to 11), 42·8 F. Light rains and showers are frequent during the summer months, but the total rainfall is not great; during July and August rain fell on forty days. The prevailing winds of summer are from west and northwest, and they are generally accompanied by clear weather, with passing showers.

Snow.

Temperatures, *etc.*

GEOLOGY.

Laurentian.

General character of rocks.

The rocks met with along the greater part of the route from Richmond Gulf to Ungava Bay have been classed as Laurentian. They are composed chiefly of more or less foliated granite, made up of felspar, quartz, mica and hornblende, with minerals of decomposition. The felspar is chiefly orthoclase, and varies in colour from red through pink to white; quartz is always present and often in considerable quantities, and the mica and hornblende are generally found together, but at times one or other is absent.

Eruptive masses.

True eruptive masses are also represented by smaller areas of dark-greenish basic granite composed largely of pale-green plagioclase, quartz, hornblende and mica; and also by dyke-rocks, usually more or less altered diabase, which appear to be much newer than the rock cut by them, there are also a number of dykes of fine-grained, dark-red syenite in the granite area about Clearwater Lake. There would appear to be a great difference in the ages of the granites, but except where they cut, or unconformably underlie, known bedded rocks of the Cambrian, their age cannot be determined, owing to the close resemblance in structure and composition of the granites of different age. Where they cannot be separated they have been included in the Laurentian, as they are all very ancient, and the newest were errupted and must be assigned to a period antecedent to the Cambro-Silurian.

Oldest stratified rocks.

Intimately associated with the granites is a series of more or less quartzose, mica-gneisses and mica-schists, interbanded with hornblende-schists and hornblende-gneisses, and at times with a quartz-magnetite-gneiss. These gneisses and schists are supposed to represent a bedded series of rocks somewhat similar to the Grenville series, but they are so highly altered that no trace of their supposed former clastic structure remains. They are cut by newer granites and their present highly crystalline condition is thought to have been caused by the deep-seated intrusion of great masses of granite. The age of these bedded schists is for the most part very great, as some of them were altered by the granites and subsequently deformed along with the granite, after which they have been deeply sculptured and denuded before the deposition of the iron-bearing Cambrian rocks. While most of the schists are thus probably very ancient, others may be of the same age as the Cambrian and may represent those rocks where they are greatly altered by granite intrusions, as along the lower part of the Koksoak River, where it has not proved possible to separate some very similar gneisses and schists from the Cambrian.* The Cambrian rocks of the east coast of Hudson Bay have a breadth of twenty miles at Richmond Gulf, and the Laurentian gneisses, upon which they rest quite unconformably, are first seen at the second portage of the Wiachouan, some four miles from the shore of the gulf. Here the stream falls over a fine-grained pink mica-gneiss, while the bank of the stream opposite the foot of the fall is formed of upturned beds of coarse quartzite, red felsitic slate and fine-grained, dark-green trap, apparently thrust over the gneiss.

Highly altered Cambrian.

The few exposures seen in the valley of the Wiachouan, were all pink and gray, medium textured mica-gneiss. At the summit of the

*Similar gneisses and schists were found in 1897 along the south shore of Hudson Strait and were seen to be altered from the ordinary black shales and cherts of the Cambrian by the intrusion of large masses of granite.

Hill portage leading from the valley of the Wiachouan, bands of the mica-gneiss hold dark-red garnets and are associated with coarser, red mica-hornblende-gneiss; all being cut by a great dyke of coarse, dark-green diabase, two hundred yards wide, which runs S. 35° E. and is seen on the south side of the valley several miles away. At the upper end of the portage, another similar dyke runs N. 25° E. and may be an off-shoot of the larger dyke. These and other dykes met with along the route to Clearwater Lake, closely resemble the large diabase dykes of the Hamilton River, that cut the Cambrian rocks as well as the Laurentian gneisses * and are probably much newer than the gneisses with which they are here associated. On the portages between the Wiachouan and Clearwater rivers, frequent exposures are met with and they are mostly medium to coarse-grained mica-hornblende and hornblende-gneiss, but at times without foliation, when they pass into granite. The garnet-bearing mica-gneiss, a short distance east of the Hill portage is displaced by mica-hornblende-gneiss and granites, which have the appearance of great irrupted masses partly foliated by pressure. Coarse, red hornblende-gneiss and granite predominate along the Clearwater River, together with occasional bands of a gray colour and others where the presence of a large quantity of hornblende gives them a darker colour and renders them schistose. The coarse gneiss and granite also often hold segregations of dark-green, schistose hornblende. The direction of the foliation between Richmond Gulf and Clearwater Lake varies from N. 45° W. to S. 80° W.

Rocks on Wiachouan.

On Clearwater River.

Two diabase dykes were seen on the portage leading to Clearwater River, the first is very fine in texture and varies from five to fifty feet in width with a direction of N. 70° E.; the second is coarser in texture and lighter in colour, it is sixty feet wide and runs N. 75° W. At the head of an island in the Clearwater a short distance from the last dyke, there is another thirty feet wide and having a direction of N. 85° W. At the third portage below Clearwater Lake a dyke one hundred and fifty feet wide runs S. 60° W. Near the contact with the gneiss it is very fine-grained, but towards the middle is much coarser; it is dark-green in colour and contains a considerable quantity of disseminated pryrite. The rock is now about half decomposed to serpentine, the decomposed portions forming irregular blotches of an apple-green colour.

Diabase dykes.

The granites are also cut by acidic dykes in the form of fine-grained, dark-red, compact syenite, largely composed of flesh-red orthoclase

Acidic dykes.

*Annual Report, Geol. Surv. Can., vol. VIII. (N. S.), p. 275 L.

with a little hornblende, but no visible quartz. The weathered outcrop of a dyke of this rock formed a trough about ten feet wide and from three to ten feet deep at the southern end of the portage leading to the Clearwater River. Although this was the only syenite dyke seen in place, there are doubtless others of the same kind along the river and about Clearwater Lake, where blocks of the rock are common in the drift.

Exposures on Clearwater Lake.

The many rocky islands and points of Clearwater Lake afford numerous exposures of gneiss and granite. A red coarse-grained hornblende-mica-granite or gneiss predominates, and is associated with a coarse-textured, gray mica-gneiss, which, like the former, is of probable igneous origin. Both rocks cut and inclose bands of finer-grained, pink mica-gneiss, most abundant about the north-west end of the lake, but nowhere plentiful. Towards the eastern end of the lake and along the north shore, mica-gneiss prevails, and is more often pink or red than grey, it is usually very coarse in texture and often has an augen structure with at times large prophyritic crystals of felspar. The general direction of the foliation about Clearwater Lake is N. W.

Between Clearwater and Seal lakes.

On the first portage of the route from Clearwater to Seal Lake, the coarse augen-gneiss is cut by a dyke over three hundred yards wide and running nearly paralled to the foliation of the gneiss. The dyke-rock is a much altered mica-diabase, varying in texture from fine- to medium-grained; it contains much mica in small scales, the felspar is greatly decomposed and the augite largely changed to hornblende. Small veins of red pegmatite penetrate the dyke. At the second portage, the rock is medium to coarse-grained, very felspathic, pink and red augen-gneiss containing broken bands and segregations of finer-grained mica-schist; the direction of the foliation being nearly east-and-west. Coarse- to fine-grained, red hornblende-mica-granite occurs on the islands of a small lake two miles beyond, and from there to Seal Lake all the exposures examined were of similar granite sometimes slightly foliated in a direction N. 50° W.

On Seal Lake.

The granites and gneisses also occur about Seal Lake, where they are red or pink in colour, and are usually, coarse in texture with often an augen-gneiss structure. These rocks usually show lines of foliation which vary in direction from N. 10° W. to N. 80° W. The whole is taken to be part of a great granite area similar to the areas previously found about Lake Nichicun* and in other parts of the peninsula. This area of granite continues eastward from Seal Lake past the

*Annual Report, Geol. Surv. Can., vol. VIII. (N.S)., p. 216-217 L.

height-of-land and down the Stillwater River for seven miles below Shem Lake, where it is in part replaced by mica-schists and gneisses. The mica-schist is cut by numerous dykes of coarse pegmatite and also by the hornblende-mica-granites and gneisses. The strike of the gneisses is nearly N. W. Associated with the mica-gneisses are bands in which grains of magnetite are present instead of mica, thus forming fine-grained magnetite-gneiss consisting chiefly of magnetite and quartz with a little felspar, and having a close resemblance to the bedded iron-ores of the upper Manicuagan River* where the mica-gneisses in which they occur are associated with bands of crystalline limestone. The magnetite-gneiss is too silicious and lean to be profitably worked as an ore, but it contains segregations of almost pure magnetite often of considerable size, which if more accessible would no doubt be valuable. The schists and gneisses with their associated beds of magnetite-gneiss outcrop along the river for two miles, when they are again displaced by the coarse, red hornblende-mica-granite, which usually contains segregations of hornblende-mica and hornblende rendered schistose by pressure. All are cut in places, (notably at the rapid twenty-six miles below Shem Lake and also two miles above Russel River), by bands of dark-green amphibolite from six inches to five feet wide, which differ in appearance from the schist bands and are probably ancient basic dykes crushed, shattered and rendered schistose by pressure.

Granite on watershed.

Magnetite gneiss.

The granite rocks are met with along the river to within five miles of Natuakami Lake, where medium-grained, gray mica-gneiss is found, cut by red hornblende-mica-granite and dykes of red pegmatite. Strike N. 20° W.

The wide valley of Natuakami Lake appears to have been cut out of the softer mica-gneisses, as all the exposures seen along the shore of the lake showed varieties of these gneisses, at times garnet-bearing and sometimes shattered by intrusions of hornblende-mica-gneiss, more especially towards the eastern end of the lake.

Natuakami Lake.

The wide valley, partly filled with clay, through which the river flows below Natuakami Lake, affords no rock-exposures on the banks, and a wide margin of almost impassable swamp extends from the river to the hills on either side, so that from one to three hours were spent in going to and returning from the hills, consequently few observations were made on the rocks occupying this portion of the country. When seen the rocks were, however, found to be about evenly divided

Rocks below Natuakami Lake.

*Annual Report, Geol. Surv. Can., vol. VIII. (N.S.), p. 244 L.

between the mica-gneiss and the intrusive hornblende-mica-granite. Three miles above the junction of the Stillwater with the Kenogamistuk, the rock is a very coarse, pink mica-hornblende, augen-gneiss.

On the Kenogamistuk.

Along the first five miles of the Kenogamistuk, the rocks come out on the banks in several places, and were found to be very coarse, red hornblende-granite or in places augen-gneiss when the foliation was S. 30° W. About the heavy rapids five miles up this stream, the granite is considerably shattered and the small cracks cemented with epidote and serpentine.

Below Kenogamistuk.

Two miles below the junction of the rivers on the north side, a barren hill was climbed; and extensive exposures were thus examined. They were found to be largely red hornblende-granite varying in texture from a fine-grained, compact rock to a coarse augen-gneiss, the latter forming the small rugged peak at the summit. Several wide bands of mica-gneiss were found interfoliated with and broken by the red hornblende-granite. The hills were again visited on both sides of the valley twelve miles lower down the river. The rocks on the south side were coarse hornblende-granite, while on the north side similar rocks were associated with gray mica-gneiss.

Hornblende-granite.

For the next twenty miles the river flows between very rugged hills, which gradually approach the banks, allowing the rocks to outcrop frequently along the shore. These exposures everywhere show coarse, red hornblende-granite to the mouth of Junction River, when the granites give place to the stratified rocks of the Cambrian.

Contact with Cambrian.

The contact between the Laurentian granite and the Cambrian is concealed by the deep clays of the valley of Junction River, where the western wall of the valley is formed of granite while the east side is composed of cherty dolomite and arenaceous shale. Although the contact was unseen, it is supposed to be similar to that on the Kaniapiskau Branch some ninety miles to the southward, where Cambrian red sandstones and argillites rest unconformably upon a boss of granite.* Like the Cambrian of the Hudson Bay coast, the rocks of the eastern area have been deformed by over-thrust faults, caused by pressure developed from the north-eastward, and consequently the contact between them and the underlying granites is likely to be a modified one, the pressure having in places thrust newer beds over the older, into contact with the granites.

Granites cutting schists and gneisses do not again occur along the river for fifty-five miles, or to twenty miles below the mouth of the Kaniapiskau, the intervening country being occupied by little altered Cambrian strata.

*Annual Report, Geol. Surv. Can., vol. VIII. (N.S.), p. 269 L.

There is an interval of eleven miles between the last outcrop of unaltered Cambrian and the first exposure of the schists gneisses and granites. These schists and gneisses are taken to represent a highly metamorphic phase of the Cambrian, together with newer intrusions of granite which have changed the sedimentary Cambrian rocks into schists and gneisses by the heat and pressure due to the intrusion, and, consequently, although closely resembling many of the gneisses classed as Laurentian, these rocks are here classed as Cambrian and are more fully discussed under that heading. Schists and granites of lower river.

Cambrian.

The series of rocks classed as Cambrian was met with along the east coast of Hudson Bay to the northward of Cape Jones, and on the Larch River from its junction with the Kaniapiskau upwards for thirty miles. Cambrian of Hudson Bay.

The Hudson Bay area has been reported on by Dr. R. Bell* and only a few supplementary observations will be here added to those already noted by him.

The dolomites of this series were first seen on small islands to the southward of Long Island, a few miles north of Cape Jones. Cherty dolomites with reddish cherts were noted on prominent points of the mainland for thirty miles to the southward of Great Whale River. The Manitounuck Islands extend in a chain northward from Great Whale River for more than twenty miles, and are composed of rocks of this formation. The rocks dip seaward at low angles and present cliff-faces towards the land. The following section in descending order was noted on the inner face of the third island north of the river :— Section on Manitounuck Islands.

	Feet.
1. Dark-green, compact trap, with many small cracks filled with epidote and lilac-coloured axinite	20 to 200
2. Compact, fine-grained, light-blue dolomite; weathers yellow and holds much blackish chert in irregular sheets and nodules	20
3. Medium-grained, grayish-blue sandstone with translucent quartz-grains and small yellow spots; contains a small quantity of pyrites and is dolomitic in places	35
4. Light- and dark-gray sandstone and chert. The light-coloured chert is well-banded and splits into flags from one to six inches thick	50

The remainder of the series is hidden beneath the water of the sound.

*Report of Progress, Geol. Surv. Can. 1877-78. pp. 11-23 c.

On Castle Peninsula.

The next section examined was on the east side of Castle Peninsula, on the north side of the outlet of Richmond Gulf. The section in descending order is as follows :—

	Feet.
1. Fine-grained, dark-green trap with small amygdules filled with epidote, chlorite and agate	55
2. Light-gray, medium-grained sandstone	55
3. Thin-banded, fine-grained, compact, cherty dolomite, with thin partings and irregular masses of dark-blue chert	105
4. Concealed (probably dolomite)	50
5. Coarse, gray grit, made up of large grains of quartz and white felspar with silicious matrix	5
6. Dark-gray, rusty-weathering, ferruginous, dolomitic sandstone, the dolomite being in thin partings	10
7. Coarse, dark-gray grit with grains and small pebbles of quartz and felspar	5
8. Dark-gray, ferruginous, dolomitic sandstone	60
9. Coarse, gray sandstone, with thin beds of dark, grayish-green sandstone overlain by arkose	30
10. Light-gray, cherty dolomite, holding grains of translucent quartz and small, rusty patches; changes to a sandstone near the top	155
11. Coarse, gray grit, composed of small pebbles of quartz and white felspar in a matrix of finer grains	55
12. Pink arkose, varying in texture from fine to coarse, and made up chiefly of more or less rounded grains of quartz and red felspar, evidently not greatly water-worn	670

Character of the rocks.

Dr. Bell gives a section taken on the south side of the entrance to Richmond Gulf which corresponds somewhat with the above, but has a thickness of 150 feet of trap between Nos. 10 and 11, while only 400 feet is given for the arkose, No. 12. He also states that the upper dolomites No. 3, rest unconformably upon the sandstones but no such unconformity was observed in the section above detailed. The rocks given in the section would appear to closely resemble those of the Mesnard quartzites and Kona dolomites of the Lower Marquette series of the south shore of Lake Superior, capped by a later outflow of trap, those rocks being classed as Algonkian by Prof. Van Hise. The great thickness of arkose found at the bottom of the section and the number of felspar pebbles in the grits of the upper bands, show a great amount of disintegration in the underlying gneisses and granites previous to the deposition of the Cambrian, and also that the dèbris forming these beds had not been transported far or water-worn previous to the formation of the strata in which they now rest.

Unconformity

As before stated, trap quartzites and red felsitic slates are found resting unconformably upon gneisses at the second fall of the Wiachouan River.

Photo. by A. P. Low, 1896.
CAMBRIAN HILLS FORMING COASTAL RIDGE, SOUTH SIDE OF ENTRANCE TO RICHMOND GULF.

The Cambrian rocks found on the Larch branch of the Koksoak, are a northern extension of the great area previously discovered on the upper Hamilton and Kaniapiskau rivers.* As before stated the western limit crosses the Larch immediately below the mouth of Junction River, or thirty-five miles above the mouth of the Kaniapiskau. The contact between the Laurentian granites and the cherty dolomites and shales is not seen, there being an interval of over a mile between the granites at the mouth of Junction River and the low cliffs of nearly flat-bedded Cambrian. These cliffs, 200 feet high, are composed largely of shale resting on thin beds of light-yellow, compact cherty dolomite, while higher up the cliff thin bands of brownish and greenish argillaceous limestone are interbedded with the shales. The shale is much disintegrated and has a dark, rusty colour on weathered surfaces, but is greenish and brownish on fresh surfaces. Dip. N. 80° E. $<$ 5° to 10°. Cambrian of Larch River.

On the same side of the river, two miles below, there is a steep hill, three hundred feet high, formed of dark-blue, finely crystalline, cherty dolomite, greatly shattered and re-cemented with quartz, so that the rock resembles a breccia; it also has in places thin partings filled with a black bituminous mineral like anthraxolite. These rocks are much disturbed and appear to underlie the shales of the previous section. Dip E. $<$ 5° to 45°.

From the western limit of the Cambrian to the junction with the Kaniapiskau, there are only two outcrops of rocks on the banks of the Larch River, and in order to examine the rocks in the cliffs forming the sides of the valley, from a half mile to two miles of deep swamp had to be crossed, entailing from one to four hours for each observation. On this account only a few observations were made along this portion of the river, and in consequence many of the different rocks found along the Kaniapiskau and Hamilton rivers were not seen in place; but as they are all represented by large angular blocks on the banks, they must occur not far from where these blocks are found. The direction of the ice-movement being from the westward, if transported by glacial agencies, they could only come from that direction and not from the Kaniapiskau area which lies nearly south of the Larch River. Among the angular blocks the largest and often the most numerous are composed of jaspilite, or a mixture of jasper and iron ore; in many the jasper is not abundant and the blocks are almost pure magnetite, or a mixture of magnetite and hæmatite, forming a valuable ore, very similar in character and composition to that of the Rocks like those of Kaniapiskau, *etc.*

*Annual Report, Geol. Surv. Can., vol. VIII. (N.S.), pp. 261–280 L.

extensive areas found on the Kaniapiskau and Hamilton rivers.* The other rocks commonly found scattered in blocks along the river banks, are red argillites and red sandstones, like those forming the beds resting unconformably upon the granite at Cambrian Lake,† a dark-gray, silicious ankerite with purple spots, cherts, dark-green, fine-grained trap, and greywacke and two varieties of conglomerate. One of these resembled the conglomerate at the base of the formation, being composed of quartz, felspar and granite pebbles cemented with sand and silica; the other was composed chiefly of small pebbles of quartz, felspar and jasper, with a matrix which varied from red to green in colour, and which may have been a volcanic ash like that of the agglomerate of Dyke Lake.‡

Section nine miles below Junction River.

The next section examined was on the north side of the river, seven miles below the limestone hill. The following sequence was exposed on the sides and tops of the low hills forming the wall of the valley at that place:

	Feet.
1. Broken black shale	60
2. Bands of shale and argillaceous dolomite. The shale thins out and becomes pearly towards the top of the measures, the dolomite at the same time changing to a light-blue cherty variety, shattered and re-cemented with small reticulated quartz veins	100
3. Light-blue, buff-weathering, cherty dolomite	400
4. Black shales (partly concealed)	125
5. Light-blue cherty dolomite	50
6. Black, rusty-weathering shale with thin beds of argillaceous dolomite	175
7. Rusty-weathering, green chert, much broken	50
8. Black shale	40
9. Rusty-weathering, disintegrated shale	800

Disturbance and fracture.

The rocks of the section are greatly disturbed and there are probable repetitions in the beds, while the shales may be folded among themselves, thus giving an altogether too great thickness to the measures. Dip N. 35° E. to 40′ < 60°.

Three miles lower down the stream, at a short rapid, the rock outcrops on the north bank, showing about 100 feet of buff-weathering, silicious dolomite with broken bands and masses of black chert. The exposure has the appearance of having originally consisted of alternate beds of dolomite and chert, in which, by movement and crushing, the cherts have been broken and the spaces between the fragments filled with the ferruginous dolomite under great pressure.

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* Annual Report, Geol. Surv. Can., vol. VIII. (N.S.), pp. 270, 278-9, 283-6 L.
† Ibid, p. 269 L. ‡ Ibid, 274 L.

The hills on the north side were again visited eight miles below the rapids, where the rocks are fine-grained argillite of a dark-green colour, along with a fine-grained green chloritic rock closely resembling the fine agglomerate or volcanic greywacke at the foot of Cambrian Lake.* The buff-weathering dolomites were also seen in several places along the face of the hills below the rapid.

Five miles above the junction with the Kaniapiskau, the north bank is occupied, for half a mile, by a white and cream-coloured, fine-grained silicious limestone, which varies from an impure limestone to a quartzite, with the proportion of contained silica, and is identical with the silicious limestone found at the foot of the Manitou gorge on the Kaniapiskau. Silicious limestone.

Immediately below the junctions of the Larch and Kaniapiskau there is a small hill on the south bank formed of fine-grained, black, argillaceous dolomite with bands and lenticular patches of brownish ankerite. Both are penetrated by small grains of quartz, but more particularly the dolomite. Dip N. 80° E. $<$ 10°. Dolomite.

In my previous report it was stated that the ridges on each side of the river below the forks appeared to be formed of a thick cap of compact rock, perhaps bedded dolomite, generally overhanging the rocks below, which are rusty, black shales from 300 feet to 400 feet thick, with dolomite forming the steep slope at the bottom†. A section made over the ridges on the south side, commencing two miles below the forks, shows that this description is only partly correct, as the bands taken for dolomite are really diabase. Section two miles below Larch River.

The following is the section in descending order :—

	Feet.
1. Shaly, argillaceous dolomite, light-gray in colour, and weathering greenish. Dip N. 50° E. $<$ 45°	4
2. Light grayish-green, fine-grained, compact diabase, greatly decomposed and altering to steatite	8
3. Shaly dolomite	4
4. Light-green, decomposed diabase, somewhat micaceous	15
5. Shaly dolomite	9
6. Light-gre[illegible] coarser, decomposed diabase	75
7. Dolom[illegible]y shaly, weathering white, other bands greenish [illegible]	100
8. Fine to [illegible]se decomposed diabase	75
9. Mostly [illegible]grained, decomposed diabase	550
10. Conceal[illegible] small valley)	300
11. Light-g[illegible]n argillite, silicious shales and limestone of a pearly-green colour	120

*Annual Report, Geol. Surv. Can., vol. VIII. (N.S.), pp. 270 L, 343 L.
†Ibid, p. 272L.

	Feet.
12. Fine-grained, decomposed diabase	40
13. Shale and argillaceous limestone	8
14. Light-green decomposed diabase	200
15. Baked, silicious, argillaceous limestone	6
16. Decomposed diabase	4
17. Baked limestone	3
18. Diabase with two thin beds of shale, all cut by a dyke of diabase holding opalescent bluish quartz	400
19. Concealed, (small valley)	900
20. White-weathering, pearly, argillaceous limestone, much indurated	25
21. Pearly, green shale, somewhat rusty	40
22. Decomposed diabase	10
23. Pearly, green shale	30
24. Decomposed diabase	20
25. Silicious, argillaceous limestone and shale	50
26. Decomposed diabase	15
27. Pearly shale	3
28. Decomposed diabase	50
29. Light-green talcose schist with segregations of black decomposed pyroxene (soft like steatite)	75
30. Concealed, (small valley)	400
31. Green and pearly-gray seracite- and chlorite-schists, holding grains of pyrite, and cut by small quartz veins	150
32. Concealed	80
33. Black, micaceous, graphitic shales becoming an impure iron ore near the contact with diabase, and holding small crystals of pyrite away from contact	50
34. Decomposed diabase	800
35. Rusty-weathering, black, micaceous shale and green chloritic schists	200
36. Decomposed diabase	100

Diabase sills.

The diabase has been injected in the form of sills, generally parallel to the bedding of the detrital rocks, but when the contacts are followed it may be seen to cross from one bed to another, showing that it was intruded subsequent to the formation of the stratified rocks, and is not of the nature of a contemporaneous flow. The intrusion was probably deep-seated and the cooling slow, as the diabase everywhere shows distinct signs of perfect crystallization, and in the larger masses the texture is often very coarse. The amount of alteration to the inclosed limestones and shales is surprisingly small, and except in the thinner bands, it is only found near the contact with the diabase in the south part of the section; but it appears to have been much greater in the northern part, where the shales have been converted into micaceous and chloritic schists. A curious feature is the extreme decomposition of the diabases, both the fine- and coarse-textured varieties being often changed to a very soft steatitic rock.

In the next eleven miles, only two exposures are seen on the banks of the river, and these are both formed of light-green, coarse-textured diabase, but little decomposed, the decomposed portion having probably been removed by ice, as the rocks are well striated.

Section thirteen miles below Larch River.

Eleven miles below the last- examined exposure of the unaltered Cambrian, the rocks again outcrop on the south shore of the river, and from their to its mouth are almost continually seen. The following descending section was made where they first outcrop on the south bank :—

	Feet.
1. Light, greenish-yellow mica-schist, the mica being scales of silvery secondary biotite, the schist holding lenticular patches of quartz	2
2. Dark, grayish-green mica-schist holding many large dark-red garnets	4
3. Light-coloured mica-schist (like No. 1)	3
4. Dark, garnet-bearing mica-schist (like No. 2)	2
5. Light, pearly mica-schist	9
6. White quartzite	5
7. Light-coloured mica-schist (like No. 1)	120
8. Light, cream-coloured shaly limestone	3
9. Dark-green, garnet-bearing hornblende-schist	9
10. Dark, garnet-bearing mica-schist	15
11. Light-gray, tremolite-limestone, fine-grained and very silicious	4
12. Dark-gray mica-schist	15
13. Light, pearly schist containing mica and steatite (squeezed dyke)	35
14. Dark-green mica- and mica-hornblende-schists, all containing many large garnets, with bands of hornblende-schist, 3, 6, and 12 inches wide	15
15. Rusty-weathering mica-gneiss (sillimanite-gneiss) holding considerable pyrite in small grains	15
16. Rusty-weathering mica-gneiss (sillimanite-gneiss)	200
17. Dark mica- and hornblende-schists full of garnets	30
18. Light-coloured mica-schist	50
19. Quartzite	8
20. Pink and gray mica-gneiss, fine-grained and very quartzose.	300

Highly altered clastic rocks.

The presence of limestone and quartzites in the above section, together with the evident bedded structure of the schists, leads to the belief that most of the members were ordinary clastic rocks that have been altered to a crystalline state by the adjacent masses of granite which have burst through the beds in the immediate neighbourhood of the last member of the section and which forms part of a great mass of granite to the eastward. All the members are cut by large dykes of coarse white pegmatite and the pegmatization appears to have continued, on a smaller scale, in the deposition of felspar and quartz between the laminæ of the schists to the production of the gneisses. Opposite the section on the north side of the river, there is an immense mass of granite, and further down stream the granite is seen inclosing broken beds of the schists. Here, whenever large masses of the schists are found, they are penetrated by a net-work of pegmatite veins and dykes, many of which are very large. The hornblende- and steatite-schists of the section are probably altered irruptives and the last closely resembles the alteration product of the diabase dykes described above.

Similar schists elsewhere.

Similar schists were found about the edge of the unaltered Cambrian areas on the Hamilton River* and south of Lake Michikamau† but their relations were not understood and no special attention was given to them. The remarkably formed hills of the Cambrian area continue into the region of the metamorphic schists and granites, and although somewhat modified by the granite masses, they all have sharp slopes inland or towards the south-west with an easy grade in the opposite direction. There is little doubt that the schists and associated rocks of this locality are but highly metamorphised representatives of a portion of the Cambrian, and that the granites which have broken through and altered them, are considerably newer, as the bedded rocks appear to have been subject to the pressure which caused the over-thrust faulting by which the ridges of the hills in the region were formed, previous to the granite intrusion.‡

Rocks seen below last section.

Half a mile below the place at which the measured section was made, the dark mica-schists form less than a fourth of the rock-mass the greater part being a medium-grained, pink mica-hornblende-gneiss and pegmatite, both penetrating the schists.

At the next point, the schists are greatly contorted and are chiefly rusty-weathering mica-gneiss often holding garnets in bands. Between the Tide Rapid and High-fall Creek, the south shore is very rocky, and in this vicinity dark and light mica-schists predominate, being interbanded with dark-green, garnet-bearing hornblende-schist, and in several places with narrow bands of light, pearly, green, schistose steatite, which in one band held rounded masses of light-green plagioclase. This rock appears to have originally been a light-green diabase like the masses found associated with the Cambrian rocks below the Kaniapiskau. There are also bands of rusty-weathering mica-schist

*Annual Report, Geol. Surv. Can., vol. VIII. (N.S.), p. 227 L.

†Ibid. p. 229 L.

‡In 1897, along the south shore of Hudson Strait and about Ungava Bay, the writer found the Cambrian rocks passing from unaltered black shales, grits, and ferruginous, silicious dolomites with associated greenstones, into garnet-bearing mica-schists, hornblende-schists and gneisses, quartzites and crystalline limestones, in consequence of adjacent intrusive masses of granite and associated dykes of pegmatite.

holding pyrites, and pink and gray fine-grained mica-gneisses all cut by a coarse-grained mica-hornblende-granite often holding large porphyritic crystals of orthoclase, and, in turn, along with the other rocks, cut by great dykes of white pegmatite. The rusty-weathering mica-schists contain much pyrite, but it is seldom sufficiently pure to be of value. For three miles below High-fall Creek there are several exposures of dark mica-schists and mica-hornblende-schists cut by the porphyritic granite and pegmatite.

Pyrite.

Rocks near Fort Chimo.

There is then an interval of low shore to where the river narrows at the large islands above Fort Chimo, where the shores again become high and rocky. The mica-schists and hornblende-schists are met with along with the rusty-weathering gneiss and occasional garnet-bearing bands. The light-coloured, coarse-grained granites are more abundant as are the great dykes of pegmatite.

On the north shore, opposite Fort Chimo, there is a dyke or sheet of fine-grained, dark diabase, six feet thick, interbanded with mica-schist, all with a gentle dip towards the water and evidently an undisturbed portion of the series.

Below Fort Chimo.

Between Fort Chimo and the mouth of the river the dark mica-schists and hornblende-schists are frequently seen to be cut by coarse granite and pegmatite, but they gradually thin out, and the rusty-weathering gneiss totally disappears before the mouth is reached. The granites and pegmatites compose over four-fifths of the rock near the coast, and they change in colour from gray to pink and red along the lower fifteen miles of the river.

Superficial Deposits and Glaciation.

The ice-cap.

The observations of striæ and other glacial phenomena along the route between Hudson Bay and Ungava Bay, show that the region was completely covered with ice during the glacial period, and that the ice moved outward and downward from a narrow névé near the present watershed.

The thickness of the ice-cap cannot be determined, but it had a sufficient depth to over-ride all the inequalities of the surface, so that the tops of the highest hills were equally striated and rounded with the lower lands. On the Hudson Bay coast, the high range of Cambrian rocks which separated Richmond Gulf from the main bay, were striated to their summits, 1200 feet above sea-level, or some 300 feet above the level of the interior watershed.

Névé region.

The region of névé cannot have been very wide, and lay on and slightly to the eastward of the present watershed. As elsewhere in the peninsula it is characterized by poorly marked striæ and by an accumulation of unstratified drift, full of large, partly rounded boulders and blocks of rock similar to that found in place in the immediate neighbourhood. The drift is arranged in steep, irregular hills from fifty to one hundred and fifty feet high, that run in no particular direction either parallel or transverse to the striæ, and which appear to be accidental in both height and shape. Their surfaces are largely covered with boulders and blocks, and they seem to be composed of decayed rock-material only slightly displaced by the movement of the ice. This condition of the drift extends from the east end of Seal Lake to the east end of Shem Lake, the drift hills being most conspicuous near the present watershed.

Drift.

Glacial striæ.

The following list of glacial striæ observed along the line of exploration, shows that the direction of ice-movement on the western slope was almost from east to west, with a slight divergence towards the south. On the eastern slope, the movement was almost directly opposite from the region of névé to near Natuakami Lake, sixty miles to the eastward. It then changed to about E. N.E., and continued so to the junction of the Larch and Kaniapiskau rivers, below which the striæ run nearly N.E., or parallel te the river-valley, to the neighbourhood of Fort Chimo, when the course again changed and the ice flowed north into Ungava Bay.

List of Glacial Striæ.

Cape Hope, James Bay	S. 55° W.
Paint Hills, "	S. 20° W.
15 miles S. of Fort George, James Bay	S. 40° W.
10 miles N. " " " "	S. 70° W.
40 " " " " "	S. 55° W.
20 miles N. of Cape Jones, Hudson Bay ... S. 65° W. and	S. 25° W.
3rd island, Manitounuck Sound	W.
2 miles S. of Little Whale River	S. 87° W.
Foot of Castle Peninsula, Richmond Gulf	S. 45° W.
Summit of " " " "	S. 45° W.
Island inside entrance to Richmond Gulf, direction of outlet	N. 85° W.
North-west end of Clearwater Lake	S. 80° W.
" " " "	N. 85° W.
Top of Burnt Mt., " "	S. 85° W.
Near mouth of river leading to Seal Lake	S. 60° W.
2nd portage on " " " "	S. 60° W.
Narrows 2nd lake " " "	S. 80° W.
Mouth of south bay, Seal Lake	S. 75° W.
5 miles beyond last, " "	S. 70° W.

South side of mouth of east bay, Seal Lake............	S. 65° W.
2 miles east of last (top of hill 180 ft.).......	S. 80° W.
Shem Lake, 2 miles east of water-shed..........	S. 55° W.
Stillwater River, 4 miles below Shem Lake...........	N. 75° E.
" " 3 " " last..................	E.
" " 1 " " "	N. 80° E.
" " 9 " " "	N. 80° E.
" " 6 " " "	N. 70° E.
" " 8 " above Natuakami Lake	N. 40° E.
" " (on hill-top).......................	N. 20° E.
" " 5 miles above Natuakami Lake......	N. 70° E.
" " 4 " " junction with Kenogamistuk....	N. 65° E.
Larch River, 2 miles below Kenogamistuk (on hill).....	N. 65° E.
" " at mouth of Junction River	N. 40° E.
Koksoak River, on knoll 1 mile below Kaniapiskau.....	N. 45° E.
" " 7 miles above Fort Chimo............	N. 25° W.
" " opposite Fort Chimo....	N. 45° E.
" " 18 miles below Fort Chimo.....	N. 5° E.
" " 22 " " " "	N. 5° E.
" " at mouth of river, north side..........	N.

The lower portions of the country passed through are everywhere more or less covered with a mantle of till or boulder-clay. The hills for the most part are bare rock, and only on the leaside was a tail of drift deposited by the ice. The unmodified till on the lower areas is usually arranged in a series of low lenticular hills or drumlins, more or less parallel to the direction of the glacial striæ. These ridges are unstratified and are formed largely of the finer material of the drift associated with boulders and blocks of rock. The fine material is a sandy clay resulting from the disintegration of the underlying granites and gneisses. Boulders and partly-rounded blocks, often of great size are common in the till, and are also scattered over the surface of the drift hills and those formed of rock; in fact, these fragments are usually so numerous that it is possible to walk almost anywhere without putting foot to the solid rock or ground. The boulders in the till or scattered over the rocky hills, as a rule belong to the locality in which they are found, and either represent cores of the otherwise decayed rocks which covered the country previous to the glacial period, or have since been produced by the action of frost in the cracks which has broken the rocks in many places to a considerable depth below the surface. These latter blocks are usually easily distinguished from glacial boulders by their more angular shape, and also by their mode of occurrence, as they are usually found in lines along the course of some small buried streams. Boulder-clay.

The number of erratics or far-travelled boulders in the drift is small in comparison with the number found almost in their original position. Erratics.

Eskers.

Eskers or ridges of modified drift were observed in several places between Hudson Bay and the watershed, and also in the valley of the upper part of the Stillwater River. These are quite distinct in shape and material from the drumlin ridges. They generally form long narrow ridges resembling railway embankments, very narrow on the top and falling away sharply on both sides. At times several ridges of this description are found together, when they have a more or less parallel arrangement. The surface between such ridges is occasionally deeply pitted with irregular depressions or pot-holes. The material from which the ridges are formed is usually well rounded sand and small gravel, and it is usually partly stratified, the bedding being generally at a low angle from the horizontal. In many places the ridges are thickly strewn with boulders, but as a rule these are not common in the mass; and those that do occur included in the sand and gravel are generally small and well-rounded.

Their position.

Ridges of this description are found along the courses of existing valleys and appear to have been formed by streams flowing on or under the ice during the period of glaciation, and if this is the mode of their origin, these streams as a rule followed the courses of the present valleys, and the system of drainage under the ice would appear to have been practically the same as it is to-day. Along the portage-route between the Wiachouan and Clearwater rivers, small eskers were seen in a number of places, especially along the course of the small tributary of the Clearwater, but none of them were large or persistent.

In Clearwater Valley.

Along the Clearwater River, scarped banks in places revealed the presence of partly stratified sand and gravel in the ridges of drift of the valley, but the amount of modified drift is not larger, as the glacial stream flowing out of the basin of Clearwater Lake appears to have followed the course of other channels to the northward of the present main channel. In two deep bays at the north-west end of this lake there is an abundance of well-rounded sand thrown up in narrow ridges from thirty to sixty feet above the level of the lake. From a distance these ridges have the appearance of terraces, but on close examination they are found to have steep faces toward the land as well as toward the water, and their irregular contours show that they are not water-levelled terraces, but rather the deposits of glacial rivers leaving the lake-basin. At the mouth of the small stream by which the portage-route leads to Seal Lake, there is a wide area occupied by sharp irregular ridges and hummocks of well rounded sand, which appear to have been formed by a large glacial stream entering the lake at this place. Esker ridges are very common and persistent up the valley to the south bay of Seal Lake, where the long narrow ridges extend outward from the west shore and in a number of places nearly divide the bay from the main body of the lake. From the mouth of the south bay to near the narrows of Seal Lake, the esker ridges are not well marked along the shores of the lake, but at the narrows they are again seen along the foot of a rocky hill on the north side, where they rise about sixty feet above the lake, and continue for a mile along the shore; they then form a long string of narrow islands that stretches four miles up the lake, and after an interval again appear along the north shore of the lake continuously to the mouth of the north-west bay. Passing this bay, they again come out on the north shore and islands of the east bay of the lake, and from its head can be traced up the valley of the small stream leading to the watershed and across it, for two miles, into Shem Lake, where a narrow ridge of stratified drift almost divides the lake into two. Beyond this the eskers were not observed until the Stillwater River had been descended a few miles, when they were again noticed in the valley and continue to Natuakami Lake, below which they give place to horizontally bedded sands and clays of river or marine origin. On Seal Lake. On Natuakami Lake.

Terraces of marine origin marking the former level of the sea in later glacial time, and also the subsequent elevation of the land, were found both on the coasts of Hudson Bay and of Ungava Bay. On the Hudson Bay side of the peninsula, the best-marked marine terraces and sea beaches were noted on the portage leading from Richmond Gulf to beyond the first fall of the Wiachouan. As previously described, the portage leads up the face of a wide hill of drift that faces the gulf and lies between the rocky hills forming the walls of the Wiachouan Valley, which at its mouth is about two miles across. As it rises from the sea, the route, in a mile and a half, passes up over thirty-five terraces or beaches, the highest of which is 460 feet above sea-level, and some of the others as follows:—1, 36 feet; 2, 54 feet; 4, 63 feet; 8, 89 feet; 9, 98 feet; 10, 143 feet; 17, 270 feet; 27, 332 feet; 28, 360 feet; 34, 424 feet. Many of these terraces are narrow, and resemble steps cut into the hillside, others are wider and have along their outer edges low hummocks of well-rounded pebbles and other signs of ancient beaches. The summit of the highest terrace is of this character and is about one hundred yards wide. Behind it there is a drop of about ten feet to a wide, swampy plain which extends some two miles. The portage from the highest terrace passes along the side of a rocky hill that rises above the drift between Terraces.

the swamp and the river to the south of it. The rise along this hill in a mile, to its eastern end, is 135 feet, where the rock terminâtes and a sharp narrow ridge of boulders begins with steep slopes on all sides and facing up the valley or toward the direction of ice movement. The material composing this ridge was probably dropped by the glacier at its parting in front of the rocky hill. The summit of the ridge is fifty-five feet above the stratified clays out of which it rises, and the clays consequently rise 540 feet above the present sea-level. On the south side of the valley, the line of junction of the clay and overlying sand is seen at the same level. No fossils were found in these bedded clays in the short time devoted to search for them; but as they can be traced from the present sea-level to this height they are undoubtedly of marine origin.

Height of stratified clays.

Highest terrace on west slope.

For fifteen miles, the hills forming the sides of the valley of the Wiachouan are flanked with clay overlain with sand, and in these deposits terraces are cut to heights of 300 feet above the river. Where the portage-route leaves the valley and ascends to the table-land on the north side, the road rises over terraces, of which the heights above the river are 30 feet, 160 feet and 310 feet. This upper terrace, which is 710 feet above sea-level, forms a plain above which the rocky walls of the valley rise in small hills; it extends backwards about half a mile into the valley of the small tributary followed by the portage-route, and would appear to represent the maximum limit of marine terraces, as none higher were observed between it and Clearwater Lake.

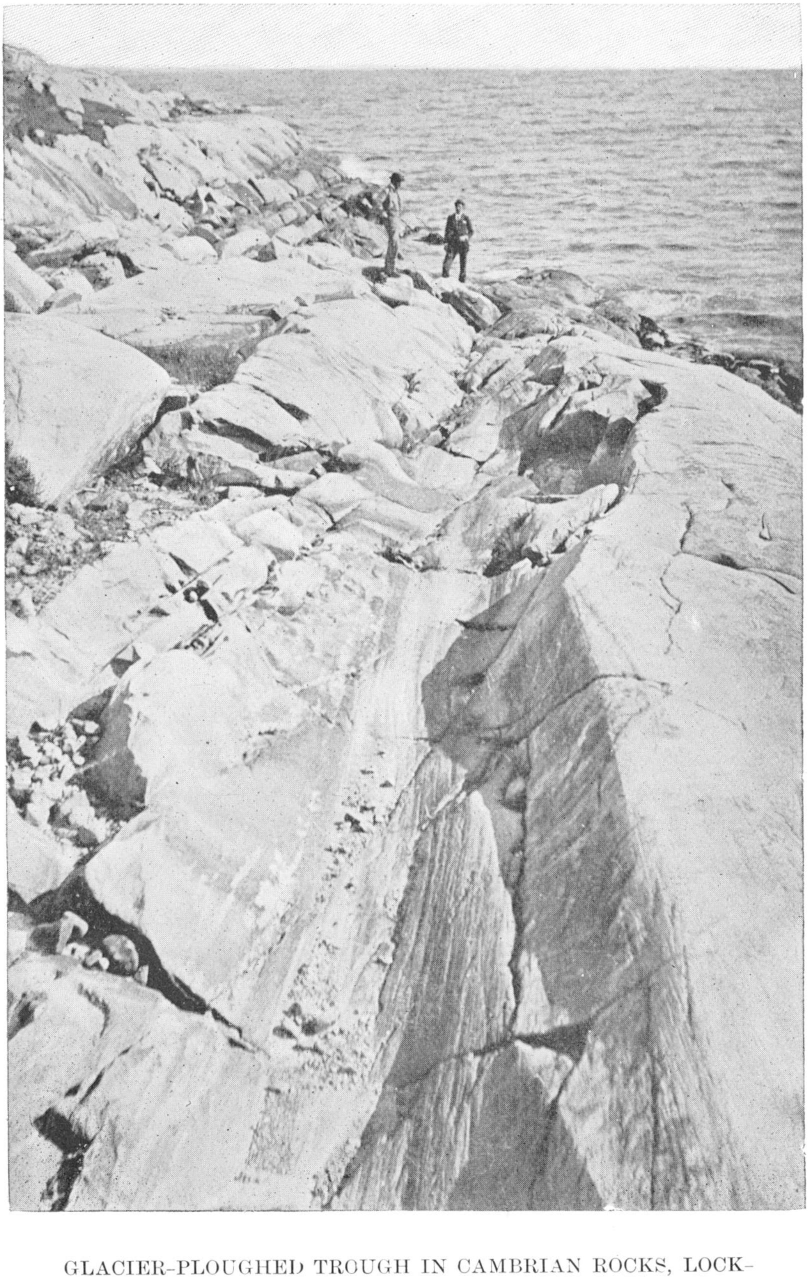
Terraces on east slope.

On the eastern slope, or that facing Ungava Bay, all the evidence of uplift was seen along the Koksoak River and its branches. Below Fort Chimo the hills on both sides of the river do not rise more than 400 feet, and the scant deposits on their sides are terraced up to an elevation of 250 feet above the water. Above Fort Chimo, to the junction of the Kaniapiskau and Larch rivers, the valley is wide and terraces along the hills are not well marked, being seen only in places and never much above 300 feet higher than the river.

Along the valley of the Larch River, to the forks of the Kenogamistuk and Stillwater, the terraces are well marked and almost continuous, especially the highest, which is everywhere nearly 300 feet above the river. This high-level terrace is also very persistent along the Stillwater, and ten miles below Natuakami Lake it rises 165 feet above the river and has its top fronted with an old beach of rounded shingle. At the outlet of Natuakami Lake its elevation is only about 100 feet above the lake or 620 feet above sea-level. Above Natuakami Lake, no well-defined, continuous terrace was noted and any small terraces seen there were supposed to have been of river origin. In conjunction with the terraces above mentioned, continuous deposits of stratified clay were traced from the sea to within a few miles of Natuakami Lake, or 100 miles from Ungava Bay, and it is probable that the encroachment of the sea toward the close of the glacial period, as marked by the terraces, extended so far or farther inland, covering much of the lower country and filling all the principal river-valleys on both sides of the peninsula; at this time the seals now found in Seal Lake might easily have reached that lake, as the difference in level between it and the sea must have been less than 150 feet. The subsequent uplift of the land would appear to have been about 100 feet higher on the Hudson Bay coast than on the eastern side, but this difference may be only due to imperfect estimations of barometric heights, especially on the long river-stretches on the eastern slope, where the estimated heights of the interior above sea-level, may easily be 100 feet too low.

Differential uplift.

Terraces up to fifty feet above the water were noted in many places along the Stillwater River above Natuakami Lake, but none of them were persistent. On the banks of the Clearwater River no definite terraces were noted, and the same applies to Clearwater Lake, where no evidence of a former higher level was noted. In Upper Seal Lake there are broken terraces at fifteen feet above its present level, but they probably mark a former greater height of the lake itself, which might easily have been caused by a barrier of drift at its present outlet.



GLACIER-PLOUGHED TROUGH IN CAMBRIAN ROCKS, LOCKPORT ISLAND, N. S.

GEOLOGICAL SURVEY OF CANADA

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

REPORT

ON THE GEOLOGY

OF

SOUTH-WEST NOVA SCOTIA

EMBRACING THE COUNTIES OF QUEEN'S, SHELBURNE, YARMOUTH, DIGBY AND PART OF ANNAPOLIS

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. 628

To Geo. M. Dawson, C.M.G., LL.D., F.R.S.,
Director Geological Survey of Canada.

Sir,—I have the honour to submit the following Report upon the geology of South-western Nova Scotia, made by myself and successive attendants at various times between the years 1891 and 1896.

In December, 1893, a report, embodying the results of explorations in the counties of Queen's and Shelburne only, and prepared in accordance with the directions of the then Director, Dr. A. R. C. Selwyn, was submitted to that gentleman for approval, and was accepted for publication, but owing to the want of funds for printing was held over to await further appropriations. In the meantime, the field-work was extended to include the counties of Yarmouth and Digby, and a second report relating thereto was also submitted. In connection, however, with the latter, several important questions having arisen requiring further investigation, and appropriation for publication being still in abeyance, it was deemed advisable to further study the points in doubt, at the same time that a preliminary report should be prepared, summarizing the more important results which had been definitely ascertained. This report, with an accompanying map, forms a portion of Volume VII. of the Annual Reports (New Series). Still further delay in publication being unavoidable, I was finally directed by yourself, early in 1896, to devote another season to the clearing up, if possible, of all doubtful points, and to prepare a report in which the substance of both the previously written reports might be condensed. In connection with this object it has been found necessary to extend the field of observation so as to include a considerable portion of Annapolis county, especially in the vicinity of Annapolis Basin. The results of the observations thus made, together with those previously attained, form the substance of the present Report.

During a portion of the season of 1890 I was assisted by Mr. J. W. Bailey, in 1891 by Mr. Lee Street, in 1892 and 1893 by Mr. W. H. Prest, and in 1896 by Mr. Roy Van Wart. While each of these gentlemen cheerfully rendered all the assistance in his power, the services of Mr. Prest were especially valuable; his previous training as a prospector, his knowledge of geology in general, and of the Cambrian system of Nova Scotia in particular, together with his skill as a draughtsman and surveyor, to say nothing of his enthusiasm and power of endurance, all combining to make his work thorough and effective.

I have the honour to be, Sir,

Your obedient servant,

L. W. BAILEY.

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

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BY

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The region to which this report relates, exclusive of Annapolis county, embraces 3370 square miles, being distributed as follows:—Queen's county, 1065 square miles; Shelburne, 948 square miles; Yarmouth, 736 square miles, and Digby, 1021 square miles. The portion of Annapolis considered would be about one-third of its extent, or about 327 square miles. These counties collectively constitute what are commonly known as the "Western Counties," and are so disposed as nearly to meet at a common point, whence they spread like a fan, to terminate, in every direction but one, upon the coast. Area to be described.

As usual in Nova Scotia, the coast-lines of the region in review are broken and indented, but, if we except St. Mary's Bay and Annapolis Basin, much more broken upon the southern than upon the northern side. As a result of the facilities thus afforded for the prosecution of maritime pursuits, the coast region is almost everywhere thickly populated, while it also includes the city of Yarmouth, as well as the considerable towns of Liverpool, Shelburne, Lockeport, Barrington, Maitland and Weymouth, besides Digby, Bear River, Clementsport and Annapolis. Portions of the interior also, especially along the principal rivers, the Liverpool, Port Medway, Roseway, Tusket and Sissaboo, are the seats of thriving settlements; but few of these are more than ten or fifteen miles distant from the coast, while further inland are extensive tracts which are not only unsettled, but of such a character as seemingly to be unfit for settlement. Distribution of settlements.

Previous publications.

Prior to 1895, the only publications referring to this region, so far as known to the writer, were the "Acadian Geology" of Sir J. W. Dawson, in its several editions and appendices, a report of Dr. A. R. C. Selwyn upon the Gold-bearing Rocks of the Southern Coast (1871), and references by Dr. Honeyman, Prof. H. Y. Hind and others in various periodicals. The observations of these writers were, however, confined to very limited areas, with but few references to any portion of the district other than that forming the immediate seaboard. The preliminary report referred to in the letter of transmittal of the present Report, with the maps accompanying these reports, are, it is believed, the first attempt, based upon personal and systematic surveys, at the representation of the geology of the entire district. It is but right to add that even these surveys have not been as yet of an instrumental character, the great tracts occupied by unproductive rocks, such as granite, together with the rugged and unsettled character of the region, with a multitude of small lakes and streams, having been thought to involve, for their minute delineation, such an expenditure of time and money as would be unwarranted at present by any return likely to accrue therefrom.

Groups of rocks.

Regarded geologically, the district under review embraces the following groups of rocks :—

1. Granite.

2. Quartzites and slates, resembling the quartzites and slates of Halifax and Lunenburg counties, like them auriferous, and believed to be of Cambrian age, but without ascertained fossils.

3. Micaceous, hornblendic and staurolitic strata, supposed to be the metamorphic equivalents of the Cambrian rocks.

4. Fossiliferous slates and iron ores, of Oriskany or Eo-Devonian age.

5. Red sandstones of Post—Carboniferous age—Triassic ?

6. Trap (dolerite, amygdaloid, etc.), associated with No. 5.

Physical Features and Surface Deposits.

The consideration of these different groups of rocks may be advantageously prefaced by some remarks upon the physical features and surface deposits of the region in which they occur. The study of the superficial geology of the latter not having been a primary object of exploration, no attempt has been made to present this with any

Surface geology.

degree of fulness, or to solve the numerous and interesting problems connected therewith. As being, however, the last chapter in the geological history of the region, and intimately connected with the development of its mineral and other resources, the features of the surface well deserve some measure of attention. It is therefore proposed to notice here, though somewhat briefly, such facts relating to this subject as have incidentally been brought under observation.

Areal divisions.

For the purpose under consideration, south-western Nova Scotia may be conveniently divided into the following areas, the contrasts between which will, in the sequel, be shown to be intimately connected with corresponding differences of geological age and structure :—

1. The central granite axis.
2. The southern coast.
3. The southern interior.
4. Yarmouth county.
5. The region south of St. Mary's Bay.
6. Digby Neck, with Long and Briar Islands.
7. The south side of Annapolis Basin, Digby to Middleton.
8. The Annapolis Valley.

Position of granite area.

1. The Central Granite Axis.—The area referred to under this designation is but a part of that great mass of granitic rock which traverses so large a portion of the peninsula of Nova Scotia, and is the most important element in its physical structure. Details as to its position and limits are given in later pages of this report. Though described as central, it is only so through a part of its course, approaching in fact, in Annapolis county, the waters of Annapolis Basin, while on the other hand, in Shelburne county, it curves southward to reach the southern coast; and yet central, inasmuch as it forms the divide between the rivers which flow directly or indirectly into the Bay of Fundy, and those which drain into the Atlantic. That portion of it which occurs in Annapolis county is known as the South Mountains, while in Digby and Yarmouth counties an important diverging spur has received the appellation of the Blue Mountains.

Physical features.

The physiography of the above and of other smaller granitic areas indicated on the map, is well marked. For agricultural purposes they are well-nigh worthless, and it is interesting to notice with what suddenness and completeness settlements disappear when from any side a close approach is made to the granite. This is at once seen to be due to two causes; the first being the thinness or complete absence of soil, often exposing broad, bare surfaces of rock, and the second, the abundance of immense boulders. Over large areas, especially over the Blue Mountains, there is little vegetation except that of low shrubs, relieved now and then by strips of wild meadow, but there can be little doubt that the whole country was once abundantly forest-clad, its depletion being the result of oft-repeated forest fires. Some portions of these forests still remain, especially in Annapolis county, about the head waters of the Sissaboo in Digby county, and at the sources of the Tusket in Yarmouth county, and these supply considerable quantities of valuable timber. Berries also are abundant and nowhere excelled for size or flavour. The general elevation of this region is about 600 feet. Over its surface are innumerable lakes, usually well stocked with fish, and the source of the numerous streams, large and small, which flow from it on every side.

Character of coast-line.

2. The Southern Coast.—The first feature to attract attention in this district is the irregularity of the coast-line. Like that of the entire southern seaboard of the province, it is especially characterized by the occurrence of numerous long, narrow indentations, separating corresponding long, narrow tongues of land. Through this peculiarity the actual length of the coast-line is almost quadrupled, as compared with the shortest distance between its extreme limits. When to this is added the occurrence of numerous islands of all dimensions, the facilities offered for the residence of a maritime population and for the prosecution of its appropriate industries, fishing and ship-building, will be at once understood, and have been thoroughly utilized, the whole shore being continuously and often thickly settled, although from the paucity or sterility of the soil, few harvests are to be gathered, other than those of the sea.

Settlements.

Indentations.

The indentations referred to vary in length from two miles or less to seven miles, and in breadth from half a mile to three or four miles their sides being in most instances approximately parallel, though occasionally widening outward into bay-like forms. In the latter case they are usually divided by more or less considerable islands, into two or more main channels. A more important feature, as bearing upon their origin, is that of their close parallelism with each other and their general conformity to a north-west and south-east trend, at right angles or nearly so, to the general trend of the coast, as also to that of the peninsula as a whole, and to the strike of the rock formations which traverse it. Comparing the median lines of the principal harbours,—

those of Port Medway, Liverpool, Port Mouton, Port Jolie, Port L'Hebert, Sable River, Ragged Island, Green Harbour, Jordan Bay, Shelburne Harbour, Negro Harbour, Port Latour and Barrington, their course is found to vary from N. 45° W. in Queen's to nearly true north-and-south in Shelburne county; the minor indentations according with the prevalent trends. A like feature is also often observable in the form and grouping of the numerous islands.

The occurrence, as described, of these long and narrow inlets, can be satisfactorily explained only upon the supposition that they were formed during a period when the peninsula stood at a higher level than now. They are in fact veritable fiords, and it is interesting to notice that one of the impressions recorded by Sir Charles Lyell at the time of his first visit to America in 1841, was that of the close resemblance borne by the similar indentations further east upon the coast, to those of the well known and typical fiords of Norway. Confirmation of this view is abundantly afforded by the associated phenomena of the coast, as it is by those of the interior, to be presently noticed. Fiords.

The evidences of extensive glacial action upon the seaboard are to be found in the nature, size and arrangement of boulders, in the occurrence of both terminal and lateral moraines, of smoothed, striated or in some instances deeply ploughed surfaces, together with kames or horse-backs and irregular accumulations of till. On the other hand, the general absence of anything in the nature of raised beaches, or of clays containing marine organisms, would seem to indicate that the moulding of the surface and the distribution of its glacial deposits has been but little affected by the action either of marine currents or of floating ice. It may be added that the great extent of the dunes or sand-hills which occur at various points along the coast, and which, as in Barrington Bay, sometimes attain a height of fifty or sixty feet, give reason to believe that the coast has undergone but little change of level in recent times. Evidences of glaciation. Dunes or sand-hills.

The boulders to which reference has been made vary greatly in size, but are often of large and sometimes of enormous proportions. One, near the eastern bank of the Liverpool River, seven miles from the town of Liverpool, was found by measurement to be 30 feet long, 20 feet wide and 20 feet high, while in the vicinity of Shelburne others as large or larger may be seen. For the most part these boulders are similar to the adjoining rocks, consisting largely of granite, gneiss, quartzite and mica-schist, the latter in many varieties. But while in most instances these would seem to have travelled to no great distance Boulders.

from their parent beds, some, and especially those of granite, show both by their position at a distance from any known outcrops and by their well rounded forms that they have come from more remote sources. They are often piled together in great rough heaps, or are thickly distributed over limited areas, while adjacent tracts contain relatively few or none. Many of the smaller islands adjacent to the coast are nothing but irregular heaps of boulders; and even some of large size, such as Coffin's Island, off Liverpool Bay, appear to be wholly composed of drift material. That some of the accumulations are of the nature of terminal moraines, would appear probable from the circumstance that they are heaped up in lines parallel to the general coast-line and transverse to that of its indentations.

Terminal moraines.

Glacial striæ.

Glacial striæ are of common occurrence upon the coast, and are often strongly marked. From the table appended to this Report it will appear that along the coast of Queen's county their trend varies from south to south 20° east, and this is also true of much of Shelburne, but near Jordan Ferry and Negro Harbour, a deflection of 10° to the westward has also been observed. It may be noted that the average direction, about south 5° to 10° east, is also that of the principal indentations or fiords already noted, both conforming to the general slope of the country. It may be added that, in addition to ordinary striations, evidences of furrowing and ploughing are also met with, and in some instances to a depth which is very remarkable. Thus, at the extremity of the island on which Lockeport is situated, alternating beds of quartzite and slate, dipping steeply to the sea, are ploughed along their edges into canoe-like troughs, thirty or forty feet long, three or four feet wide and as many deep; while on a small island near Port La Tour, similar beds have been gouged by a like agency to a depth varying from ten to twenty feet.

Glacial troughs.

3. The Southern Interior.—In contrast with the irregularity of the southern coast, the interior region bordering upon the latter presents but few salient features. True hill ranges are entirely wanting, although the land gradually rises to where it blends with that of the granite axis, a distance which in Queen's county is from fifty to sixty miles, but is greatly reduced in that of Shelburne. Minor irregularities are, however, of frequent occurrence and are mainly attributable to two causes, the combined effect of which is clearly marked alike in the topography of the surface and in the character of its drainage.

Surface features.

Determining causes.

The first of these determining influences is that of the strike and varying capacity of resistance of the rock formations, and the second the distribution of the superficial deposits. The strike being, as a rule, nearly parallel with that of the peninsula, while the groups of strata represented are of very unequal hardness, a tendency towards the development of long, but only moderately deep, north-east and south-west troughs is determined, separated by corresponding low swells. From similar differences in the ease and amount of erosion, the soils of the harder bands, which consist largely of quartzite, are comparatively meagre or wholly wanting, while those of the intermediate slate belts are usually much deeper, and the country is thus zoned with alternate bands of poor and fertile land. This arrangement is, however, markedly modified by the distribution of the surface deposits, the more prominent of which, in the form of low ridges, are generally found to be disposed in directions transverse to the alternating bands, in other words, to present northerly and southerly courses, with their steeper slopes usually to the westward. Instances, however, are not rare in which trains of boulders or other detrital matter are arranged parallel with the underlying bed-rocks, along north-east and south-west courses, and are in these cases probably frontal moraines. Under the combined influences of the two causes mentioned, much of the surface has acquired a hummocky character, low rounded hills or short ridges being separated by numerous hollows, many of which are occupied by ponds or lakes.

Moraines.

The above described features have a marked influence upon the drainage of the country. Of the larger rivers which traverse it, such as the Port Medway, the Liverpool, the Jordan, the Roseway and the Clyde, it may first be noticed that they all conform quite nearly to northerly or north-westerly trends, and exhibit for long distances the parallelism already noticed in the case of the harbours into which they severally discharge. At the same time, in the course of their descent, they either expand at intervals into more or less considerable lakes, or are directly connected with groups of the latter occupying transverse depressions. This is well seen in the case of the Port Medway River, which rises in Annapolis county among the granite hills and expands in northern Queen's county into Ponhook Lake, parallel with which and separated only by a narrow ridge, is the still larger sheet of water known as Molega Lake. Similarly, the Liverpool River, also starting from the granite hills of the South Mountains, and at a point not far removed from Annapolis Basin, traverses the several basins of Liverpool Lake, Fairy Lake and Lake Rossignol; while the same feature, though less conspicuously, is seen both on the Jordan and Roseway rivers. On the other hand, between Lakes Rossignol and Ponhook, we have the chain of the Christopher Lakes, at least fourteen in num-

Drainage.

Lakes.

ber, marking the existence of an east and west trough, while similar depressions are indicated in the cases both of the Tobeatic and the Fairy lakes. As a result of this disposition of the surface waters, easy access is given by canoe to extensive tracts, including a ready passage, with only short portages, from the Port Medway waters to those of the Liverpool River, or from the latter to those of the Jordan.

The total number of lakes included in Queen's and Shelburne counties alone is not less than one hundred, while in Annapolis, Yarmouth and Digby they are even more abundant. In the majority of instances examined, their existence and character are found to be directly connected with the distribution of the drift, and due either to the damming up of their natural outlets or to their division into more or less numerous basins. As might be expected under the circumstances, the lakes are generally quite shallow, with low and irregular shores, and their surfaces are dotted with numerous islands, the latter not infrequently consisting of mere piles of boulders. The abundance of these islands tends to introduce diversity into the aspect of the Nova Scotia lakes, but these, as seen in the counties under review, are certainly not to be compared in scenic beauty with those of the interior of New Brunswick and Quebec. At the same time, though well stocked with fish, they are only available to the angler in the spring and fall, the comparative absence of cold springs and of mountain brooks, and the consequent warmth of the water during the summer months, making fishing at that season very unsatisfactory.

Fish.

In connection with the subject of drainage, it may be worth while to note that the valleys occupied by the main streams in the section under review are, like the basins of the lakes, comparatively shallow, and but rarely exhibit distinct terraces along their banks.

If the superficial deposits to which reference has been made be more closely examined, they will be found, like those of the coast, to include boulders, gravel, sand and clay, variously intermixed. Boulders are especially abundant along the course of the "whin" or quartzite belts or in the vicinity of granite, and they are often so heaped together as to make travelling over the surface well-nigh impossible. The hills overlooking Tupper Lake in Queen's county, from its north-eastern side, are especially remarkable for the number and size of the granite boulders met with, as is the vicinity of Tobeatic Lake, Pescawess and Kejamakuchee lakes in southern Annapolis county, or the northern edge of Lake John in Shelburne county. Bald Mountain, in the latter county, seems to be little more than a pile of huge granite

Boulders.

blocks, and both here and elsewhere the abundance of granite boulders make the determination of exact boundaries exceedingly difficult. On the other hand, the distribution of boulders, in the case of the whin and slate belts, is of the utmost importance to the prospector as being the only guide to the presence and position of auriferous veins. In this latter case it is evident that the boulders can have been removed to but limited distances from the parent beds, and this is probably true of most of the larger boulders, whatever their nature. On the other hand there is also abundant evidence of a wider dispersion of the drift, probably at a period somewhat earlier than that last referred to, the contained masses being such as could only be derived from a distance.* Large boulders, it may be added, are most abundant in the bottom and on the sides of valleys or depressions, while the tops of the bounding ridges are comparatively free.

Distance of travel.

Another noticeable feature of the region under discussion is that of its kames or horse-backs. These sometimes extend for miles, with more or less sinuous courses, but in many instances appear to be arranged in series of parallel and overlapping lines, the individual ridges being somewhat short and spindle-shaped. In some instances they bifurcate, and in others, as on the road from Shelburne to Lake John, east of Jordan River, they include a series of round and deep depressions or "kettles." In the case of one of the most remarkable of the ridges, which was traced by Mr. Prest from Perrot's Settlement in the southern part of Annapolis county across the Maitland River to Long Lake and Frozen Ocean, and finally into Digby county, the general course is approximately east and west; but in other instances, as at the head of the Port La Tour Peninsula, the direction is nearly a meridional one. The origin of these curious ridges, of which other instances occur in Yarmouth and Digby counties, is still disputed, but there can be but little doubt that they are in some way connected with the melting of the great ice sheet which, it is believed once enveloped all of Nova Scotia.† When exposed in road making, the interior of these kames is usually found to consist largely of fine sand, with only a small percentage of clay, in which rounded boulders of all sizes are distributed.

Kames or horse-backs.

The only other feature in connection with the superficial geology of Queen's and Shelburne counties to be noticed here, is the frequent

*In several instances boulders of the characteristic traps of the North Mountain range, skirting the Bay of Fundy, have been observed upon the shores of Queen's and Lunenburg counties.

†For further discussion of this and related topics see article by W. H. Prest in Proceedings of Nova Scotia Institute of Science, vol. IX, Part II.

occurrence and large size of the peat bogs and barrens. These are most abundant near the coast, but are found in all parts of the district and are evidently the results of its imperfect drainage. In the case of true peat bogs the surface is nearly a dead level, and probably marks the site of a former lake; but many barren tracts are more or less undulating or broken, and the sterility is largely the effect of forest fires. From the two causes combined, probably two-thirds of the entire area embraced in the counties under consideration has become wholly unfit for settlement.

Peat bogs.

Growth of peat bogs.

From the examination of the numerous peat bogs in the interior of Queen's county, it would seem probable that these originated in very shallow lakes, in which the first stage was mud banks and water plants, the second meadows with cranberries and moss, the third swamps with peat-moss, which increased its growth until the central part of the bog became frequently two to ten feet higher than the edges.

Pubnico Lake region.

Lying between the region last described and that next to be noticed is what may be termed the *Pubnico Lake Region.* This is properly an extension of the central granite axis, which here bends southwards to the coast, but by its position becomes connected with the tracts above reviewed, and to a large extent shares their character. Lying between the Clyde and Pubnico rivers, and on either side of the line between Shelburne and Yarmouth counties, the district is everywhere extremely rough and rocky, and except for small quantities of timber and slight mineral indications, would be almost utterly valueless.

Timber.

The principal timber region is near the middle of the tract, its existence being probably owing to its inaccessibility. Hemlock is the most abundant wood. Then comes spruce, with a small tract of pine between Wagner, Clearwater and Stony Creek lakes. The rest of the forest consists of scrub spruce, larch, white birch and white maple, with occasionally oak, poplar and fir. White birch, especially, is very abundant. Through these forests run sluggish brooks, the sources of Barren Lake Stream, Barrington River and Medoshak Brook. There are several shallow and rocky lakes, the largest of which are Pubnico (7 miles), Great Barren (4 miles), Medoshak (3 miles), and Wagner and Hepsamateejek (each 2½ miles long). Another feature of the district is the presence of large tracts of interminable thicket, composed of interlaced alder, scrub spruce, white birch and laurel (*Kalmia*), with other small bushes. This is a second growth, occupying land once covered with heavy timber, of which dead and fallen trunks are lying

Water-courses

Shrubs.

in every direction, making the growing brush almost impenetrable. The agricultural capabilities demand no description, as the surface is nothing but a mass of disintegrated boulders, with here and there a peat bog or swamp.

Yarmouth County.—As in the case of Queen's and Shelburne counties, a review of the physiography of this county necessitates a separate consideration of the coast and the interior.

As regards the coast, no more remarkable illustration of the effects of glacial action in modifying ocean contours could well be found. From Pubnico to Yarmouth Harbour the shore is wonderfully broken and ragged, presenting a continuous succession of bays and inlets, off or among which the diversity is further enhanced by a multitude of islands of every size and form. These islands are rarely rocky, but usually rounded and drift-covered, their wooded surfaces, contrasted with the dark blue of the intervening sea, producing scenery which is at once varied, striking and picturesque. North of Yarmouth Harbour this irregularity becomes less marked, while the shores become at the same time much bolder, though less bold than are those of Digby county, to be noticed presently. Features of coast. Scenery.

The interior of Yarmouth county, exclusive of the Blue Mountains and the Pubnico Lake region, both of which have been already noticed, is largely coincident with the valley of the Tusket. The length of the main Tusket, including its windings, is about 45 miles. About three miles and a half or four miles from its month it divides into two branches, called by the people the Carleton and Kempt rivers. The Kempt or eastern branch is slightly the longest, and obtains the credit of being the main river. There are ten or twelve tributaries, from five to twenty miles long, which flow through a great number of lakes, Wallybeck Lake (3½ miles long) being the largest. Some of them are noted for their beauty, especially Barrio in the interior. These streams are frequently broken by picturesque falls, and supply abundant water-power for numerous saw-mills. Tusket valley. Tributaries of Tusket.

The surface of the tract under review is undulating in the south and west, but more level in the eastern half. The western part is deeply covered with glacial detritus, giving rise to a deep soil and a well-wooded country. In the eastern and north-eastern part the land is more barren, especially in the neighbourhood of the Blue Mountains, which here project to the south-west. Surface.

The underlying rock in this tract is mostly blue quartzite, with narrow and alternating belts of greenish slate. This has given rise in the west and south-west to partly stratified accumulations of boulder-clay and gravel beds. Those parts of the Tusket valley contain a deep soil and high rolling land, which appears to be very productive. The northern portion is bordered and underlain by granite, forming a sandy and often very strong soil. This part is still covered with timber of different kinds.

Soils.

Intervales.

There does not seem to be much intervale land upon the Tusket, except over its lower course from Kempt to the sea. The upper tributaries contain a large extent of uncultivated meadow land. One fine strip extends from Barrio Lake several miles up the Silver River. The meadows around Rockingham produce upwards of 200 tons of hay, which, although not equal to that cut upon the uplands, still proves a valuable addition to the winter's store. The streams running through the barren tracts are often bordered by meadows which are in pleasing contrast to the desolation around.

A large part of the northern portion of the Tusket valley, consists of slightly undulating deposits of gravel, sand and small stones. Across it stretches, in a west-south-west direction, another of the remarkable kames or horse-backs to which reference has before been made. It is known in the neighbourhood as the "Boar's Back," and, in the form of a gravelly ridge, can be traced from the Devil's Den, near the Blue Mountains, across the Tusket valley, nearly to Hectanooga station, six or eight miles from the western coast. It varies from ten to forty feet in height, and from twenty to one hundred feet in width, and runs for about twenty miles. The large desolate tract of sandy barren through which the ridge runs bears nothing except blueberries and occasional clumps of white birch, poplar and undersized spruce. It seems to have been the result of long-continued submergence beneath either marine or fluviatile waters.

"Boar's Back."

The south-east part of the Tusket valley is mostly rocky and uneven, consisting chiefly of blueberry barrens and patches of valueless swamps and forests. The only exception to this is a small tract styled "The Prairie," near the south-east end of Wallybeck Lake, and several miles from the nearest settlement. It is composed of sandy and loamy knolls, mingled with large stretches of level marsh land, which recede and advance much like the indentations on portions of the Atlantic coast. It is destitute of trees, and its dark and mellow-looking soil seems only waiting for the plough to turn it into fields of waving

"The Prairie."

grain. This tract is several square miles in extent, and overlies a wide belt of hard blue quartzite.

This district contains considerable woods in its western and northern parts, the trees being the same species as those of the sections above mentioned. To the north-east the pine becomes a little more abundant, and to the east of Moose Lake Brook, a tributary of the Tusket, a strip of fine timber is reserved by the owners. It is apparently one of the best pieces of timber land in the province. Occasional gigantic oaks are found scattered over the barrens in the extreme north-east of the district, where young trees of the same species are rare. This leads to the belief that the large trees are the remains of a once prevailing oak forest. Two or three species of maple are seen, but neither maple, beech nor birch grows to as large a size here as in the eastern and central counties. Black ash is very large and plentiful, and it and the swamp maple are the prevailing trees on the intervale, as the birch and beech are on the uplands. **Distribution of trees.**

Parallel with the valley of the Tusket, from which it is distant about six miles, is that occupied in part by Yarmouth harbour and in part by the chain of connected lakes which discharge their superfluous waters into this harbour. In the immediate neighbourhood of this chain of waters, the protrusion of hard hornblendic rocks gives to the surface a somewhat rugged character, but not sufficiently so to prevent successful farming, while the flourishing villages of Hebron and Ohio on the line of the Dominion Atlantic Railway, sufficiently attest the general capacity of the region. In addition to the Yarmouth and Hebron lakes, others farther east are Lake George, three and a half miles long, Brazil Lake and Lake Annis, all noted for their quiet beauty. Innumerable sea gulls frequent the larger of these lakes. **Yarmouth lakes.**

5. Region south of St. Mary's Bay.—This region embraces that portion of Digby county which lies between the southern shore of St. Mary's Bay and the granite hills of the interior, being about fifty miles in length, with a breadth of about fifteen miles at its western extremity, but narrowing eastward to about eight miles. **Area.**

The coastal features of the district are, in its westerly half, from Port Maitland to Meteghan, remarkable for their boldness, the shores being almost continuously fronted by precipitous bluffs facing directly the waves of the Atlantic; but to the eastward of the last-named point, where they form the southern shore of St. Mary's Bay, these become much less prominent. On either side of the indentation of Cape Cove **Coastal features.**

and especially at St. Mary's light and thence nearly to Meteghan, the shore is simply a succession of precipitous bluffs, attaining in places a height of nearly 200 feet. Owing to the nature of the rock, consisting of highly inclined slates, for the most part turned edge-on to the sea, the action of the latter has been to carve them out into all sorts of irregular and sometimes fantastic forms, columns resembling chimneys and detached from the cliff, or caves hidden by the sea at high tide, being common features. At but few points is it possible to descend with safety the almost perpendicular and slippery gulches, and after the descent is made, there is always a possibility of being cut off from a return by the rapidly rising tide. In some places the cliffs overhang to such an extent that the water drops from their tops far out on the beach. Even with a boat, except in periods of unusual calm, the exploration of this coast is difficult and dangerous.

Precipitous shores.

Soils.

The nature of the soil in this region depends, as usual, upon its geological structure. Where quartzites prevail, as along much of the St. Mary's Bay shore, it possesses but little depth or is very stony, and this portion has been for the most part cleared of all its valuable wood. What remains is either a second growth of fir or larch, or the scrub spruce, which usually covers wet or untillable lands. This spruce seems to be the same species as the larger variety used for lumber, but in exposed situations upon precipitous shores it becomes stunted and flat topped, with the branches turned inland. Some thickets consist of nothing but wooden pillars crowned with a dense and flat green mass of limbs and twigs, beneath which it is impossible to creep. Near the edge of the cliffs these spruces are often so stunted and compressed by the force of the gales that some of them have the appearance of low green mossy mounds. Another peculiarity of this coast is the abundance of orchids, especially over and in the vicinity of peat bogs. The most common species is the white-fringed orchis (*Habenaria blephariglotis*, Hook) but the purple-fringed orchis (*H. psycodes*, Gray) is also very common. Another plant very abundant upon the coast and found nowhere in Nova Scotia except in Yarmouth and southern Digby counties, is the skunk cabbage (*Symplocarpus fœtidus*).

Stunted spruces.

Interior.

The interior of Digby county, exclusive of the granite, is in general features similar to that of northern Yarmouth, the underlying rocks and general conditions being the same. It is drained by the Salmon River, the Meteghan and the Sissaboo or Weymouth River, as well as by the head-waters of the Tusket. Of these the Sissaboo is much the most important, the main branch with its windings being probably thirty-five miles long. In the upper part of its course it runs through

Sissaboo valley.

a rough country, containing numerous lakes, but lower down to the south and west is a fine wooded rolling country, which has been covered with drift to a considerable depth, and which post-glacial erosion has carved into high rounded hills. The quality of the soil in this section is indicated by the well wooded condition of the country and by the rankness of the weeds and undergrowth, while wherever farms have been cleared, the strong growth of the mixed crops shows its productiveness. Fertility.

On the south side of the Sissaboo above Weymouth, is a large tract of gravelly and sandy land that seems to owe its origin to the erosion of a local outcrop of granite, or to a local deviation in the direction of glacial transportation. The nearest source of the granitic débris seen here, is about four miles and a half south-east or six miles east-north-east.

A considerable quantity of valuable timber, spruce and pine, is still held by speculators and lumbermen in the south and south-east part of the lower Sissaboo valley. A fine tract of spruce, with scattering pine, stretches from Riversdale in a southerly direction to the head-waters of the Western Tusket. Great quantities of fine hemlock are also to be found in the same region as well as along the banks of the Sissaboo, and from that south-east towards the north-eastern tributaries of the Tusket.* This is probably the best tract of timber to be found in the western part of the province. Pine is very scarce, and spruce is almost the only tree used by the lumbermen. This also is lessening at a rapid rate, and it will not be long before the now despised hemlock and fir will be the principal resource. Hemlock exceeds many times in quantity the combined spruce and pine, and in some parts of this region grows to a huge size. Timber lands.

Between the Sissaboo or Weymouth River and Annapolis Basin, about Digby, the land is as a rule more elevated than to the westward of the first named stream, and as a whole less inviting. Much of it has the character of a gently undulating elevated plateau, but near the town of Digby it becomes broken up into a number of separate hills, separated by trough-like valleys. The soil is in many places a sandy loam, in some parts fertile and especially adapted to the culture of fruit, but more commonly coarse and gravelly, while over large tracts the abundance of scattered stones, or imperfect drainage, determining swamps and ponds, render it nearly or quite unfit for cultivation. The larger Tract between Sissaboo River and Digby.

*These and the other notes given as to the nature and distribution of timber are largely based on observations of W. H. Prest.

part of the district has been deforested, but groves of spruce and birch are met with here and there, while over the more barren tracts the vegetation is mostly confined to alders and ericaceous shrubs. Along the shore of St. Mary's Bay, where the possibility of fishing partly makes up for the want of productiveness in the land, the district is somewhat thickly populated, and there are also many good farms along the slaty belt extending south-westward from Jordantown; but between these two the country, being underlain with quartzites, is for the most part uninteresting and unproductive.

Shore of St. Mary's Bay.

Annapolis Valley.—The portion of this valley coming under review in the present connection is that which is included in Annapolis county, extending from the head of the basin of the same name to and a little beyond Middleton. Only portions of it have been subjected to critical examination, but its features would seem to be very uniform throughout.

Form of Annapolis valley.

In a general way the sides of the valley exhibit distinct parallelism, the one constituting the North and the other the South Mountain range, but both exhibit in detail many irregularities, in the form of projecting spurs or re-entering valleys. The moment, however, that the true bottom of the main depression is reached, this is found to vary but little from horizontality and to be sharply contrasted with its bounding ridges. It is rarely the case that any rocks *in situ* are disclosed, and except near the hills there are but few boulders. The soil is often sandy, especially in the neighbourhood of Middleton, but considerable tracts are also underlaid by clay, which is largely used in the manufacture of bricks. Both kinds of soil are remarkable for their exceeding fertility, and especially for their adaptability for fruit growing, the vast orchards of apples, as well as the vigorous growth of all kinds of crops, fully justifying the appellation of the "garden of Nova Scotia" by this which and the region continuing it to the east-ward, is commonly known.

Soils.

Fertility.

Drainage.

Through that portion of the valley included in this Report, and mostly near its centre, runs the Annapolis River, receiving various tributaries, such as Torbrook, the Nictau and the Laquille; while directly into Annapolis Basin flow the more considerable streams of Moose River and Bear River. From above Middleton to Lawrencetown the Annapolis River is fresh, but beyond that point is affected by the tide, and prevented from overflowing its banks by artificial dykes. It is probable that the whole region has been, in post-glacial times, an arm of the sea, as attested by the fact that the brick clays

Former submergence.

of Middleton contain layers filled with marine shells, together with remains of star-fishes (*Ophiopholis*). Probably no portion of the bed of the valley westward of Middleton is even now more than thirty feet above tide-level.

In this connection some reference may be properly made to the isthmus separating Annapolis Basin from St. Mary's Bay, at one time no doubt its direct continuation. Uniting Digby Neck with the mainland, this isthmus has a breadth of from three to four miles, with a length, from bay to bay, of about six miles. Its elevation, on the eastern side, or near Digby, is considerably greater than that of the Annapolis valley proper, and it is also much more irregular, the general level, as on Racquet Hill, where it is crossed by the conduit pipes of the Digby water-works, being 175 feet, but to the westward the land slopes gradually away, until at the head of St. Mary's Bay it becomes continuous with extensive tidal flats. Yet here, too, an exception is found to the so-called "sea wall," six miles from the town of Digby, where the shore, for half a mile or more, presents a series of perpendicular bluffs, one hundred feet or more in height.

Isthmus between Annapolis Basin and St. Mary's Bay.

Elevation.

The soils of this isthmus are similar to those of the Annapolis valley, being usually sandy, but capable, when properly tilled, of affording an abundant harvest.

Soils.

At the head of St. Mary's Bay, on the farm of Walter Nichols, is a marsh beneath which is a bed of soft black mud, five feet in thickness, and having at its base a bed of oyster shells. Beneath this again is a layer containing leaves, which are probably of birch or beech. It is now forty or fifty years since oysters have lived in St. Mary's Bay, and their occurrence here in a fossil state is one of several instances marking not only a former depression of this part of Nova Scotia, but somewhat different climatic conditions in its coast waters. The sea is again making inroads on the marsh referred to, indicating a second depression.

Evidences of submergence.

The South Mountains.—This designation properly includes the great central granitic axis of the Nova Scotian peninsula already described, but with reference to the Annapolis valley and for the purpose of this report is restricted to the belt of high land which, as opposed to the North Mountains, overlooks the said valley from its southern side. At several points and for considerable distances, as between Clementsport and Annapolis, and again about Round Hill, Paradise and Williamston, the granite itself borders or sends spurs into the valley;

Northern border.

but elsewhere the hills consist to a large extent of slates and associated quartzites, determining quite a different physiography.

Elevation.

In general the rise from the valley to the hills is abrupt and not unfrequently steep, the mean elevation attained being probably between four and five hundred feet. The steepest slopes as well as the highest elevations are south of Lawrencetown, and again south of the Torbrook, where in one instance it is possible to look over the summit of the opposing North Mountains to the Bay of Fundy and the distant shores of New Brunswick. Owing to the steepness of the slope, ascent has usually to be made along the valleys of water-courses, which, as in the case of Moose River, Bear River, the Nictor, &c., have cut their way deeply into the comparatively soft slates. The tributaries of these rivers, as well as the smaller streams, often exhibit the same ravine-like character, but elsewhere the land above the summit level is comparatively flat, or with but slight undulations. Owing to the softness of the slates the soils are usually deep and good, and have been very generally utilized. But little land remains uncleared.

Drainage.

Soils.

The North Mountains and Digby Neck.—Though separated by the transverse gap known as Digby Gut, these two are essentially the same in their physical as they are in their geological aspects, while the same is also true of what is their obvious extension in Long and Briar islands. As a much more complete study has been made of the portion of the range westward of the Gut than that to the eastward of it, the following descriptions are for the most part confined thereto.

Digby Neck.

Digby Neck, together with the extension in the islands named, is undoubtedly the most remarkable tract in the district to which this report relates, presenting unusual features alike in its contour, its relief, its climatal conditions and its botanical characteristics.

Form.

Connected with the mainland by the narrow and relatively low isthmus, already described, at the head of St. Mary's Bay, it extends south-westerly in the form of a long, narrow but prominent ridge, separating the waters of that bay from those of the Bay of Fundy, the total length from the Gut to the Petite Passage being nearly thirty miles, to which Long and Briar islands would add about fourteen miles more. Excepting the isthmus referred to and a few minor indentations, the northern and southern shores of the entire tract are very nearly straight, and trend about north-east. They are also essentially parallel, the distance separating them varying but little from two miles, though, in relation to the Neck, Long Island as a

Dimensions.

Parallelism of sides.

TRAP BLUFFS NORTH ENTRANCE OF PETITE PASSAGE, NEAR TIVERTON, N. S.

whole stands a little farther to the north than the former, and Briar Island again a little to the north of Long Island, as though each had been pushed slightly out of place with reference to the other. The two shores are also much alike in character, being almost continuously rocky, but the south shore is in general both higher and bolder than that upon the north. Both shores again present numerous views of coastal scenery of remarkably picturesque character. This feature is familiar to travellers as seen in the high ridges overlooking Digby Gut, and is again exhibited about Gulliver's Cove, but becomes much more striking in the vicinity of the Petite Passage and along the southern sides of Long and Briar islands, where, in addition to the generally high and abrupt character of the shore, the columnar and castellated structure of the rocks and their irregular carving by the action of the sea, produce scenery which in some degree recalls that of the Giant's Causeway in Ireland. In the case of the Petite Passage, the effect is greatly heightened by the large size and grotesque aspect of the boulders perched upon the summit of the bluffs overlooking the picturesque little village of Tiverton, as well as by the aspect of the powerful tides which sweep through this passage to and fro, as through a sluice, and with such rapidity and strength as to cause, when opposed by the winds, tumultuous seas and whirlpools such as can only be safely traversed with the aid of steam.

Coastal scenery.

Petite Passage

Tidal flow.

In the case of Digby Neck proper, a noticeable feature in its topography is the occurrence, at a number of points, of indentations breaking for short distances the continuity of the shore. The "coves" thus produced are of the highest importance to the occupants of the peninsula, as affording the only available means of ready access from the high land to the shore, as well as the only harbours of refuge from the perils of the sea. They are at once more numerous and of larger size upon the southern than upon the northern coast, the most important being Sandy Cove, Mink Cove and Little River, all of which are the seats of thriving settlements. Even when no marked break occurs in the coast-line, the contour lines of the main ridge show numerous indentations.

"Coves."

A section or profile of almost any part of Digby Neck would show its surface to be not less peculiar than its contour. One such natural section is afforded by Digby Gut and another by Petite Passage ; but the best of all is that of the similar though less deep trough at Sandy Cove. At Digby Gut the abrupt ascent of the land from the water level is well exhibited, as is also the fact that the Neck is but the westward prolongation of the ridge which, to the eastward of the Gut, constitutes

Relief.

the so-called North Mountains, extending to Blomidon and Minas Basin; but at Sandy Cove the whole structure of the peninsula is admirably revealed. As viewed to the westward from the high and precipitous bluff which overlooks the depression in question, the surface of the land, as far as the eye can reach, reveals a series of prominent ridges so arranged as to resemble in appearance successive steps, or a serrated outline, in which the successive sheets of rock slope gradually to the northward at angles of 5° or 6°, while in the opposite direction they terminate abruptly in steep hills or mural fronts. One result of this structure is the zoning of the peninsula with approximately parallel belts of prominent ridges, often bare of vegetation, separated by intervening depressions in which the soils are deeper and which are the principal seats of cultivation. Another result is seen in the direction and character of the drainage, the troughs referred to being in some instances occupied by meadows or long narrow lakes; while still another result is the rising of the land on the northern or Bay of Fundy side by a gentle slope from a comparatively low shore to the point of maximum elevation (about 250 feet), while upon the southern the ascent is much more abrupt, even the highest hills here rising directly or even perpendicularly from the sea-level.

View at Sandy Cove.

Features of relief.

Drainage.

Contrast of slopes.

A peculiar feature in the case of the transverse valleys to which reference has been made, is the fact that while oblique rather than rectangular in their relations to the trend of the peninsula itself, they are at the same time parallel to each other, and run in a direction about true north, which is that of the prevalent glaciation in the region. In the case of Digby Gut it was long ago suggested by Sir J. Wm. Dawson that that channel probably owed its origin to the currents of the Ice period; and though glaciers are not now usually regarded as *originating* such channels, ice of this nature probably had an important influence in modifying the features of the Gut, as it did those of the Grand and Petite Passages, and in a lesser degree, the valleys of Sandy Cove, Mink Cove and Little River. In the case of Sandy Cove the bottom of the trough is now occupied by deposits of sand, the higher beds of which are about 150 feet above high tide level; but it is not improbable that this trough, like that of Petite Passage, may have been at one time wholly occupied by water. In the case of the passage last mentioned, sand and gravel beds are also a conspicuous feature, especially upon the eastern side, where they form the high and steep hills about the ferry landing, but they are less marked on the Long Island side, while the depth of the channel is said to be about 100 feet.

Transverse valleys.

Origin of transverse valleys.

Boulders about Petite Passage.

Reference has already been made to the remarkable character and position of the boulders which crown the hills overlooking the Petite Passage. It is difficult to account for these peculiarities. As seen upon the summit of the bluffs above the road leading from Tiverton to the lighthouse, and as represented in the accompanying photograph, they attain in many instances enormous proportions (30 to 40 feet in diameter) and are piled together in a most irregular and often fantastic way. Their general appearance and arrangement is such as would naturally be expected at the base of high and precipitous cliffs from which they had been detached by the action of frost or the undermining power of the sea; but these rest loosely upon the very top of the bluffs, and are most numerous as well as of the largest size upon the edge of the latter. They are also wholly wanting upon the eastern side of the passage. They are all composed of trap, and they resemble the beds on which they rest in the character of the veins by which they are conspicuously traversed, showing that they have not been derived from a distance; but unless it be supposed that they represent something of the nature of a lateral moraine, formed in connection with a glacier once traversing the passage, and completely filling the latter, it is not easy to account satisfactorily for the peculiar features they present.

Erratics.

In this connection, it is interesting to notice that some very large boulders besides those of trap are to be seen in the vicinity of Tiverton, but at a much lower level than these noticed above. One of them, not far from the Tiverton post-office, and not more than thirty or forty feet above the waters of the passage, has diameters of fifteen and twenty-five feet, and is composed of a dark-gray felsite-conglomerate, closely resembling in aspect many of the rocks found in the so-called Huronian of southern New Brunswick, but which have not yet been observed in any part of south-western Nova Scotia. Granite boulders, but of moderate size, were also observed in several instances both here and on Briar Island.

Glaciation.

Glacial markings are of comparatively rare occurrence upon Digby Neck. They have, however, been observed at a number of points, some of which are of special interest as bearing upon the time and circumstances of the evolution of the surface features of the region. Among these may be mentioned in particular certain striæ observed at Israel Cove near the southern part of Petite Passage. They include both ordinary striæ and broad groovings, both of which run across the tops of the denuded trap columns, which are here prominently developed, with a course S. 40° W. (mag.). They are only about ten feet above high-water mark and fully 100 feet below the level of the highest banks which border the passage on either side, and would therefore seem to indicate that whatever the origin of the passage, it has at some time been traversed and scored by glacial ice to at least one-half its present depth. The post-glacial deposits of sand and gravel which overlie them, and which thence extend down much of Long Island, are distinctly stratified, and show a succession of fairly well defined terraces, the summit of the highest one being about 150 feet above tide-level.

Post-glacial deposits.

Supposed conditions of glaciation.

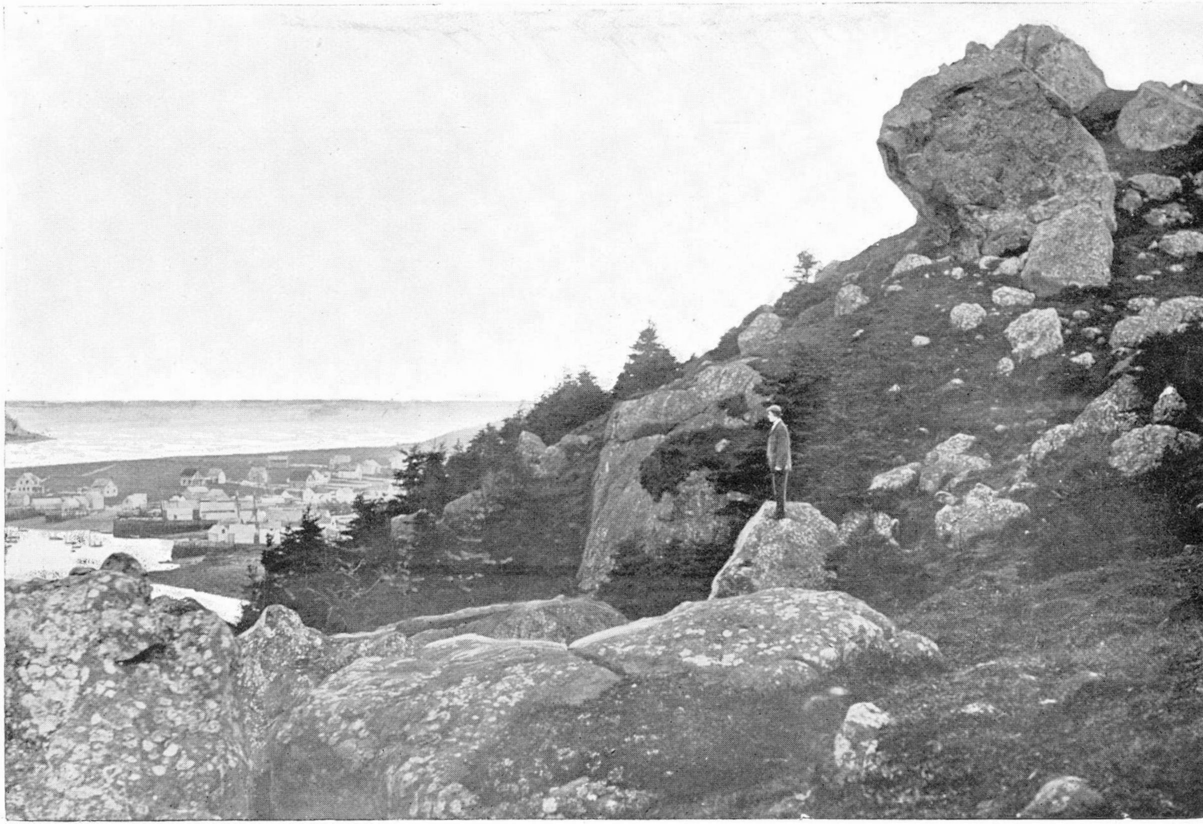
As in other parts of south-western Nova Scotia the facts connected with the glaciation of Digby Neck are, in the opinion of the writer, best explained upon the supposition of submergence beneath a continental glacier moving southward and bringing débris even from the other side of the Bay of Fundy, followed by a period of more local and restricted distribution, when the higher portions of the peninsula became themselves the centre of the movement, the latter now occurring in all directions.

Climate.

It may be supposed that in a district so peculiarly situated and possessing such a structure as that of Digby Neck, there should be corresponding peculiarities of soil and climatal conditions, and these should be reflected in the nature and distribution of vegetation. Thus, while no portion of the peninsula is distant more than a couple of miles from the sea and its climate is therefore essentially insular, being subject to frequent fogs and abundant rainfall, yet such is the difference of elevation of its lower and upper portions that the one is often enveloped in mist at the same time that the other is exposed to the full glare of the sun. Again, the fogs are more generally prevalent upon the Bay of Fundy shore than upon that fronting St. Mary's Bay, and this difference, together with that of exposure respectively to cold northerly and warmer southerly winds, determine more favourable conditions of growth upon the one side than upon the other. It is true that the north side of the peninsula is more generally covered with woods than the southern, but this is largely for the reason that there is here less inducement for their removal, the soil being of poorer quality and the conditions of existence more severe. The contrast referred to is seen in the nature of the vegetation quite as much as in its amount, the trees throughout the northern tracts being more largely evergreens than those of the central and southern belts, while in approaching the Bay of Fundy, shore the marked dwarfing of the trees, as well as the increasing abundance of low straggling or prostrate shrubs, bear abundant evidence of a struggle against unfavourable

Contrast of northern and southern shore.

Contrasts in vegetation.



TRAP BOULDERS ON BLUFFS ABOVE TIVERTON, PETITE PASSAGE, N. S.

environment. So marked indeed are the contrasts sometimes exhibited that in the case of a valley like that of Sandy Cove, sheltered on either side by high hills, a distance of half a mile or less is, in the summer season, often quite sufficient to effect a transition from a warmth which is almost tropical to a temperature which by contrast is as decidedly frigid. In the little lake which lies at the bottom of this depression the white water-lily (*Nymphæa odorata*) may be seen in luxuriant growth, while almost in sight, at the northern end of the valley, the cliffs are clothed with saxifrage, *Sedum Rhodiola*, and other plants, of boreal types. It may be added that upon the warm southern sides of the trappean hill were observed, as late as the end of September, numerous blossoms of *Gerardia purpurea*, a plant rarely met elsewhere in Nova Scotia, and not known in New Brunswick. **Rare plants.**

Cambrian System.

In describing the rocks referred to this system, it is necessary to observe that they occur in widely different conditions in different parts of the area examined, and yet with so many features in common as to leave no doubt as to their essential identity. Thus over extensive areas the rocks in question exhibit evidences of profound metamorphism, while in others equally extensive they are comparatively little altered. In Queen's county the highly crystalline rocks are mostly confined to the neighbourhood of the coast, but in Shelburne county they are found in the interior as well. In Yarmouth again the rocks of this system are in general highly metamorphic, while in Digby comparatively unaltered strata prevail. Between the altered and unaltered portions of the system it is, however, impossible to draw any distinct line of demarcation. They pass into each other by insensible gradations, they exhibit a similar sequence of beds, and are equally destitute of ascertained fossils, their reference to the Cambrian system being therefore only provisional. With the more metamorphic portions areas of granite, as already noticed, are of frequent occurrence, and their condition is no doubt due mainly to the circumstances in which the latter had its origin. **Varying aspects.** **Absence of fossils.**

From a careful study of the sequence of the supposed Cambrian strata in Queen's county, a sequence which is almost exactly paralleled in Digby, but which, owing to metamorphism, is less obviously seen in Shelburne and Yarmouth counties, their succession would appear to be as follows, in ascending order :— **Sequence of strata.**

Ascending Succession of Cambrian Strata.

I. Quartzite Division.

(*a.*) Heavily bedded bluish quartzites, alternating with much thinner beds of gray argillite.

(*b.*) Greenish-gray sandstones or quartzites, somewhat chloritic and less massive than in (*a*), and alternating with slates which are arenaceous below but become progressively more argillaceous above.

II. Banded Argillite Division.

(*a.*) Greenish-gray slates, becoming bluish or light-gray, and passing upwards into—

(*b.*) Purple slates, marked in the lower beds by pale, yellowish-green seams, with faint bedding lines, which are wanting in the higher beds.

(*c.*) Bluish-gray and gray slates, often with cloudings of green, purple, lilac, buff or yellow, in places exhibiting a conspicuous banding or ribbanding of the beds.

III. Black Slate Division.

Black, with some blue or gray slates, often studded with cubes of pyrites, and very rusty-weathering.

Effects of metamorphism.

The above divisions are those of a region comparatively little altered, such as the interior of Queen's county and the neighbourhood of Digby. Where the metamorphism is more extreme, as through the whole of Shelburne and much of Yarmouth, the strata present a somewhat different aspect. The two main divisions are still usually recognizable, but the minor differences disappear or show themselves only in other forms; the quartzites becoming, through an increase in the amount of mica, a sort of fine-grained gneiss, while the argillites become mica-schists, marked over large areas by the abundance of staurolite, andalusite and garnet developed in them. Finally, along certain well defined belts, as in the centre of Yarmouth county, the beds become very hornblendic as well as chloritic, assuming at the same time something of the character of conglomerates, a feature elsewhere of very rare occurrence. In most instances the degree of metamorphism is in direct relation to the occurrence of masses of intrusive granite.

Plications.

Throughout the district under consideration, the strata above described have been affected, in common with those of similar character in other parts of Nova Scotia, by the great series of earth movements which from time to time have influenced the rock formations along the whole eastern coast of America. As the result of pressure, coming in all probability from the direction of the Atlantic, the strata have been thrown into a series of more or less numerous folds, the prevalent direction of which is north 45° east, or approximately parallel to that of the coast, but with evidence also of other and probably later movements whose direction has been transverse or oblique to the former. Under the combined influence of the two pressures thus exerted, the whole district occupied by the Cambrian rocks has been made to present the appearance of an extensively warped or wrinkled surface, the irregular denudation of which has left the harder rocks, chiefly those of the quartzite group, to form a series of domes or ridges, usually "Domes." anticlinal in structure, around which are enwrapped the remains of the higher and less resisting slaty beds. In general these ridges are elliptical or ovoid in outline, but some are greatly elongated, while others again are so greatly contracted as to present a form which is nearly circular. Along the axes of the folds the dips are usually high, and regular for considerable distances, but in approaching the intervening Minor flexures. Faults. synclines the dips rapidly become less, and the strata either approach horizontality or become the subject of innumerable and complex minor flexures. Evidences of faulting are also not uncommon, though no dislocations of great magnitude have as yet been recognized.

From their importance in connection with the subject of gold-mining, much time has been devoted to the working out of the position and relations of the various anticlinal folds just noticed and to their correct delineation.

As will appear by reference to the map accompanying this Report, the anticlinal domes of Queen's county tend to group themselves along three or perhaps four nearly parallel zones, in each of which "whin" Zones. or quartzite is the prevailing rock, while the intervals are in most instances strongly marked by the occurrence of the black pyritous slates of Division III. of the system. In Shelburne these upper dark and slaty beds appear to be wanting, except at a single locality near its eastern boundary, but reappear to some extent in Yarmouth, and are again conspicuous in Digby.

In the following descriptions the quartzite division is first considered, and later the slate divisions of the Cambrian system, in the four counties under review, in the order above alluded to.

I. Queen's County.

DIVISION I, QUARTZITE DIVISION.

Quartzite and Green Slate Groups.

1. Central or Molega-Rossignol Belt.—This belt stretches east and west across the width of Queen's county, extending in one direction into the county of Lunenburg, and in the other into that of Shelburne. It includes the region about Molega and Ponhook lakes, as well as a portion of that bordering Lake Rossignol, while within it are also found the important mining centres of Molega, Whiteburne and Brookfield. As a belt, it is limited north and south for the greater part of its length, by the black slates of Division III. and has an average width of eight or nine miles. It is, however, broken by several subordinate flexures into a number of smaller areas of more or less elliptical outline, marked by the encircling of quartzite tracts by zones of green slates, as well as by the varying dips of both. The most important of these quartzite areas are:

Limits.

Subdivision into areas.

(*a.*) The Molega area.
(*b.*) The Whiteburne area.
(*c.*) The Rossignol area.
(*d.*) The Brookfield area.

Molega area.

The form of the Molega district (which is typical of the whole Cambrian system in this portion of Nova Scotia, and which will therefore be somewhat fully described) is that of a somewhat broad ellipse, the greater diameter being about thirteen and the lesser or transverse diameter about six miles. At its eastern extremity, in the county of Lunenburg, it is separated only by a narrow band of green slates from a nearly circular dome of quartzites occurring about the Pleasant River mines, and is similarly bordered on all its sides, though to the westward, towards Lake Rossignol, the difficulty of access and want of exposures have prevented its exact delimitation.

Quartzites of Molega mines.

Minerals.

As seen at the Molega mines, the rock which makes up the great bulk of the deposit (Div. I *a.*) and which is locally known as "whin," is seen to be a massive fine-grained quartzite of nearly uniform gray colour, and occurs in beds varying from two to thirty or more feet in thickness. The quartzite is almost everywhere slightly micaceous, and crystals or nodules of pyrite, galena and arsenopyrite are also usually present, the latter often quite abundantly. With the quartzites, however, slates or argillites are also found to occur, though they are relatively much thinner, usually not exceeding three or four feet, and often forming mere partings between the coarser strata. When these are present the attitude of the beds is very easily ascertained, especially if the inclination is high, but where it is at lower angles and the slaty partings are wanting, the determination of the true dip is often a matter of considerable difficulty. From observations made it seems probable that between the northern and southern limits of the belt there are several minor undulations, subordinate to a general anticlinal structure; but throughout the peninsula separating Ponhook and Molega lakes, as well as around the other shores of these lakes, and in the adjacent country east and west, little is seen but boulders with occasional ledges of massive whin or quartzite. Interbedded slates.

In passing in either direction from the axial line of the quartzite area above described, the rocks become less massive and include a larger proportion of slaty beds, which at the same time assume a more or less conspicuous greenish tint, due apparently to the fine dissemination of chlorite. Within the limits of the belt under review these green slates (Div. I *c.*) are the highest strata met with; but north and south of the main belt they are in each case followed by the coloured and black pyritous slates of Divisions II. and III. Passage from quartzites to green slates.

A second area, closely resembling that of Molega, is that of Whiteburne. Its centre is about ten miles to the north-west of the centre of the first named district. It is, however, somewhat smaller than that of Molega, the longer axis, which extends from near Cameron's Lake to the head of Lake Rossignol, being a little over eight miles, while the breadth (between the Christopher Lakes on the south and Whiteburne settlement on the north) is a little more than three miles. The strata here are better exposed than about Molega, and both about the Whiteburne mines and along the road leading south from the latter to the Christopher Lakes, they are seen for a distance of nearly two miles, rising from the barrens in a series of parallel and very prominent ledges, with a nearly constant dip throughout, about N. $<$ 30° to 40°. From the facts observed here, as well as other points, it seems probable that the thickness of this division of the Cambrian system cannot well be less than 5000 feet and may be much more. Whiteburne area. Dimensions. Thickness of quartzites.

A third area of quartzites, with surrounding green slates, is indicated as existing to the west of Lake Rossignol, and includes a part of this large sheet of water. About one half of the area is in Queen's county (where quartzite ledges may be seen at "The Screecher" or Lake Rossignol.

"Thoroughfare"* between Lake Rossignol and the fourth lake, as well as at the similar "thoroughfare" at the head of the second lake) and about one half in Shelburne county. In the latter county, however, the tracing of the beds is very difficult, partly from the infrequency of exposures and partly for the reason that the rocks here assume a metamorphic character and are less readily recognizable. An exploration of the region lying between Lake Rossignol in Queen's county and Lake John in Shelburne was made by Mr. Lee Street, my assistant, in 1891, and the following summary from his notes will indicate the general nature of the country, as well as of such few exposures as were observed.

Lake John.

Starting from Lake John, an expansion of the Jordan River, a one-mile portage over low flat land, without exposures, leads to Lake Grande. From this lake to Rush Lake the distance is about one-fourth of a mile, whence to Jordan Great Lake there is about half a mile of marshy ground. From this lake there is a portage of a quarter of a mile to Silver Lake, through hemlock woods; from Silver Lake to Sixth Lake half a mile; from Sixth to Codd Lake a quarter of a mile; and thence one mile to a small brook, two miles long, leading to the Fourth Lake of Rossignol. The only exposures seen were on Jordan Great Lake; one, opposite a large island upon the eastern shore, being of slate spotted with small crystalline specks (Dip N. 5° W. < 85 and another, also on an island in the same lake, being of a gray micaceous sandstone. These evidences of metamorphism are the result of proximity to granitic masses, one of which at Lake John is clearly indicated by the enormous boulders of this rock which strew its northern shore, its southern side at the same time exhibiting ledges of gray micaceous sandstone with dull crystalline specks. The metamorphic strata of Shelburne county will be further considered later.

Jordan Creek Lake.

Brookfield area.

Still another area of quartzites included in the belt under consideration is that of Brookfield. It is directly north of the Molega district already described, and is separated from it by only a narrow band of green slates. As shown in the sequel it has recently acquired much importance as a gold producing centre. An admirable section of the quartzite portion of the series is made by the Port Medway River at and below South Brookfield, while to the north of this place, as well as along the road leading to North Brookfield, the overlying slates are prominently exposed. The chloritic character of the latter is especially well marked in the rocks traversed by the auriferous quartz veins of the North Brookfield mines.

*Local name for a narrow pass connecting two lakes at the same level.

2. The Southern or Port Medway and Liverpool Belt.—About three miles south of and parallel to the great Molega-Rossignol belt of quartzites and green slates, a second belt of similar rocks is again found to traverse the whole of Queen's county. It enters the latter from Lunenburg county, where it includes the gold-fields of Malipsegate Lake, and extends into Shelburne county until by metamorphism its identity is lost. On its northern side it is separated from the belt previously noticed by a well defined band of black pyritous slates (Division III.) extending from Greenfield through the northern part of Middlefield, to the Indian Gardens at the foot of Lake Rossignol, and to the south of this belt includes all the area thence to the coast. In this direction, however, it becomes increasingly metamorphic; and at various points, both in Queen's and in Shelburne counties, is invaded by massive granite. It has also, like the belt previously noticed, been the subject of subordinate flexures, and partly from this cause and partly from varying erosion, has been subdivided into a number of more or less separate areas in which domes or elliptical folds of quartzite rock, having a general anticlinal structure, are encircled and isolated by concentric belts of slate. Of these quartzite anticlines, three lie to the eastward and three to the westward of the Liverpool River, the latter for the most part traversing the area which marks their line of junction.

Southern belt.

Limits.

Minor folds.

Of the areas to the eastward of the Liverpool River, the most northerly is that of Middlefield, and is traversed by the Port Medway River between Barry's Falls and Eight-mile Lake Brook, thence extending easterly into Lunenburg county and westwardly to the Liverpool River in the vicinity of Long Lake; the second is also traversed by the Port Medway for six miles north of Mill Village, and reaches the Liverpool River just south of Milton; while the third occupies the area south of Mill Village and about the shores of Port Medway Harbour. Of those west of the Liverpool River, the first lies between the head of Broad River and the county line of Shelburne; the second lies directly south of the last and embraces all the middle portions of Broad River; and the third, of small extent, borders the granite along the north side of Port Mouton Harbour. Throughout this belt the rocks are much more metamorphic than those of the middle or Molega-Rossignol belt. The quartzites are often quite micaceous and graduate into fine-grained gneisses, while the finer beds are represented by mica-slates, often conspicuously spotted by the development of crystalline minerals in their mass, such as mica, staurolite or garnet. Further facts relating to these metamorphic strata will be given in the sequel.

Middlefield area.

Mill Village.

Broad River.

Port Mouton.

3. Loon Lake Belt.—A third area, in which quartzites are the prevailing rock, but of more limited extent than those already noticed, is found in the northern part of Queen's county along the course of the Liverpool River, south of Fairy Lake. It is well seen in the vicinity of Loon Lake and for a mile or two below, where its outcrop, with a northerly dip of 45°, forms Loon Lake Falls. The area is probably small; for while the width on the river is hardly two miles, being followed both north and south by bands of blue slates, it is similarly surrounded by the latter in the direction of West Caledonia; and in the opposite direction, the occurrence of granite about the Tobeatic and associated lakes would show that it is here cut off by the latter rock.

Loon Lake.

4. Maitland Belt.—Finally, a fourth band of quartzites is found to limit the entire Cambrian area upon the north, bordering the southern edge of the granites in Annapolis county. This band crosses the Liverpool and Annapolis road at the Twin Lakes, one mile and a half north of Maitland settlement, and is well exposed at the falls of the Liverpool River, whence it sweeps around through Northfield to Tupper Lake. Along the northern half of the shores of this lake, ledges of micaceous quartzite are seen, skirting a southwardly projecting granite tongue.

Maitland.

DIVISION II. BANDED ARGILLITE DIVISION.

The strata referred to this division of the Cambrian system and embracing several minor subdivisions (see p. 28 M) cover considerable areas in Queen's county. The largest is in the northern part of the county, where rocks of this character cover the greater part of the district lying between Tupper Lake upon the east and the Annapolis post-road upon the west. Thence they extend north to Fairy Lake in Annapolis county. They underlie for the most part the settlements of Rosette, Westfield, Harmony, West Caledonia, Kempt and Grafton.

Distribution.

Owing to the comparative softness of these rocks and their ready disintegration, they often produce soils of considerable fertility; but they also often present only broad bare ledges of rock, while the abundance of loose blocks of argillite or the occurrence of kames or horsebacks, determining imperfect drainage, detract materially from their capacity for successful tillage. As usual the region abounds in lakes, including Tupper Lake (in part), Minard's Lake, Eel Lake, Fairy Lake and others.

Surface features.

A second, but smaller area of such rocks occurs near Pleasant River, the strata being well exposed in Pleasant River village and along the several roads converging at that point. As this latter is a typical region and that in which the relations of these coloured slates to other members of the Cambrian system was first clearly made out, it will now be more particularly described. Pleasant River.

The passage from the quartzites of Division I. to the banded slates is well seen in approaching Pleasant River from the west. In the barrens near Waterman's Brook are numerous exposures showing an always increasing amount of greenish-gray slate as we go east, while this in turn is gradually changed to purplish-gray or bluish-gray, the dip remaining the same, though the beds become subject to frequent and sudden corrugations. At the Pleasant River bridge on the New Elm road, the rocks, though the same in general character, become finely striped, and through much of the region this feature is a conspicuous one. As seen on Pleasant River above the bridge, some bands are of a purple tint with fine light-coloured pea-green seams, while others are greenish with fine light-coloured seams. Similar strata would appear to occupy all the valley of the stream above Pleasant River village, except that, about two miles below Sugar Lake, the bluish slates are first associated with and then replaced by the black slates, probably marking the centre of a syncline. Further north the succession is reversed, and bluish and gray slates are again found between the black slates and the quartzites which immediately border the granites of Annapolis county. Transitions similar to the above may also be seen in the southern part of the Pleasant River basin. Here the beds are further remarkable for their almost horizontal attitude over large areas. The transition referred to is partly one of colour and partly one of texture, the gray slates, owing to an increasing admixture of purple colouring matter, getting gradually darker until this latter tint becomes predominant, and at last exists to the exclusion of all but an occasional light, yellowish-green band; the purple slates being themselves succeeded by lighter gray bands, and finally by greenish-gray bands alternating with gray quartzite. Passage beds. Pleasant River. Horizontal beds.

One particularly distinctive feature and strong point of resemblance between nearly all the rocks of the Pleasant River syncline, is the intercalation of narrow contorted bands of finely laminated material. These bands are never more than two and a half or three inches thick, and never less than three-fourths of an inch. They are separated by from one to four or five feet of fine-grained sandstone or quartzite. The colour differs somewhat in different places, but is usually lighter Colour bands than the inclosing quartzite. The general colour ranges from purple to purplish-gray, bluish-gray or slightly greenish-gray, and also light- and dark-gray, but through all there can be traced the narrow, contorted and laminated bands referred to above. Another feature, quite as distinctive, is the presence at wide intervals of light, yellowish-green bands, one to two inches thick, in the purple slates. These are limited to the upper part of the said slates and are an unfailing guide in their recognition.

Corrugations. The stratigraphy of the Pleasant River district is very complicated and at first somewhat puzzling, some portions showing beds remarkable for their high dips and frequent corrugations, while in other parts the beds are nearly or quite horizontal. At some points, however, a complete gradation of dips may be seen from 40° to 0°, the beds evidently occupying the same geological horizon.

Syncline. On tracing Pleasant River south from the Tory Bridge on the New Elm road, the greenish-gray and bluish-gray slates are seen to form a shallow basin. This coincides very fairly with the course of the river, and is the syncline dividing the Molega quartzite dome from that which occupies the Pleasant River barrens. The dip on the west of the syncline is far steeper than on the east side, where for some distance the beds are almost flat. There is, however, on the east side, at first a slight inclination to the north-west, then to west, and finally south-west (*mag.*) corresponding with the western curve of the dome which occupies the Pleasant River barrens. Going east from this intermediate syncline, the horizontal beds gradually assume an inclined position around the western end of the dome last mentioned. They are surrounded and overlain conformably, on the northern side, by the purple and blue slates. In the syncline the purple slates are not seen, as they are cut off by the elevation of the greenish-gray slates from beneath. The contortions and apparently unconformable dips of the slates are plainly owing to pressure between the two anticlines mentioned, as well as to force exerted in a direction from the North Brookfield anticline. East and west of this interruption the gray, purple and blue slates continue their usual orderly sequence.

Port Medway River. The relations above described in the Pleasant River district, as well as the conclusions to which they lead, are repeated in the district lying to the west of Tupper Lake and north of Caledonia. This tract is traversed in a north-and-south direction by the Port Medway River, and its valley affords an admirable section of the underlying rocks. The great granite area in which this stream takes its rise, and which, east of Tupper Lake, descends quite to the foot of that sheet of water, on the Port Medway River is wholly confined to Annapolis county, its southern border being to the north of De Long settlement, and about five or five miles and a half south-west of the Half-way house on the road to Dalhousie. The rocks which immediately border the granite at this point, like those found around the shores of Tupper Lake, are highly metamorphosed and very micaceous, but appear to have been originally greenish-gray slates with bands of quartzite. They are followed southward, in De Long settlement, by bluish-gray slates, and then by purple slates, the breadth of the former being nearly three miles. Near the granite the dips are rather high, but southward they gradually decline, the beds being spread over large areas in wave-like undulations. On the shores of Dean's Lake, an expansion of the Port Medway, are fine and continuous exposures of purple, banded slates, showing the characteristic yellowish-green bands not exceeding one and a half inch in width, already noticed upon Pleasant River, and here occupying a perfectly horizontal position. South of Dean's Lake, purple and banded slates continue to be frequently exposed as far as McGowan's Lake, on the northern border of Westfield, the dip being sometimes as much as 12° or 15°, but often wholly wanting. The ribbanding is often very conspicuous and the colours varied, including lilac-gray, bluish-gray, greenish-gray, buff, purple, light-gray and white, the proportion being in the order named. South of McGowan's Lake to the Westfield and Harmony bridge, the rocks are chiefly purple slates, often with light-green partings, and with dips which are nearly north at angles varying from 40° to 60°. South of Westfield bridge the dip gradually rises to 80°, and the blue slates hold occasional bands of light-gray with smaller seams of black slate, closely resembling those of Pleasant River. Small quartz veins are seen in the slates and are often charged with pyrites. A little above the junction of the Westfield River with the Port Medway, purple and lilac-gray slates again come in, still with a northerly dip of 75° to 80°, and are followed to the south by blue, black and occasionally light-gray bands, which are the only rocks seen as far as South Brookfield, a distance of about one mile and three-quarters. The black slates are more prominent about the mouth of Westfield River than north or south of it, and are often seamed with small veins of quartz, which, as well as the inclosing slates are pyritous. The succession corresponds on both sides of the black slates, and is similar to that of Pleasant River. Here, as before, the evidence would go to show that the blue and purple banded slates are a part of the Cambrian succession, and that they hold a position above the quartzites and below the black

De Long Settlement.

Westfield.

South Brookfield.

slates. From observations made between Westfield and Brookfield, it would appear that a synclinal fold here intervenes, the order of succession, beginning on the south, being as follows :—

Ascending series.

1. Quartzite—Brookfield anticline.
2. Quartzite and greenish-gray slate.
3. Greenish-gray slate.
4. Purple slate.
5. Bluish-gray and gray slate.
6. Blue and black slate, with gray seams, marking the centre of the syncline, and the highest member of the system.

The section on the opposite page, reaching from the granite to the Brookfield anticline, gives the probable arrangement of the beds, as observed by Mr. Prest :—

Westfield River.

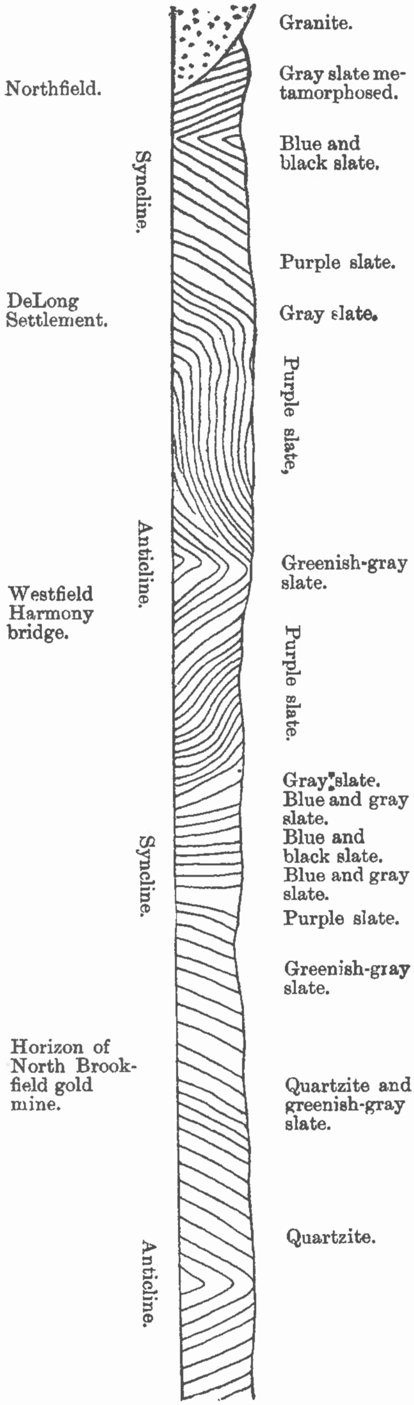
At the mouth of the Westfield River, the slates present the banded appearance already so frequently mentioned, and this feature appears with little variation to the Westfield bridge, south-east of the Westfield or so-called "Jumbo" mine. Further remarks upon the latter will be given in the sequel. Along the whole course of this river the altitude of the beds is nearly vertical. At one point, near the mouth of a brook emptying into the Westfield River, the strata include a deposit of very hard breccia or conglomerate, the cement of which is oxide of iron.

Harmony.

The features of the group of Cambrian strata above described, along the course of the Port Medway River, are repeated to the west of that river over a large part of northern Queen's county. North of the black and highly inclined slates of Caledonia corner (Division III.) the blue and banded slates spread widely in flat or gently undulating beds through the settlement of Harmony, and are well exposed at many points along the Liverpool and Annapolis post-road as far north as Maitland bridge, where the black slates again appear in force. From this point northward the distance to the southern edge of the granite is about three miles and three-quarters, the interval being chiefly occupied by whins in a highly metamorphosed condition.

Little River.

West of Maitland and the Annapolis post-road, another good line of section across the strata under discussion is that afforded by the Little River, between the sheet of water known as the Frozen Ocean in Annapolis county and Keja-ma-kuja Lake, more commonly known as Fairy Lake, on the borders of Queen's county. The tract immediately


Granite.
Northfield.
Gray slate metamorphosed.
Blue and black slate.
Syncline.
Purple slate.
DeLong Settlement.
Gray slate.
Purple slate.
Anticline.
Greenish-gray slate.
Westfield Harmony bridge.
Purple slate.
Gray slate.
Blue and gray slate.
Syncline.
Blue and black slate.
Blue and gray slate.
Purple slate.
Greenish-gray slate.
Horizon of North Brookfield gold mine.
Quartzite and greenish-gray slate.
Quartzite.
Anticline.

bordering the Frozen Ocean and extending thence westerly into Digby county, is occupied by quartzite much altered; south of which, in ascending order, are greenish-gray slates, purple slates, greenish-gray slates and blue slates. The latter border the shores of Keja-ma-kuja Lake, where the slightly inclined but strongly cleaved beds, worn smooth by glacial action, have served to develop the artistic tastes of the early aboriginal races, as well as of their more recent successors. On several of the low points projecting into the lake along its south-eastern side, the surfaces of the rocks are profusely covered with pictorial illustrations of such objects as ships, canoes, deer, dogs, the human hand, etc., mingled with various dates; and although many of these are undoubtedly modern, others, both by their character and their position below the ordinary level of the water, afford strong ground for believing that they are genuine and ancient Indian pictographs*.

Keja-ma-kuja Lake.

Keja-ma-kuja Lake (Micmac for "next big lake") is a fine sheet of water about five miles in length. In addition to the blue slates upon its shores are others showing shades of lilac or purple, but of these there would appear to be two horizons, the lower purple slates being distinguished from the upper purple or lilac slates by their far greater width, by the presence of yellowish-green and dark green seams, similar to those of the beds at Pleasant River, and by a slightly deeper shade of colour. The entire succession as here seen would appear to be, in ascending order:—

Sequence at Keja-ma-kuja Lake.

1. Quartzite.
2. Quartzite and greenish-gray slate.
3. Greenish-gray slate.
4. Lower purple slates.
5. Bluish-gray slate and blue slate.
6. Upper purple slate.
7. Bluish-gray slate.
8. Blue slate, with light-gray bands.
9. Black, blue and gray slate.

To the west of the section above described, it is well-nigh impossible to determine the geological structure with any degree of certainty or completeness, the increased frequency of granite bosses and the associated metamorphism of the strata making the recognition of the

* These have been made the subject of examination by Col. Garrick Mallery, and are described in the Tenth Annual Report of the United States Bureau of Ethnology.

latter difficult; while the drift covering by its abundance and coarseness not only serves largely to hide from view the underlying rocks, but makes travelling through the region extremely arduous. The following extracts from the notes of Mr. Prest will at once indicate the general geological features of the district and the obstacles encountered in its exploration:—

"The southern limit of the granite, after crossing into Digby county, goes about west by south, crossing the centre of Big Liberty Lake, thence on the same course past the head of the Big Meadows on the West River. The quartzite around Big Meadows shows very little metamorphism and every appearance of a farther extension into Digby county. Throughout this whole region the granite consists of black mica, quartz and felspar, the latter in large crystals. The tract shows no soil capable of cultivation, except the meadows which in places border the streams and lakes. The Thomas meadows, near Long Lake, are the largest. Heavy hardwood hills are almost absent, but the barrens are scattered over with young pines from five to fifteen inches in diameter. There seems to be no very young pine springing up, the undergrowth being principally oak. The inference is that when the present lot of pine is cut, the oak alone will form the next forest. This tract, a generation ago, is said to have formed an almost unbroken forest of pine, stretching toward Annapolis. Extensive fires, years ago, have destroyed millions of dollars worth of timber. Thousands of acres of thickly clustered, but bare and burned, white pine stems remain to attest the destruction thus wrought. This tract lies to the north and west of the Frozen Ocean, while still further west are ridges and groves of white pine and hemlock. Hardwood is scarce and the land rough and rocky. South-eastern Digby county. Effect of forest fires.

"Around Liberty Lake, on the line between Digby and Annapolis counties, the country is rough, rocky and full of swamps and barrens, with clumps of woods, in which moose find a home. South of this region, in the neighbourhood of West River, the land is mostly bare of forest. It contains, however, many groves of young pine, which promise to be quite valuable in a few years. There are long stretches of level barren lands of a light mellow nature and almost free from stones. Some parts of them would take the plough at once. The underlying rock is quartzite, merging into slate on the south-east. Fine meadows border the streams here, one of which on the headwaters of West River (in Digby county) yields nearly forty tons of hay. The country abounds in moose, caribou, raccoons, martens, foxes, wildcats and bears, especially the first and last. Beavers were once abundant, but trappers say that now none exist in the region—and but rarely in Nova Scotia. Liberty Lake.

Loon Lake.

"The land between West Caledonia and Keja-ma-kuja Lake has been so often burned that it is quite barren; south of Loon Lake, however, there is a tract of timber land. The barren land reaches about one mile west of Loon Lake, after which it is wooded to the Pescawess and beyond. The land to the east and south-east of Pescawess is very level and beautifully wooded, the oaks being especially fine. Pine and hemlock are also seen, but are scattered. Birch and beech of immense size prevail in some places, but do not equal the oak in smoothness, straightness, size or healthful appearance. On the south-west of Pescawess Brook are fine forests of hemlock, which are now being made use of for lumber. On the east side of the same stream is an abundance of white pine timber, and on the west an abundance of hemlock, spruce, hardwood and white pine. The Norway pines are scarce here.

Pescawess Brook.

"At the foot of Pescawess is an exposure of greenish slate with a little quartzite. The land here, in common with that of the country around, is very rocky. Two horse-backs composed of rough glacial débris run parallel to each side of the Pescawess Brook. The granite comes in about one mile and a half north of the foot of Pescawess, and from here onward (north-west) the land is strewn with immense masses of granite, with thickets of alder, laurel, blue-berry, white birch and poplar, with occasional spruce and hackmatack. Exploration here is very difficult, the whole country north-east of the Pescawess, and thence to Keja-ma-kuja, being covered with huge granite boulders, one of the latter projects like a pyramid 35 feet from the underbrush at its base, while another, standing on the top of a high ridge, is 47 feet long, 22 feet wide, and 15 feet high, with a probable weight of 1050 tons. Progress through this boulder-strewn region, involving incessant climbing over huge blocks, separated only by moss-covered crevices serving as pitfalls, and overgrown with a jungle of alder, laurel and scrub pine, is very exhausting."

From the Pescawess Lake and the Tobeatic River, country similar to the above is found along the county line separating Shelburne and Digby counties to the lakes at the head of the Roseway River. Though equally rugged the surface here presents some unusual features. "A somewhat oval basin, some eight miles in diameter, almost bare of trees and inclosed in a rim of more elevated land, is seen just south of Horse Lake. Its floor is a wide and barren plain, slightly undulating and intermingled with meadows, laurel swamps and scattered copses of white birch and juniper; while over this on every slope and hill, in fact in every part as far as the eye can reach, are strewed granite boulders of immense proportions. They are white and lichen-covered,

Horse Lake.

angular and often tower-like, some standing with the small end down as if a touch would upset them, some firmly rooted and others piled in great groups with bare intervals between. To the north-west are gently sloping plains, destitute of trees, but dotted here and there with boulders so large as to be quite prominent at a distance of four or five miles. It is probable that the area represents the basin of a former lake, of which the water has levelled up the spaces between the rocks, leaving similar collections of boulders on higher land untouched. To complete the desolation fires have cleared off all the trees except a few copses on swampy ground."

Former lake-basin.

The chain of the Roseway Lakes has a general course which is nearly south-west, being approximately parallel to the county line between Shelburne and Digby counties, and to the chain of the Blue Mountains lying along the southern border of the latter. This chain is granite, and between the great basin described above and the Roseway Lake proper, immense ledges of this rock are exposed along the stream. "The porphyritic character, before so pronounced, now disappears and the rock becomes very fine-grained, inclosing at the same time numerous masses of metamorphosed slate. These inclosures become more frequent in going westward, and at the foot of the lake the rock shows a banded appearance, the bands being alternately granite and gneiss. Some large boulders observed here are wholly of the latter rock.

Roseway Lakes.

"A strip of young pine timber is seen to run for some miles along the north side of the lakes and south of the Blue Mountains. It reaches from the western part of the great basin to the north of Roseway Lake. A quantity of pine is also seen on the east side of the Roseway Lake, and the southern side of the same lake is heavily timbered with hemlock. Other trees are scarce above Roseway Lake. Below that the land is more generally wooded.

Timber.

"At the eastern end of the Schoodic Lake is seen the first unmetamorphosed blue or bluish-gray slate. This is followed, going south-west along the shore, by a light greenish-gray slate, showing occasionally a little fine mica. A little farther south-west this changes to greenish-gray sandstone or quartzite."

Owing to the want of reliable maps, great difficulty was experienced in locating correctly the observations made in this complex lake-region, while the exhaustion of provisions made it impossible to spend any considerable amount of time in correcting their inaccuracies. Mr. Prest's observations, however, appear to indicate that the blue slates here lie next to the granite upon the north, they being seen on the

Difficulties of exploration.

northern side of Schoodic Lake as well as on some of the lakes farther west, but chiefly in drift. Then comes the greenish slate seen on the south side of the same lake, while at the head or south end of a long cove connected with this sheet of water, is a sort of gray or greenish-gray quartzite. This latter is also seen on the barrens north-east of Whetstone Lake. The whole country is, however, covered with immense quantities of granite drift, which obscures everything except in the valleys and on some of the lake-shores. Proceeding south from Whetstone Lake, the land for two miles is covered with granite and quartzites, the latter in angular and unworn blocks, indicating a local origin. A short distance east of the river, granite, however, is again found *in situ*, forming a portion of a range of hills running south, and cutting off the sedimentary beds. At a distance of about two miles south of Whetstone Lake are seen large boulders of mica-slate, the result no doubt of the metamorphism of the green or gray slates which naturally come in next the quartzites. Half a mile south of this, at the head of Indian-field Lake, the granite approaches closer to the river than usual; in fact it seems, from the quantity of huge boulders present, to cross to the western side, with the result of cutting off and metamorphosing the schistose rocks. Thus the whole succession here seen, from north to south would appear to be :—

Indian-field Lake.

Succession in northern Shelburne.

1. Granite at the Blue Mountains.
2. Gneiss at Roseway Lake.
3. Blue slate at Schoodic and Crane Lakes.
4. Gray slate at Schoodic and Whetstone Lakes.
5. Quartzite at Schoodic and Whetstone Lakes.
6. Mica-slate one mile north of Indian Fields.

A second old lake-basin.

" At Indian Fields is seen another of the basins such as is described above. This is a slightly undulating plain, covered with sand and gravel, but not littered as in the former case with huge boulders. The gentle swells are also less elevated, the material finer, and the lowest parts filled in with a rich black mud, forming meadows. The plain shows no gravel ridges on the edge, nor any fan-shaped glacial deposits, nor any order in the distribution of the elevations. It presents no indications of being gradually deposited by the outflow from a glacier front. On the contrary it looks as if the original hummocky deposits of glacial débris had been slowly levelled down and ground fine by the action of shallow water moved by wind, as in a lake. The large boulders, of which there are few, remain in their original positions, the sand being smoothed around them. The presence of beds of incipient bog iron ore interstratified with the sands of Indian Fields (as in Schoodic Lake) favours the impression that this place was once covered by a body of fresh water. It is surrounded by a rim of elevated land, except at the southern edge where the river runs out. Part of the basin is yet occupied by a lake, which seems to have been lowered to its present size by the wasting away of the morainic barrier to the south. The level of Schoodic Lake has been similarly lowered four or five feet during the last twenty years.

Destruction of timber.

"Nearly the whole of the country from the Upper Ohio north-east and north for thirty miles, has in a great part been wantonly burned, and millions of dollars worth of timber destroyed, in order, as explained to us, to make better walking for trappers and hunters. The largest tract of timber remaining in this neighbourhood is that on the south-east of the Roseway River, from Roseway to Crane Lake. A large fire had only recently been set in that region and had burned over many square miles of land. It has been estimated that fully nine-tenths of the original forest growth of Shelburne county has been destroyed by fire."

DIVISION III. BLACK SLATE GROUP.

It has been already stated that at many different points the green slates which form the upper portion of Division II. of the Cambrian system, may be seen to pass beneath a thick series of black slates which here, as elsewhere, form the upper division of this system.

Lithological characters.

The rocks of this group form belts quite as distinctly marked as do the quartzite and green slate beds below them, and which, as indicated in the foregoing descriptions, they serve to separate. They are also more uniform in character; for while the quartzites, even when most massive, are rarely without intervening slaty beds, which in the upper portion predominate, the black slates of the present group, as far as observed, contain no arenaceous strata. They are generally earthy, and while the presence of disseminated carbonaceous or graphitic matter makes them nearly always dark and often intensely black, the abundance of pyrite in cubical crystals with which the beds are often profusely studded, by its decomposition produces a rusty aspect, which is rarely wholly wanting. Both features would seem to favour the view that the beds have been formed in somewhat deep waters, and that these were abundantly supplied with life; but owing partly if not wholly to the pressure to which they have since been subjected, and the fact that the slaty cleavage thus developed seldom coincides

Absence of fossils.

with the dip of the folded beds, only rarely has anything resembling a fossil been found. The only specimens we have as yet been able to obtain after long and careful search, which may possibly be of this nature, are certain small circular or ovoidal pit-like depressions found in the black slate drift in the vicinity of Bridgewater, in Lunenburg county, and again upon the coast of the same county near Heckman's Island. In outline they bear some resemblance to brachiopods of the genus *Obolella* or *Linnarsonia*, but they are lacking in markings or other distinctive features by which their nature can be definitely ascertained, and for the present at least they are unavailable in evidence.*

Caledonia.

Of the several belts of black slates referred to above the most noticeable, because traversing and determining a district which is well settled, is that which underlies much of the country surrounding Caledonia Corner, extending from the Liverpool and Annapolis post-road easterly to and beyond the foot of Tupper Lake, and westwardly through West Caledonia and the northern part of Whiteburne, certainly as far as the Liverpool River, (being seen at its forks two miles and a half above Lake Rossignol) and probably to the eastern side of Tobeatic Lake.

Supposed thickness.

The width of the belt of black slates, near Caledonia Corner, is about three miles, and the inclination of the beds is northward at high angles. They apparently represent an aggregate thickness of at least 3000 feet. There can be but little doubt, however, that the beds are to some extent repeated by faults, and may also include overturned folds, making any definite estimates of thickness necessarily uncertain.

Westfield.

In tracing this belt of slates to the eastward of Caledonia, it is found to be met and cut, near the foot of Tupper Lake in Westfield, by granite, near the contact with which (at the Westfield or Jumbo mine, and upon the stream which there connects the lake with the main stream of the Port Medway River), the greatly disturbed strata are considerably altered, while they at the same time contain veins or irregular masses of white quartz of remarkable size, which are to some extent at least auriferous. A little further eastward, towards Pleasant River, the black slates give place to the banded or ribbanded slates already described, and are not again seen as far as the county line, but eastward of the latter reappear, and are conspicuously seen in Hemford, in Lunenburg county, whence they may be readily followed to the Ohio River and the settlement of New Germany.

Pleasant River.

*For the occurrence of fossils in the quartzites, see remarks on the rocks of Lockeport.

It is interesting to notice in this connection that an effect which is probably due to the same granitic intrusion as that of Westfield and Tupper Lake, is to be seen far beyond the point where the granite ceases to be a surface rock, the black slates one mile and a half south of Caledonia Corner, and along a line corresponding to the strike of the Westfield rocks, showing in their hardness and semi-crystalline character, as well as in the abundance of pyrite crystals, not only a resemblance to those of the lake last named, but evidences of alteration by a similar agency. The beds are here nearly vertical. Metamorphism.

A second band of black and pyritous slates, in every way similar to the above, has already been referred to as succeeding the great whin belt of Ponhook and Molega Lakes upon its southern side. This band, as observed along the Port Medway River, between the foot of Ponhook Lake and Bang's Falls, in the settlement of Greenfield, is but little less broad than that of Caledonia, but while its northern edge has been continuously traced from the county line in Buckfield to the Indian Gardens at the foot of the First Lake connected with Lake Rossignol, its southern border has been observed at comparatively few points. Upon the Port Medway River, the black slates may be seen overlying the quartzites of the southern belt between Bear Falls and Bang's Falls, and it may be again observed in the northern part of Middlefield, but westward of the post-road which traverses this settlement, the country is uncleared and largely drift-covered, making observations difficult. It is believed, however, that the band in approaching the Liverpool River bends northward about the First Lake of Rossignol, and gradually disappears in the country eastward of Lake Rossignol proper. To the west of this point no trace of this second belt has been observed. Second belt. Greenfield. Port Medway River.

The third belt of black slates is only partially included in Queen's county, being found along portions of its northern border and partly in the county of Annapolis. It may readily be observed on the post-road in the settlement of Maitland, just north of the county line, and, including a part of Queen's county, is nearly five miles wide. Its southern limit passes just south of Minard's Lake and eastward through the settlements of Northfield and Hillsboro', while its northern limit is between three and four miles north of the county line, or a little over five miles from Kempt. The black slates here meet, and overlie the quartzites of the northern belt. Third belt. Maitland.

The only other point at which rocks probably referable to this division of the Cambrian system have been observed, is upon Broad

Broad River. River, about three miles above its mouth. Being in the metamorphic portion of the district and themselves highly altered, they may be most conveniently considered a little later in connection with the other metamorphic rocks of the coast.

METAMORPHIC ROCKS OF QUEEN'S COUNTY.

Though in some degree the above title is really applicable to all the rocks of the Cambrian system, there is much difference in the amount of metamorphism exhibited, making some further reference to the more altered rocks desirable.

Degrees metamorphism.

In Queen's county the more highly crystalline rocks, though not wholly absent from the interior, are most conspicuously developed near the sea-board, their occurrence here as elsewhere being evidently connected with the occurrence of masses of intrusive granite. The alteration is also, as might be expected, much more marked in the slaty than in the quartzose bands. Between the quartzites or whins of the coast and those of the interior there is but little difference; at the same time that the intervening beds, which are in the one case simple argillites, are in the other glistening mica-schists. In general, however, there is, even in the quartzites, a greater development of mica in the coastal rocks, giving them the aspect over large areas of fine-grained gneisses. The change from the unaltered to the altered rocks is progressive, and without any well-defined line of demarcation, while even among the comparatively unchanged slates of the interior one now and then meets with beds covered with little angular specks, evidence of incipient crystallization.

The following details will serve to indicate the position and extent of the areas in which metamorphism has been marked as well as some of its varying results.

Details.

It has already been stated that the rocks exposed along the lower portion of the Port Medway River consist of fine-grained quartzites alternating with mica-spotted mica-schists and fine gneisses. Similar rocks probably occupy all the area surrounding the head of Port Medway harbour, but, with the exception of a few beds exposed in East Port Medway, are concealed from view by a mantle of drift, abounding in large quartzite blocks. Near Port Medway village the quartzites are well exposed with a dip S. 30° E. $<$ 85°. They are also well exhibited along the road to the lighthouse, skirting the shore in massive beds of which the true attitude is not easily determinable.

Port Medway.

Their great uniformity for a distance of a mile or more, together with their broad flat or rolling surfaces broken by innumerable joint-planes, favour the idea that they are in part at least lying in low undulations, but both at Vogler Cove, on the east side of the harbour, and again at the lighthouse on the western side, the dip is comparatively high. Off the mouth of the harbour are several small islands of which one, Toby Island, shows on its east side ledges of gray sandy slate, more or less micaceous and dipping N. 10° E. < 60°, while a second or outer island, known as the Frying Pan, shows massive gray quartzites which are apparently nearly flat. It is probable that the above beds are in the course of a low anticlinal which enters Queens county from Lunenburg and which is continuous eastward to and beyond Liverpool.

Toby Island.

Passing Rugged Harbour, a small but very irregular indentation in the coast line, we next meet with beds similar to the above in the fishing settlements of East and West Berlin. At the head of Blueberry Bay, just west of Berlin, the fine gneissic sandstones are very regularly bedded, with a dip S. 50° E. < 50°. At Eagle Head, also, they exhibit the same regular southerly or south-easterly dip for a continuous space of a quarter of a mile; but here they include some gritty beds and are further remarkable as holding in places corrugated layers, the tortuous or serpentine twistings of which are minutely followed by small quartz veins from one to two inches in thickness. Approaching Beach Meadows the previous southerly dip becomes reversed, and from this point westward to Liverpool Bay the dip is northward. In connection with this anticline an interesting feature is the occurrence, on the shore fronting Coffins Island, of enormous veins of granite, the principal vein being for several rods conformable to the gneissic and micaceous strata, which here dip N. < 40°, but at the eastern end turning almost at right angles to their course, as well as penetrating the same beds in irregular tongue-like masses. The granite is of a coarse character, with red felspar and much mica, and is in places porphyritic. The width of the main mass is from thirty to forty feet, while the smaller veins and branches vary from seven or eight feet to as many inches. In general they do not seem to have affected either the dip or strike of the beds, many of which are cut off transversely with singular abruptness. It is probable that other and more considerable masses of granite occur outside of the present coast line, Coffins Island being wholly composed of granite boulders, though no ledges could be found.

Rugged Harbour, Berlin.

Beach Meadows.

Granite veins.

Coffins Island

At the Eastern Head of Liverpool Harbour, the fine gray micaceous or gneissic sandstones dip N. 10° W. < 40°; and a similar north-

Liverpool Harbour.

ward dip, but with some variation in its amount, is maintained all along the eastern side of the harbour, through the village of Brooklyn, being well exposed at the Brooklyn breakwater. A little north of the head of the harbour and near the road to Milton, is a somewhat prominent eminence, known as Wildcat Hill, composed of gray mica slates, spotted with large crystals of black mica, and alternating with gray, micaceous quartzite. The dip is still northward (N. 10° W. < 40°). Still further north, on the Milton road, are other ledges of quartzite, followed, a quarter of a mile below the lower bridge in Milton, by gray, glossy and wrinkled talco-micaceous slates, which are nearly vertical. Similar but finer gray talcoid slates occur also at the upper bridge and near the church, in a like attitude. Half a mile north of this, in the upper end of Milton, the slates give place to a wide belt of whin, indicated however for the most part only by the number and size of the boulders with which it is thickly strewn, and which from this point northward on the Annapolis Road are the only rocks seen for a distance of seven miles. In a road-cutting on Seven-mile Hill glossy micaceous slates or mica-schists come into view; but with this exception, the strata along the Annapolis Road are wholly concealed until the band of black slates is reached, already described as crossing the same thoroughfare in the northern part of Middlefield. It is probable that the succession along the road is essentially the same as that of the parallel section on the Port Medway River, only eight miles to the eastward.

Brooklyn.

Milton.

Seven-mile Hill.

Liverpool River.

West of the Annapolis Road another transverse section of these rocks is afforded by the Liverpool River between Milton and the foot of Lake Rossignol. As in the case of the sections previously described the larger part of the area is occupied by whins or quartzite, which are more or less micaceous; but about four miles above Milton the beds become more schistose, consisting of greenish-gray, slightly chloritic, fine-grained mica-schists, dipping N. 10° E. < 40°, with a strong and vertical cleavage.

Liverpool Harbour, west side.

Returning to Liverpool and continuing the examination of the coast, we find along the western side of Liverpool Harbour the evident extension of the same beds as those which skirt its eastern shore, viz., alternating beds of quartzite and mica-schists. Some of the former are hardly distinguishable from the "whins" of the interior, but others are finely micaceous, while the slates or schists are highly crystalline and present the features, elsewhere frequently observed in this region, of large black crystals of mica scattered through a much finer micaceous base which is white or silvery. These strata are continuously exposed below the lighthouse for a distance of two miles or more, and possess throughout a northerly dip (N. 10° W. $<$ 70° to 80°). Approaching Black Point the quartzites also become more crystalline, and graduate into an unstratified granitoid rock of dark-gray colour, containing hornblende as well as mica. Black Point.

At Moose Point the rocks again consist of gray micaceous quartzites or fine-grained gneisses, dipping N. 25° W $<$ 60°, together with gray highly lustrous mica-schists. In places these beds contain concretionary nodules, from six inches to one foot in diameter, arranged in rows parallel with the stratification, and show concentric gneissic rings of different degrees of coarseness and colour. Veins of coarse syenitic rock also occur. The whole of the shore between Moose Point and Scotts Bay is composed of similar strata, often much crumpled; but at Strawberry Point they are again invaded by large masses of light-gray granite. The relations of the latter to the gneissic beds is quite similar to those already described on the opposite side of Liverpool Harbour, near Coffins Island; but here the contacts are further complicated by the inclosure in the granite of large detached blocks of quartzite or gneiss, which are strongly angular and vary in size from a few inches to as much as three or four feet. Both the granite and the gneiss carry small veins of white quartz. Still finer illustrations of like relations are to be seen at the government wharf, at the Western Head of Liverpool Bay. The gray micaceous quartzites here form beds varying from ten to thirty or forty feet in thickness, and alternate with beautiful silvery mica-schists, usually not exceeding two or three feet, and both very regularly bedded (N. 25° W. $<$ 70-80°), while both along and across the stratification run large veins of granite, remarkable for the coarsely segregated character of their constituent minerals. Moose Point. Syenite and granite, Western Head. Granite dykes.

To the west of Western Head, the recession of the shore-line, forming the indentation of Gull Cove, exhibits only a repetition of the beds described above; but the dips are southerly, indicating that here, as on the opposite side of Liverpool Bay, the granitic extrusions are connected with and mark the crown of a lengthened anticlinal. At Whites Point the granite is represented only by small veins, the promontory being composed chiefly of gneiss and mica-schist; but at Hunts Point, forming a portion of the eastern shore of Port Mouton Harbour, granites again appear in force, as they also do in the vicinity of Somerville Centre. As before, these granites are very coarse, holding crystals of mica often as much as one inch in diameter. At the point last named the dips again become northerly, and so continue to the mouth of Broad River. The stream last mentioned affords an admir- Gull Cove. Port Mouton. Broad River.

able opportunity for the study of these crystalline rocks, besides revealing certain beds which have not been elsewhere observed within the metamorphic area of the coast. Where the post-road crosses the mouth of the stream are ledges of lustrous mica-schists, side by side with which are gray quartzites which are scarcely at all micaceous, and which differ but little, if at all, from the typical "whin" of Caledonia and Whiteburne. For a quarter of a mile above the highway bridge the rocks are chiefly sandstones or quartzites, with but few slaty beds; but in ascending the stream these become more frequent and, about a mile and a half up, are the prevailing rock. The latter are at the same time noticeable as containing not only scattered crystals of mica, (in this respect resembling the beds of the Liverpool River), but also as holding much larger, though imperfect, crystalline (andalusite) masses, varying from half an inch to an inch and a half in length, which project from the surface of the rock and give it a singularly rough aspect. Some of the beds also contain numerous but small and poor, garnets, and more rarely, crystals of staurolite and tourmaline. These rocks are frequently exposed for a distance of two and a half or three miles from the post-road, the dip being throughout to the northward, though gradually rising from 60° to 90°; but at the distance mentioned a sudden change in the nature of the beds occurs, the gray strata previously noticed being immediately followed by a broad band of very black and heavy rusty-weathering slates, holding much pyrites, as well as small veins, or beds, coincident with the bedding, of black micaceous iron-rock. These beds are also highly crystalline, being both micaceous and staurolitic. The entire breadth of the band is about 900 feet, but this may be double its actual thickness; for if, as is probable, these black and pyritous beds are the altered equivalents of the black slates of Division III., they must here be in the position of a compressed synclinal. In accordance with this supposition, they are immediately followed to the northward by light-gray silvery mica-schists in every way similar to those on their southern side. These are thence continuously exposed nearly to the forks of the stream. Above this point exposures are infrequent, but the blocks with which the bed of the river is strewed indicate that their general character remains unaltered. It is probable that the same beds, which have a very uniform and similar course both on the Liverpool River and on Broad River, occupy also the country west of the latter to the county line, but the district is so extensively covered with bogs and barrens, or strewn with boulders, that little can be seen of the underlying formations.

Crystalline minerals.

Black slates, Division III.

It has been stated that granite masses protrude, at several points, through the siliceous and micaceous strata upon the eastern side of Port Mouton Harbour. The western side of the same indentation is wholly composed of the first-named rock, as are also most of the islands which dot its surface, including Mink, Spectacle, Massacre and Port Mouton Islands. The granite of these several islands is light-gray and moderately fine, but contains coarsely crystalline segregated veins. It affords many beautiful examples of rounded, grooved and striated surfaces. On the shore of the mainland, opposite the Spectacles, striking illustration of the effects of its decomposition and erosion is afforded in the occurrence of hills of blown sand which stretch along the shore for a mile or more, and in places attain a height of forty or fifty feet. The sand is so white as to appear at a distance like banks of snow; it is almost purely siliceous, and is apparently well adapted for the manufacture of glass. Similar sand-hills, though less extensive, occur on the eastern side of the harbour, as well as at points to the westward, to be hereafter noticed.

Port Mouton, west side.

Granites.

Blown sand.

As far as could be ascertained, nearly the whole of the tongue of land separating Port Mouton Harbour from that of Port Jolie is composed of granite, the only exception being that portion of the promontory separating Caddens Bay from Port Jolie Harbour, and terminating in Jolie Point. Here the rocks are in part micaceous quartzites or fine-grained gneisses, and in part coarser granitoid gneiss, both penetrated in places by granitic veins, which often carry beautiful plumose mica.

Jolie Point.

The northern limit of the granite between Port Mouton and Port Jolie harbours is difficult of determination, the thick covering of drift completely concealing the underlying rocks. From the distribution of boulders, however, and other facts, it is thought to occupy a position varying from one to two miles north of and approximately parallel to the post-road which connects the heads of these two indentations. Granite ledges appear *in situ* just south of Robertson Lake and again at the mouth of Douglas Brook, where, amidst immense granitic boulders, are sometimes found the remains of ancient Indian shell heaps. The western shore of Port Jolie Harbour is mostly low and boulder-strewn, but at Sandy Cove, near the entrance to the harbour, gneisses and mica-slates, similar to those of Port Jolie Point, reappear, and are similarly penetrated by more or less considerable granitic masses, mostly very coarsely crystalline. The interior of the peninsula appears to be largely composed of granite. and is covered by extensive barrens.

Granite.

Gneiss and mica-slate

The narrow but long inlet of Port L'Hébert is, in its upper half, unbordered by roads, and its low shores show few if any exposures.

Port L'Hébert

Nearer its entrance, however, at the Lighthouse, are ledges of gneiss, dipping N. 20° W. < 40°, and directly opposite, at Taylor's, similar beds, but with dip S. 20° E. < 70°.

II. Shelburne County.

A large part of this county is occupied by granite. The sedimentary rocks which constitute its other portions are also all highly crystalline, making the recognition of the several members of the Cambrian system somewhat difficult.

Quartzites.

Staurolitic beds.

Garnets.

Parallelism of strata.

Of these members the quartzites are the most readily recognizable, there being no change other than the development of a more micaceous character, which sometimes, and especially near the granite, may become quite coarse, giving the rock all the aspect of a true gneiss, though usually lacking in felspar. At many points these quartzites, with associated mica-schists, representing the lower member of the Cambrian system, are found to graduate upwards into a series of beds which, while more slaty, have usually an aspect of much greater coarseness and roughness. This appearance is almost wholly due to the development in the beds of vast numbers of staurolite crystals, associated not unfrequently with crystals of andalusite, and less commonly of garnet. The staurolite crystals are often quite perfect, and usually easily separable from the mass of the rock. The andalusites, on the other hand, are but imperfectly formed, not separable from the matrix, and, like the latter, often studded with prismatic hexagonal scales of black mica. The garnets, though well formed and clear, are generally minute. From the position of the beds observed at many points, there can be no doubt that they represent group *b* of Division I., though it is probable from their thickness that they include as well some of the beds of Division II. No rocks suggesting a parallelism with the black slates of Division III. have been recognized in this county.

In describing the details of the metamorphic rocks of Shelburne county it will be most convenient to resume the consideration of the rocks at Port L'Hébert, this being part of the boundary between the county named and that of Queens, already described.

On entering Shelburne county, the first peninsula projection of the coast is that separating Port L'Hébert from Sable River Inlet. This area but repeats the structure of those last described, in Queens county. Along the post-road, connecting the heads of the two indentations, granite boulders of large size are abundant, and at one point, three miles from Port L'Hébert, ledges of this rock appear; but at the mouth of Tom Tidney Brook, which enters the head of Sable River Inlet, and for a mile above the bridge upon the post-road, the rocks are gray quartzites and mica-slates. They dip northerly at low angles but are greatly jointed and broken. No other rocks are seen upon this stream. Farther down upon the peninsula the exposures are few until the extremity is approached; but here the gray micaceous sandstones and gneisses are frequently met with, especially about Little Port L'Hébert and Jones Harbour. They present, however, no new features of interest.

Tom Tidney Brook.

Jones Harbour.

The same remark applies in the main to the area separating Sable River from that of Ragged Island, on the latter of which is situated the town of Lockeport. Along the post-road connecting Sable River with Jordan River a small patch of granite was observed nearly midway between these two places, but with this exception the rocks of this area are everywhere stratified and do not differ materially from those already described.

One mile above the mouth of Sable River proper, is a somewhat prominent ridge in which alternate beds of fine-grained gneiss and mica-slate have, by unequal weathering, produced an appearance which has caused the name of "Cart-wheel Rocks" to be locally applied to them. They dip very regularly S. 40° E. $<$ 60°. On the other hand, along the roads leading around the shores of the peninsula, and on the more prominent headlands, such as Raspberry Head, Hemans Head, and Black Point, the rocks, like those of Jones Harbour, are fine-grained micaceous quartzites, with a dip which is usually at a high angle. Beds of a like character were also observed in Rockport, about half a mile below the head of Ragged Island Inlet, on the post-road around the head of the latter, in Allendale, on its western side, and southward to Lockeport. The dips at nearly all these points are southerly (S. 42-50° E. $<$ 50-60°), corresponding to a north-easterly trend, which is also that of Lockeport Peninsula and of the adjacent islands. Admirable exposures of the beds may be seen at the southern end of Lockeport Island, and are made more interesting by the fact that the surface of the quartzite beds, dipping towards Cranberry Island, at an angle of about 50°, here exhibit, despite their highly metamorphic character, numerous well-marked remains of *Asteropolithon*, the only evidences, if such they can be considered, of organic remains yet noticed in the Cambrian rocks of south-western Nova Scotia. The evidences of intense glaciation, shown by the ploughing

Sable River.

Lockport Island

Glacial troughs.

of the adjacent beds along their strike into canoe-like troughs three or four feet deep and two or three feet wide, for distances of thirty feet or more, are other features of interest in the same vicinity.

Western Head.

On Western Head fine opportunities are also afforded for the study of the Cambrian strata, these, though mostly similar to those of Lockeport, include some coarser beds made up of well rounded quartz pebbles of the size of bullets, and in places exhibit surfaces which are distinctly ripple-marked. They are intersected by numerous joint-planes, some of which, widened by the action of the sea, have originated remarkable "spouting horns."

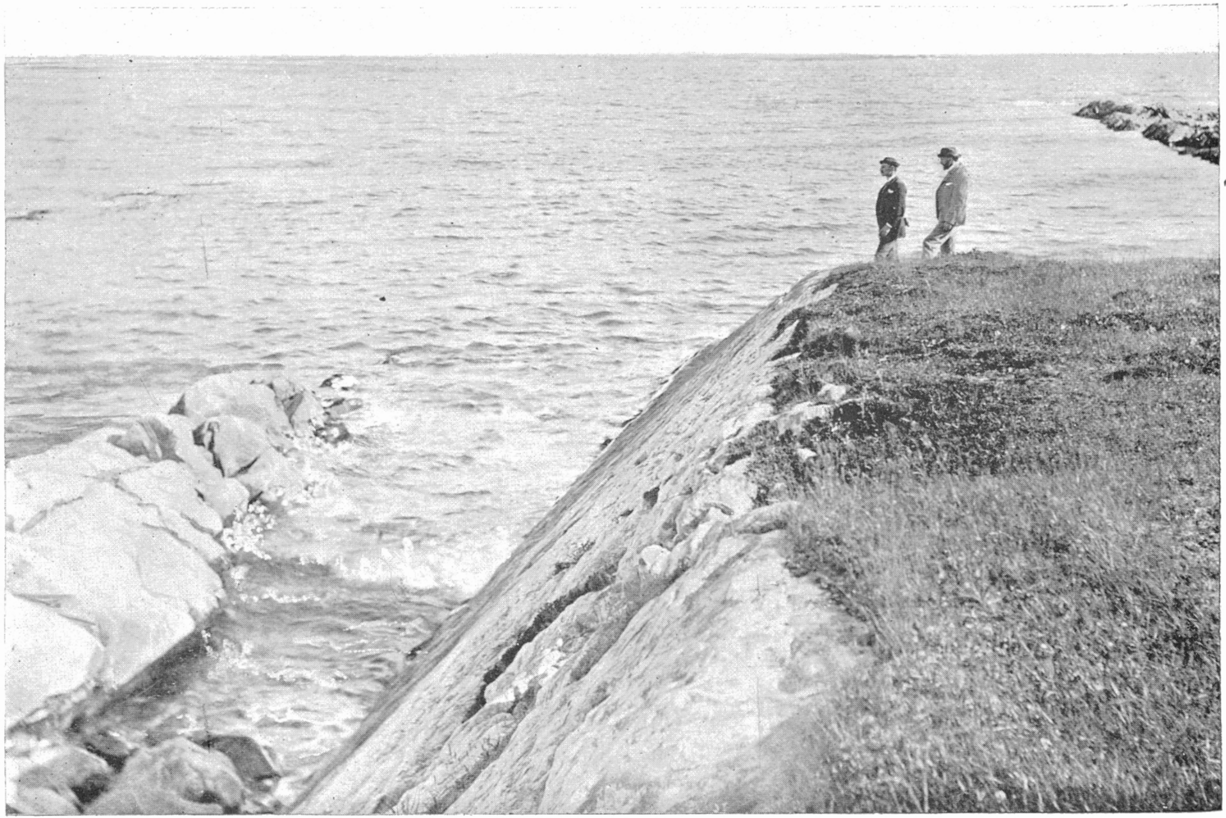
Green Harbour.

The next indentation of the coast, that of Green Harbour, presents no new features, except that some of the gneisses seen along the post-road at its head are coarser than ordinary, and contain thin layers of black mica-slate which are studded with small staurolite crystals. The general structure is anticlinal, the dip at the head of the harbour being N. W. $<$ 60°, while on the extremity of Patterson Point it is S. 30° E. $<$ 45°.

Jordan Bay.

Between Green Harbour and Jordan Bay, there are but few exposures either on the shore or in the interior, which is largely occupied by barrens; but ledges of quartzite occasionally protrude, indicating the nature of the underlying rocks. About a mile and a half below the head of Jordan Bay these quartzites become more prominent, forming a notable range of hills, the beds of which dip regularly N. 30° W. $<$ 60°. In addition to quartzites they include fine gneisses which are more or less studded with staurolite crystals, and the fact that these staurolite beds occupy the same position as the green sandy slates above the quartzites in the less metamorphic portions of the Cambrian system is well exhibited. Strata of similar character are still better shown at Jordan Falls, a locality long known for the abundance and perfection of its metamorphic rocks and minerals. In the strata here exposed the staurolites occur in both rhombic and hexagonal forms, and attain at times a length of half an inch or more. Mica crystals of black colour, distinct from and much larger than those which form the mass of the rather soft rock, give to the latter a curiously spotted aspect, while the frequent occurrence, on many of the layers, of obscurely prismatic projecting knobs, sometimes two or three inches long, that are really partially developed crystals of andalusite, still further adds to the peculiar appearance of weathered surfaces. Finally, many of the beds are studded with small red garnets.

Jordan Falls.



CAMBRIAN QUARTZITE WITH ASTEROPOLITHON, LOCKPORT ISLAND, N. S.

The development of crystalline minerals, to which reference has been made, is the evident accompaniment of a near approach to a granite mass. A small area of the latter rock has already been referred to as noticed a few miles to the eastward of Jordan River, along the post-road from Sable River; but another and much more considerable area of similar rock is met with a few miles to the westward, along the same post-road, extending to Shelburne. Between Jordan Falls and this granitic mass the staurolitic strata are exposed for a little over a mile. At the falls their dip varies from N. to N. 25° W. < 40°, but a mile westward similar beds dip N. 20° E < 5°, to 10°, while at a less distance southward, on the road to Jordan Ferry, they graduate downward into and are replaced by quartzites. At the cove, one mile and a quarter below Jordan Ferry, the quartzites dip N. 20° E. < 40°. Granite. Staurolitic strata.

A careful examination of the remainder of the peninsula separating Jordan Bay from Shelburne Harbour, shows this to be composed, as regards its southern half, almost wholly of quartzites, such as are well exposed at Jordan Ferry, along the lake road between Lake Rodney and McLean Island, about Berry Bay, and on the shore facing McNutt Island to a point nearly opposite its northern extremity. Here the quartzites may again be seen to be directly overlain by and graduate into mica-schists studded with staurolite and andalusite crystals, some of these latter being two or three inches in length. Some of the beds are also noticeable as holding layers filled with sheafs of hornblende, a feature which helps to connect them with the hornblendic rocks of Yarmouth to be presently noticed. The two sets of rocks, *i.e.* the quartzites and staurolitic slates, are strictly conformable, with a regular dip S. < 30° E 80° to 90°, and in the same relations reappear on McNutt Island; while to the northward the staurolitic and andalusitic beds are alone seen, occupying all the shore to Sand Point and thence up Shelburne Harbour nearly to the town of Shelburne. Grays or Pettis Island, two miles wes tof Cape Roseway lighthouse on McNutt Island, is said to be also composed of mica-slates The distinction as to limits between granitic and schistose rocks is, in the vicinity of Shelburne, as indicated elsewhere in this report, a matter of much difficulty, due partly to the absence of exposures, but chiefly to the irregular way in which the one set of rocks is invaded by the other. Of this a good illustration is afforded at the Shelburne Mills on the Roseway River, near which ledges of gneiss, several hundred feet wide and very regularly stratified, are not only cut off abruptly by granite, across their strike, but appear to be completely surrounded by that McNutt Island. Shelburne Harbour. Roseway River.

rock. So to the westward, while the larger part of the ridge separating Shelburne Harbour from Birchtown Bay appears to be composed of granite, small areas of quartzite also occur. In general, however, it may be said that granites prevail up the valley of the Roseway as far as the bridge in Lower Ohio, and down the westward side of Shelburne Harbour through the settlement of Churchover.

Churchover.

South of Churchover, fine-grained, gray, micaceous gneisses, marking the commencement of another area of sedimentary strata, are first met with at Green Cove, dipping regularly S. 30° E. $<$ 60°, and are an extension of those of Sand Point, upon the opposite side of the harbour. Beyond this no exposures were seen as far as the upper part of Carleton, but the character of the boulders is such as to indicate the close proximity of staurolitic strata. These appear *in situ* on the south side of Sand Creek and form the promontory of Red Head. The staurolite crystals, imbedded in light-gray mica-schists, are here not only very abundant but exceptionally good, fine specimens, in both prismatic and rhombic forms and sometimes of large size, being readily attainable. Andalusite, in pale-pink prismatic crystals, is also found, but less abundantly and less completely differentiated. The dip of the beds is about N. 25° E. but only at an angle of 3° or 4°. The same beds run out to the extremity of East Point, and reappear, with abundant crystals of garnet, staurolite and andalusite, at the eastern end of the island of Cape Negro. They here dip N. 40° W. $<$ 70°. The shores of North East Harbour are mostly low and bordered by cobble beaches or sand bars; but on the western side of the indentation, in the settlement of the same name, are some slaty beds which are remarkable chiefly as containing an unusual amount of chlorite. They are, however, but poorly exposed.

Carleton.

Cape Negro Island.

Negro Harbour.

Passing round by way of Jones Point to Negro Harbour, highly micaceous strata again come into view, the slaty rocks being spotted with a black variety of this mineral in pea-like nodules, associated with which are much larger nodules, sometimes two inches in diameter, of a dark-green chloritic mineral, sometimes exhibiting a concentric structure. The dip of the beds is regular, S. 30° E. $<$ 60°. They extend nearly to Port Saxon, beyond which, to the head of the harbour, no exposures occur.

Blanche Point.

Between Negro Harbour and Port La Tour is the long narrow peninsula terminating in Blanche Point. The strata composing it, as seen at Purgatory Point and elsewhere, are similar in their general character to those of the opposite shore below Port Saxon. Some of the strata abound in small garnets, and the same peculiar chloritic blotches or nodules, referred to above, are again met with.

While the Blanche peninsula forms the eastern side of the harbour of Port La Tour, the somewhat similar peninsula of Baccaro forms its western side, separating the last-named indentation from that of Barrington Bay. Port La Tour.

In the upper part of Port La Tour Harbour, on its western side, gray, micaceous quartzites are the prevailing rocks in Upper Port La Tour settlement; but a little south of the latter, about half way between this and the settlement of Baccaro, are some long, low islands and points, one of which, known as Crow Neck Point, affords the most remarkable exhibition of metamorphosed Cambrian strata, as well as of the extent to which these have been affected by glaciation, to be found in any part of Nova Scotia. The rock is massive and in its matrix rather fine-grained, but so thickly studded with staurolite crystals and semi-crystalline nodules of andalusite (many of which are themselves studded with staurolites,) as to present, at the distance of a few yards, the appearance of a very coarse conglomerate. Crystals of black mica are also scattered profusely through the mass of the rock, while its aspect is further diversified by large dark-green blotches, of no very definite outline, but which stand strongly contrasted with the usual light-gray colour of the inclosing mass. Some portions of the rock are, however, a true conglomerate. The beds dip regularly in a southwesterly direction, but at an angle of only 20°, while great troughs have been cut deeply into their mass which clearly exhibit the ploughing action of ice. One gully, apparently wholly due to this agency, but now partly occupied and obscured by a large boulder, was found by measurement to be about forty feet long, from nine to fifteen feet broad at the top, with a depth gradually increasing seaward from five feet to twenty feet, its smoothed or furrowed sides being regularly curved downward to its base, like the sides of some gigantic canoe. The course of the trough is that of the glaciation on the adjacent ledges and has no relation to the dip of the beds or the occurrence of strata of unequal hardness. Still other troughs occur which are but little less remarkable. Staurolite and andalusite rock. Conglomerate. Remarkable glacial trough.

On John Island, towards the head of Port La Tour Harbour, strata similar to those of Crow Neck Point are again seen; but here the dip is south-easterly (S. 60° E. < 40°) while the beds with dark-green nodules are seen to lie beneath staurolitic strata not containing such nodules, and are themselves underlain, on the adjacent mainland, by John Island.

massive gray quartzites, holding quartz veins. At the very head of the harbour are some further illustrations of probable ice action in the occurrence of remarkable kames, along the top of which, for a considerable distance, runs the road from Blanche and Port La Tour to Port Clyde. In Baccaro, to the south of Port La Tour, the rocks are chiefly mica-slates, filled with dark-green spots, which here approximate the form of rhombic prisms. Near the lighthouse, at the extremity of Baccaro Point, the rocks are smooth, glossy mica-slates, dipping S. 30° E. < 50°.

Kames.

Between Port La Tour and Barrington Head, there are but few exposures along the post-road, the first three miles being continuous barrens; but along the east shore of Barrington Bay, both in and below Village Dale, are beds of highly crystalline coarse gneiss, filled with granitoid veins and having an attitude which is nearly vertical (S. 60° E. < 80°). Farther north, between Village Dale and "The Town," the shore is bordered by extensive tracts of blown sand, but in places these can be seen to rest upon well-stratified gneiss, which towards Barrington Head becomes more and more injected with granite, and finally, near the post-office, is completely replaced by the latter.

Barrington Bay.

Sand dunes.

Barrington.

From Barrington westward to the limits of Shelburne county, no other rock than granite was observed, either upon the coast or in the interior. Whether the same is true of Cape Sable Island we were unable to determine. The slight width of Barrington Passage, by which the island is separated from the mainland, together with the occurrence of large granitic boulders over various parts of it, favour the idea that it is in part at least composed of this rock, but the only exposures we could find at Baker Beach, on the south-eastern side of the island, are of gneiss.

Cape Sable Island.

Granites of Queens and Shelburne Counties.

In the foregoing descriptions numerous more or less considerable areas of granite have been incidentally alluded to, and their boundaries have been to some extent defined. It is now proposed to give a more systematic summary of these areas, with some remarks upon their character.

QUEENS COUNTY.

Coffins Island.

1. Beach Meadows and Coffins Island area.—The only rocks actually visible in this area are those of Beach Meadows shore, where they have already been described as penetrating the schistose strata in large veins, in part conforming to and in part cutting across the stratification of the latter. It is uncertain to what extent similar rocks enter into the composition of Coffins Island. No outcrops could be found upon it, but from the number and size of the boulders met with it is believed that it is chiefly composed of granite.

2. *Liverpool Bay, west side.*— Veins of granite, which are sometimes hornblendic, have been described as penetrating the gneisses and mica-schists at Black Point, Moose Point, Strawberry Point and Western Head. They present for the most part features similar to those of Beach Meadows and Coffins Island, and probably mark the continuation of a line of granitic upheaval extending from Port Medway to Port Mouton, though showing at the surface only in the form of isolated patches. These granites are remarkable for the character and size of their segregated veins, which are partly of pure quartz and partly of mixed quartz, orthoclase and light-coloured mica. Liverpool Bay.

Port Mouton Harbour.—The granites on the eastern side of this indentation consist of small veins at Whites Point and of larger dyke-like masses at Hunts Point and Somerville Centre. On the western side of the harbour, however, they are in much greater force, forming not only the whole of the western shore and adjacent islands (Mink, Spectacle, Massacre and Port Mouton), but thence extending westward across the upper portions of Port Jolie and Port L'Hébert to a point about half way between the last-named indentation and that of Sable River. The northern boundary, though ill-defined, is believed to extend in a nearly uniform line from the mouth of Broad River to within two miles of Tom Tidney Brook, at distances of from two to three or four miles north of the post-road. Much of the country is covered with piles of granitic boulders, many being of very large dimensions. Port Mouton.

The rock of this area, as seen in Port Mouton Harbour, is light-gray, weathering whitish, of moderately fine grain, rarely porphyritic, but frequently traversed by large granite veins in which the constituent minerals are remarkable for their size and individuality. In places the rock exhibits a laminated structure which is hardly less perfect than the bedding of ordinary stratified rock.

Tupper Lake area.—The upper half of this sheet of water, situated in the northern corner of Queens county, is bordered on either side by gray, micaceous quartzites; but a mile or less to the eastward these are replaced by high granite bluffs, and about half way down the lake granite comes out upon the shore. Still further down, this rock appears Tupper Lake.

upon both sides of the lake as well as in the many islands which dot its surface. To the north of the lake, the granite tongue gradually widens until, along the boundary of Annapolis county, it is at least five miles wide, forming in the vicinity of Round Lake the highest land in Queens county; but to the westward it becomes rapidly narrower, and along the Rosette road is less than a mile in width, finally disappearing near the "Jumbo" mine in Westfield.

The granites of this area may be seen in the vicinity of Tupper Lake to penetrate both the quartzites of Division I. and the black pyritous slates of Division III. In the case of the former their influence is everywhere marked by increased hardness, the development of a purple or lilac colour, and the more or less perfect development of minute crystals. The granites of this area also differ in some respects from those of the coast, being usually much coarser, and often porphyritic. They are also more variable in colour, for while the prevailing tint is light-gray, some portions are dark-gray and others tawny yellow.

Tobeatic Lake.

Tobeatic Lake region.—As the north-eastern corner of Queens county is partly occupied by the granites of Tupper Lake and vicinity, so its north-western corner also includes a granitic area at and north of Tobeatic Lake, at the head of Shelburne River, which flows into Lake Rossignol. Like the Tupper Lake area, this is a portion of the main granitic axis, being another southwardly-bending spur from the granites of Annapolis county, and to the westward continuous with those of Shelburne county. Within the limits of Queens county the granites form the northern shore of Tobeatic Lake, the eminence known as Bald Mountain, the shores of Granite or Rocky Lake and the northern end of Big Pescawess Lake, whence the southern boundary of the granite, now in Annapolis county, sweeps around in a gentle curve to the Liverpool and Annapolis road (crossing this just north of Maitland), and then south-easterly again to connect with the spur at Tupper Lake.

SHELBURNE COUNTY.

Shelburne.

Shelburne Harbour.—This area is about equal in extent to that last described. On the post-road east of Shelburne, the granite is first found *in situ* about three miles east of the town, and probably extends also southward about two miles from the latter. Its northern limits are not definitely known for want of exposures, but on the Roseway River granite may not only be well seen near its mouth, but also as far up the stream as the bridge in Lower Ohio. At several points along the Roseway it has been described as including well stratified beds of gneiss. West of Shelburne it may be seen for several miles on the road to Clyde, on the post-road to and through the settlement of Birchtown, throughout the peninsula terminating in Harts Point (where the principal granite quarries are situated), and down the western side of Birchtown Bay, through the settlement of Churchover to the point where the shore-road is joined by that from Beaver Dam. The district is mostly very rough and boulder-strewn, or occupied by extensive barrens.

Further remarks on the character of this granite will be given in connection with the economic minerals of the region.

North-east corner of Shelburne County.—A considerable area of granite has been referred to in preceding pages as occurring about the head-waters of the Jordan and Roseway rivers. On the Jordan its southern edge is indicated by the great number and the enormous size of the granite boulders which skirt the north side of Lake John. Thence it seems to occupy all the country lying to the north and west nearly or quite to the valley of the Roseway. Its western limit nearly touches John Lake, near Bower Hill, and thence it extends north-easterly almost to Schoodic and Moose lakes. In an easterly direction the belt appears to be somewhat narrowed, its northern border passing from near Schoodic Lake, by the mouth of Silver Lake, to the lower edge of Wainwright Lake, while the southern border passes by the upper end of Long Lake on the Jordan and thence to the boundary of Queens county, where it connects with the Tobeatic area already noticed.

Jordan and Roseway rivers.

Barrington area.—The granites of Barrington and the region northward of the latter, including a part of Yarmouth county, constitute the largest area of such rocks near the southern coast. They may indeed be considered as the continuation of the main axis, though at their northern extremity nearly if not wholly disconnected therewith.

Barrington.

In Barrington proper, these granites occupy the whole of the shore from Barrington Head westward to West Wood Harbour and Pubnico Beach. They probably form also the greater part of Cape Sable Island, although, as already noted, the only ledges which could be found upon the latter (on its southern side) were of gneiss. North-west of Barrington Head the granite was found to extend along the Yarmouth post-road to and beyond the county line of Yarmouth, and includes all the country bordering Barrington Lake and River, with about half of the tract

Pubnico.

River Clyde. lying between the county line and the River Clyde. Just above the mouth of Bloody Creek, a branch of the Clyde, a spur passes off to the eastward, that may possibly connect with the granite area about Shelburne. Still farther north, the granites under notice occupy a belt from six to seven miles wide, bisected by the county line, and including numerous lake-basins, such as those of Great Pubnico, Great and Little Medoshak, Clearwater Lake, Wagner Lake and others, mostly connected with the head-waters of the Clyde. The topography of all this region, as laid down in Church's county maps, is very incorrect. The position of lakes and streams is frequently several miles out of place, while in some instances sheets of water of considerable size are wholly omitted. Even the position of the county line between Shelburne and Yarmouth is uncertain, that given in the county map of the latter being wholly and widely discordant with that of the former. In the mineral map of Nova Scotia, the large island known as McNutt Island, of which the southern extremity is Cape Roseway, crowned by one of the most important lighthouses on the coast, is wholly omitted, an omission which has been unfortunately repeated in the map accompanying the preliminary report of which this is an extension, and which, as regards its topography, was based thereon. This has made the determination of geological boundaries in the region a matter of much difficulty, a difficulty which has been further enhanced by the fact that the boundaries themselves are ill-defined, the granites some times showing actual transitions into gneiss, as this does into quartzite, while the granite sends into both irregular tongues and veins, of very variable size, often resulting in a complicated interblending of the two. A further consideration of this subject will be given in the succeeding section on the rocks of Yarmouth county.

Pubnico Lakes.

Inaccuracies of existing maps.

Yarmouth County.

Yarmouth county.

In this county, as in Queens and Shelburne counties, the rocks, exclusive of the granites, are believed to be referable to the Cambrian system only, or at least to the same horizon as those of the counties just named. It will be most convenient in the consideration of the rocks to refer first to the distribution of the granite.

GRANITES.

Granites.

It has been already stated that the granitic area north of Barrington is bisected by the line separating Shelburne and Yarmouth counties, and descriptions have been given of the portion included in the former county. It remains to notice the portion forming the southern or south-eastern part of that last-named. The following notes are based on observations made here by Mr. W. H. Prest.

Great Pubnico Lake.

Great Pubnico Lake.—This sheet of water lies about three miles and a half north of the south-eastern border of Yarmouth county, and is wholly within the limits of the latter. It is extremely irregular in outline and is diversified by numerous islands. Around the north-west end of the lake there is an abundance of gneiss and syenitic granite, while about the centre and towards the south-east end granitic drift prevails.

Medoshak Lakes.—These two lakes, Big and Little Medoshak, lie to the north of Great Pubnico, a little west of and parallel to the county line. The country around them is drift-covered, boulders of granite and gneiss, or of the latter banded with quartzite, being most plentiful, and sometimes of immense size.

Medoshak Lakes.

Clearwater Lake.—This lake is also close to the county line and in the same line with the Medoshak Lakes, with which it is directly connected. On its west side there are great cliffs of gneiss, holding biotite, tourmaline, iron-pyrites and a great abundance of garnets. The latter are of a dark colour, but perfect in shape, and sometimes nearly or quite half an inch in diameter. The beds dip generally S. 42° E. < about 72°, but faults and twists are frequent, and with the stratified beds are numerous dykes or veins of granite.

English Mill Lake.

English Mill Lake.—This lake, also known as Stony Creek Lake, is one mile and three-quarters north of Clearwater Lake. Its general course is N. 20° W., and it embraces two divisions, the east and west lakes, connected by narrows. It is surrounded, at least on its S.W., S.E. and E. sides, by mingled gneiss and granite, the latter occurring in veins as well as interbedded, and in both large and small masses. Garnets, some of them half an inch in diameter, are inclosed in the gneiss.

Wagner Lake.

Wagner Lake.—The north end of this lake is about E. by N. from the S.E. end of English Mill Lake, and distant two miles and a half, or two miles and three-quarters. Wagner Lake is about two miles long and its general course is about S. 20° E. Its foot is about three miles and a quarter from McGill's farm on Hamilton Brook, or about five miles from the main road in Upper Clyde. The lake, like other parts of the district, is surrounded by granite mingled with gneiss and highly crystalline quartzite. Some of the boulders are of gigantic size, and would weigh 600 or 700 tons each. The usual minerals, garnet, mica (biotite and muscovite), tourmaline and sometimes olivine, are seen.

Hepsakateejik Lake.—This lake lies about five or six miles N.N.E. of Wagner Lake. Granite boulders are in great profusion, and granite is, in all probability, the underlying rock.

Blue Mountains.

Blue Mountain area.—A second and considerable area of granite in Yarmouth county is that of its eastern extremity, there forming high lands, popularly known as the Blue Mountains. The latter are in reality but a spur of the great central granitic axis extending thence through Digby and Annapolis counties to Lunenburg and Halifax counties and mark its western termination, though possibly connected by a narrow neck with the granitic region about the head-waters of the River Clyde, in Shelburne county.

The southern border of the Blue Mountain spur has been traced with considerable certainty from the county line of Shelburne, which it crosses above the head of Bloody Creek, a tributary of the Clyde, a little south of Moose Lake, past the head of Wallybeck Lake, and so on nearly to the third lake on the Tusket. The tongue here terminates with a width of not more than a couple of miles; the line of its northern border thence extending north-easterly, in a nearly uniform line, and south of the settlement of Rockingham, to the head-waters of another branch of the Tusket. Here a new course is abruptly taken, the line of contact thence running north-westerly by way of Wallace Lake until it passes into Digby county. The greatest width of the Blue Mountains proper is near the middle of the spur, and would be about five miles. Their maximum elevation is about 600 feet. Their southern border is greatly obscured by drift, and it may be that a smaller spur, extending from the main ridge near the head of the Clyde, may connect with those described above as found on the lower portions of that stream about Wagner Lake; but the fact that this latter belt has here a breadth of only three miles, and narrows northward, gives probability to the view that a band of schistose rocks, extending eastward from near Wallybeck Lake, separates the two.

Tusket Wedge.

Tusket Wedge.—In addition to the granitic areas above described, another isolated but considerable area of this rock is to be found in the vicinity of what is known as Tusket Wedge, forming the promontory lying between the entrance of the Tusket River and the harbour of Little River. It is not quite certain whether it similarly constitutes the headland forming the eastern side of Green Bay, but is clearly indicated by the size, number and distribution of the boulders all along its western side. The same rock constitutes the picturesque group of the Tusket Islands, a few miles to the south.

CAMBRIAN ROCKS OF YARMOUTH COUNTY.

With the rocks of the Cambrian system as developed in Shelburne county, and described in preceding pages, we have now to compare those which, separated from the former by the granites about the county line, are found to the north-west of the latter, in Yarmouth county.

General features.

The actual contact of the granite with the schistose strata in this direction is rarely visible, the thick accumulations of drift along their probable line of junction being such as to almost wholly conceal the underlying formations. From the character of the boulders, however, which enter so largely into the composition of these accumulations, no doubt can be entertained as to the nature of the strata. Gneissic and micaceous rocks abound, exhibiting various shades of texture and colour, while through them, in many instances, as in the case of the similar contacts in Shelburne county, run irregular veins and masses of coarse granite, sometimes shading off insensibly into the gneiss, but at other times with sharp lines of delimitation, or with the two rocks irregularly mingled. Veins of quartz are also common, and with these at times garnet, tourmaline and other minerals are well developed. The rocks are usually greatly contorted, and but little information is to be gained by the study of their ever-varying attitudes.

In advancing to the westward (the prevalent strike being here to northward), the evidences of metamorphism gradually become less marked, though the highly micaceous character of the strata and the dissemination through them of crystalline minerals still conspicuously attest the alteration they have undergone.

Pubnico Harbour.

The first good exposures of beds of this character is to be seen along the post-road at the head of Pubnico Harbour, but they are even better exhibited at different points along the length of the peninsula bounding the latter upon the western side, and at St. Anne Point, its southern extremity.

As seen along the post-road at the head of the harbour, the highly micaceous but distinctly bedded rocks are thickly studded with crystals of andalusite, varying from half an inch to three inches in length, with now and then a crystal of staurolite or garnet ; but while the singularly rough and knobby appearance of the beds is largely due to the prominence given to these crystals by unequal weathering, a closer examination shows that it is also in part the result of the inclosure in the beds of numerous well-defined pebbles, mostly of quartzite, the rock being in reality a conglomerate. Both features are of much importance, for on the one hand they thus show a close correspondence and probable equivalency with the similar beds already described about Port La Tour and elsewhere in Shelburne county, and on the other as nearly resemble certain beds of Yarmouth Harbour and the vicinity of the city of Yarmouth which have been thought to be of more ancient origin than the beds of the Cambrian system. If the view here taken be correct, these beds, in Yarmouth county as in Shelburne, are the representatives of Division I. *c.* of the Cambrian system, and in connection with facts to be presently noticed afford a key to the true interpretation of the geology of this part of Nova Scotia.

St. Anne Point.

At St. Anne Point the width of the beds as measured across their strike is about a furlong, and the dip about E. 20° S. $<$ 80°. Both staurolite and andalusite are abundant here, but the conglomeritic character noticed at the head of the harbour is less prominent. Similar beds also form islands in the harbour.

MICACEOUS AND HORNBLENDIC ROCKS OF YARMOUTH HARBOUR, ETC.

Rocks of Yarmouth.

We come now to consider the peculiar group of rocks found in and about Yarmouth city and harbour, to which reference has been made above as differing in important respects from the usual aspects of the Cambrian rocks, and as to the position of which much uncertainty has prevailed.

Former views.

The more prominent features of the group were first described by Sir J. Wm. Dawson in "Acadian Geology," and subsequently, in considerably greater detail, by Dr. Selwyn. Both writers remark upon the contrasts which these rocks exhibit as compared with the Cambrian rocks of the southern counties, and both suggest the probability that they are older; but no facts of a definite character were in either instance obtained from which their true position might be inferred.

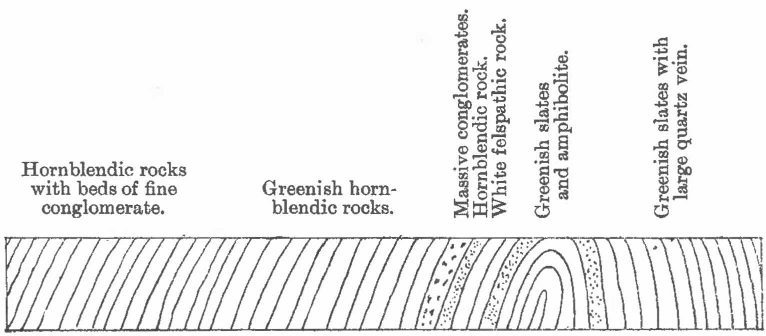
Lithological characters.

In the determination of this question it will first be necessary to consider the composition or lithological aspect of the rocks, and secondly their stratigraphical relations. As a whole, the belt, having a width of about seven and a length of about forty miles, may be described as consisting of highly metamorphosed strata in which the abundance of mica, and especially of hornblende, are the most characteristic features. Chlorite and epidote also characterize some of the beds, but are much less conspicuous, and in some instances the strata are either felspathic or quartzose. Good exposures of such rocks may be seen in the city of Yarmouth, and still better in the rocky peninsula, now used as a park, near the head of the harbour; again on the west side of the latter about Cape Fourchu and Yarmouth light, and finally along the eastward extension of the belt in Milton, Hebron and Ohio. The beds at Cape Fourchu are of special interest, for in them are presented features which would seem to afford an important clue to their true geological position, or at all events a means of correlation with rocks already noted elsewhere. Cape Fourchu.

The features referred to consist in the fact, first described by Dr. Selwyn, that the highly micaceous strata (which also contain numerous scattered sheafs of hornblende and are in part true hornblende-schists), are also to a large extent conglomerates, being filled with numerous pebbles, sometimes as much as a foot in diameter. These pebbles, in some of the beds, consist of pale-gray quartzite, and in others of a gray or purplish-gray vesicular rock, and, as remarked by Dr. Selwyn, "show a flattening and elongation in the direction of the cleavage-planes." In this conglomeritic character as well as in their general aspect, these beds closely recall those already described as occurring at the head and along the western side of Pubnico Harbour. It is true that they differ from these in the abundance of hornblende characterizing the former, and the general absence of staurolite and andalusite crystals so conspicuous at Pubnico, but the first-mentioned feature occurs to some extent in undoubted Cambrian rocks on the east side of Shelburne Harbour in connection with staurolitic strata, while in the case of the Yarmouth beds these, as will be presently noticed, exhibit in their eastward extension an abundance of both staurolite and garnet, assuming in fact aspects not distinguishable from those of many of the beds on the Shelburne county coast. The latter being clearly the metamorphosed equivalents of Division 1. *a.* of the Cambrian succession, it is reasonable to infer that such also is the position of the similar beds of Yarmouth. Observations of Dr. Selwyn. Conglomerates. Comparison with beds of Pubnico and Shelburne.

This view is entirely in accordance with the supposed stratigraphy of the region. All along the eastern side of the peninsula terminating in Point Fourchu, as well as on the opposite side of Yarmouth Harbour in the city of Yarmouth, the prevailing dips are easterly or south-easterly, usually at angles from 60° to 70°, but sometimes nearly vertical. Half a mile north of Stanwood Point on the same peninsula, the dark hornblendic schists with the same dips (about S.E. $<$ 70°) include a considerable bed of white felspathic rock, the counterpart of Stratigraphy. Yarmouth. Stanwood Point.

one traversing the centre of Yarmouth city, but associated with massive conglomerates holding boulders of crystalline rock (resembling the Huronian of New Brunswick) imbedded in the hornblende-schists. In the succeeding quarter of a mile north of the same point, there is every indication of an anticlinal fold, the saddle inclining south-west at an angle of about 25°, while the apex shows corrugations and on the north-west side increases in dip to 86°, the hornblendic rocks being here very prominent. One hundred yards north-west of this is a belt of greenish slates apparently less metamorphosed than the surrounding beds. It is about fifty or sixty feet wide, and contains in its centre a conformable five to ten foot belt of quartz, of a grayish colour, intersected at right angles by later veins of a purer and whiter quartz, dipping N.E. This again is bounded by a belt of rocks consisting in some places of almost pure hornblende. The following section will serve to make the relations of the beds at this point clear :—



Section across Stanwood Point, Yarmouth, about two-thirds of a mile.

Chegoggin Point.

To the north of Cape Fourchu, the shore for several miles is without exposures. At Chegoggin Point, however, the underlying rocks come into view, and are of interest as including strata which appear to be to some extent auriferous. These strata are, in their general character, similar to those of Yarmouth Harbour, consisting of hornblendic slates, some of which are an almost pure hornblendite, while others are composed of an intimate mixture of hornblende and garnet. Fissures in this latter rock are sometimes covered with sheets of very lustrous and well formed, though not complete, garnet crystals, while crystals of menaccanite or titanic iron, an inch or more in breadth, also occur. One belt of this hornblende and garnet-bearing schists has a breadth of eighteen feet. At other points the softer slates appear to have their bedding places curving around the hornblendic masses, as though there were included boulders, one such mass being about 10 by 25 feet. The general strike of the rocks is S. 52° W. and the dip southerly at high angles. They are traversed by immense quartz veins, on one of which a mill of ten stamps has been erected, but is not now in operation.

Cranberry Head.

The next principal headland north of Chegoggin Point is that of Cranberry Head, where again gold-bearing strata occur and are being worked, although quite different in character from those of the first-named promontory. In the vicinity of the mill erected here, at a point known as the "Cream Pots," the rocks are soft greenish chlorite slates and dark-gray argillites, probably corresponding to Division II. (possibly also Division III.) of the Cambrian system. The strata are much faulted, the general dip, however, being about the same as at Chegoggin.

North of Cranberry Head, similar strata, but including more or less arenaceous beds of a greenish colour are the predominant rocks, but vary every few yards in texture as they do also in altitude, while at several points they are invaded by dykes of diorite. In general the incission would appear to be a descending one, in accordance with which the greenish arenaceous beds appear to graduate into more massive sandstones, in which the colour is blue rather than green, and which in general aspect recall the quartzites of Division I. as elsewhere found in the Cambrian system. These rocks are met with as far as the outlet of Lake Allen.

Section not continuous.

Between the stream last mentioned and the promontory of High Head, the section is not a continuous one, but exposures are found at intervals, of which the greater part are greenish slates, sometimes including beds of quartzite, but with these are also parti-coloured slates, exhibiting shades of green, yellow, red, purple and light-blue, recalling the ribbanded beds of the Pleasant River district in Queens county. Approaching Maitland the prevailing rocks are again hard green slates, now dipping northerly, but exposures are few.

Attention may now be directed to some of the aspects of the group of rocks under consideration as seen in portions of Yarmouth county more remote from the coast.

Hebron, Ohio, etc.

From the vicinity of Yarmouth Harbour the hornblendic rocks, there so conspicuously displayed, are readily traced to the eastward, their hardness and compactness causing them to stand out prominently wherever they occur. They can thus be seen in the settlements of Hebron, Bellfield, Wellington, Hartford and Ohio, being frequently exposed in bare ridges along either side of the track of the Dominion Atlantic Railway, as well as about the chain of small lakes running parallel with the latter. Similar beds occur in the vicinity of Lake George as well as about Little and Great Brazil lakes and Lake Annis, but in this direction the hornblendic character becomes less marked, at the same time that the beds become much more abundantly charged with crystals of staurolite and garnet. About half a mile eastward of Brazil station are beds which are profusely studded with garnets, from the size of a pea to as much as half an inch in diameter, but coarse in texture, while on the shores of Lake Annis, with fewer garnets, staurolites are very abundant, the beds nearly resembling those of Shelburne Harbour and Jordan Bay. Crystals of menaccanite are also found here. A little farther to the north-east the belt passes into Digby county.

Lake George.

Brazil.

The total length of the belt, including the portion in Digby county, is about thirty miles, and the breadth, which is quite uniform, about seven miles. On its eastern side the hornblendic and micaceous beds may at some points be seen to be followed by black pyritous slates, the supposed equivalents of Division III. of the Cambrian system of Queens county, and thus completing the ordinary Cambrian succession; but on the western side it is probable that the belt is bordered by a line of fault, the beds, as already indicated upon the coast, exhibiting an abrupt change of character, as they likewise do wherever the western border of the belt is examined. Unfortunately, on this western side, the country is deeply drift-covered and no actual contacts of the hornblendic rocks with the succeeding beds could be found. The general character of the rocks in this direction has been indicated in the coast section from Cranberry Head to Port Maitland, but exposures are few.

Probable fault.

Digby County.

The formations represented in this county, as in those already noticed, are mainly the granite and the Cambrian system, to which, however, must be added limited areas of Devonian rocks, and the red sandstones and traps of Digby Neck. These more recent sandstones can best be discussed in connection with the similar rocks of Annapolis county. It remains to notice the Cambrian rocks and the granite, and of these the latter rock may first be considered.

GRANITE OF DIGBY COUNTY.

Boundaries.

The boundary of the central granite belt of central and western Nova Scotia, has already been given in previous pages through the counties of Queens, Shelburne and Yarmouth to the boundary line of Digby county. This it crosses about two miles west of where the same line is crossed by the main stream of the Tusket River, and thence extends to the vicinity of Barrios Lake.* From this lake the boundary extends to the next or Carleton branch of the same river, a short distance west of Lake Doyle; but from this point turns more to the north and east until, reaching the Sissibou or Weymouth River, it crosses this a little below its forks. From this point its course is for several miles parallel to, and nearly midway between, the north branch of the Sissibou and its tributary, the Mistake River; but above the head of the latter it makes a sudden curve to the north-west, thus helping to outline a spur which occupies a considerable area south and east of North Range settlement. From North Range its course is north-easterly until it crosses the West Branch of Bear River about half-way between Bear River village and Morgantown, and not far beyond crosses the county line between Digby and Annapolis.

CAMBRIAN ROCKS OF DIGBY COUNTY.

In preceeding pages the description of the Cambrian rocks as shown in the coast sections, has been given as far as Salmon River, about four miles north of the border line of Yarmouth county. To the north of this river, the first rocks met with are great angular blocks, twenty-five by thirty feet long, of greenish-gray hornblendic material, which are wholly destitute of stratification and carry small veins of asbestus. Very similar masses *in situ* are also to be seen on the post-road to Weymouth, a few miles north of Cape Cove, and both are doubtless diorite dykes. Beyond the masses referred to, on the coast, but separated by a considerable interval, is a light-gray slate holding narrow seams of quartzite and dipping northerly from 82° to 90°. These beds form a portion of a series of shore ledges which are exposed at intervals to Cape Cove, and which present upon the southern side of the latter a series of prominent cliffs, in places eighty feet high. The course of the beds often corresponds to the trend of the shore, and their character, as seen at different points, as well as their strike, indicates that they are largely if not wholly an extension of the beds already noticed about Salmon River. Among them may be especially noticed a series of argillites resembling those upon the shore north of Allen Lake in being many-coloured, though with green as a predominant tint. They are probably representatives of Division II. of the Cambrian succession, and as such are followed at Cape Cove by dark-gray and black slates, of a highly

Salmon River.

Cape Cove.

Allen Lake.

* This lake is shown on the County Map about four miles north of its true position.

pyritous character, that are believed to be the equivalents of Division III. So abundant are these pyrites crystals that the post-glacial beds which overlie the slates and cap the cliffs, are for a considerable distance, by the products of their decomposition, cemented into a ferruginous conglomerate, the exact counterpart of the conglomerates of similar age to be found about Bridgewater in Lunenburg county. Quartz veins are also of common occurrence, and occasionally carry small veins of copper-pyrites. The slates are often conspicuously banded with paler layers, and have a south-east dip of about 65°.

Pyritous beds.

Cape Cove.

It is probable that the indentation of Cape Cove corresponds to a band of soft and easily removed strata, for no rocks are exposed at its head, and the depression which it marks extends inland for a considerable distance. Along its northern side, however, more resisting beds again come to the surface, and running out to the coast, form the conspicuous promontory upon which stands the Cape St. Mary lighthouse.

Upon both sides of this promontory the strata are well exposed, but while those on the south are easily accessible, those to the north form, for a long distance, a series of beetling cliffs, already referred to upon an earlier page, and of which the examination, either from the shore or by water, is a task of much difficulty and of no little danger. The work was, however, undertaken by Mr. Prest, and the following is a summary of his notes thereon.

Cape St. Mary.

Upon the shore south of the promontory and east of the lighthouse, the most conspicuous rocks are greenish-gray and gray arenaceous shales, containing bands of gray slaty quartzites which are more or less crystalline, as well as felsitic bands of bluish-gray, and sometimes yellowish, colours. Their dip is pretty uniformly S. 28° E. at high angles, and their exposed breadth is about thirty paces. Immediately beneath these greenish arenaceous shales, are cream-coloured and light yellowish-gray sandstones, of coarse texture, which in addition to minute garnets include numerous hard granular particles, of a dark-gray colour, imbedded in a paste which is much lighter and at the same time soft and unctuous. These beds are also noticeable as containing numerous grains of carbonate of iron and mica. In several respects they are unlike any beds seen elsewhere in the Cambrian system, and they may possibly form no portion of it. Their dip, however, which is quite uniform (S. 27° E. $<$ 75°), accords with that of the associated beds, their breadth being about fifteen paces. Immediately below the cream-coloured sandstones, an abrupt change occurs, the next succeeding beds being light-and dark-gray argillites which are much contorted but which near the junction with the sandstones conform to the latter in dip. It is upon these argillites that the lighthouse stands.

Coast section north of St. Marys lighthouse.

The first beds exposed in the high bluffs to the north of the lighthouse, are light- and dark-gray argillites, similar to those last mentioned, and with a nearly similar dip. The precipices are about fifty feet high and often overhang; but further east they become still more bold and rugged, ranging from 100 to 200 feet in height and presenting a wild and desolate aspect. No other rocks than slates are visible, but these apparently form a series of folds approximately parallel to the trend of the coast, the first anticline being about one-third of a mile N. by E. of Cape St. Mary, followed, at about the same distance, by a syncline, but without repeating the green shales. The next anticline continues further and brings up lower slates, but still of the same character. Still another anticlinal fold extends parallel to the coast for three or four miles, the dip on the north side becoming N. 50° W. $<$ 50° to 75°. A short distance south of South Metaghan, this fold seems to run out into the sea, but one mile north of Metaghan River, on the shore, are greenish-gray quartzites with numerous small seams of greenish-gray arenaceous shales, dipping S. 47° E. $<$ 87°. Along the course of the Metaghan River also, between the village and the station, a junction of green and dark-gray or black argillites may be seen, but both the character and position of these indicate that they are the extension of strata and of folds already noticed, and the section across this part of Nova Scotia thus becomes completed.

Metaghan.

The surface of the interior of Digby county is even more generally and more deeply drift-covered than that of Yarmouth. There are, however, several considerable streams traversing the district which afford good opportunities for study, and these, with such outcrops as can be found in the intervening districts, give a tolerably fair idea of the whole structure.

West branch of the Tusket River.

The first of these streams is the West Branch of the Tusket, flowing from Wentworth Lake, which is itself fed by two tributaries, the one originating in small lakes near the western border of the granite tract, the other from similar lakes in the settlements of Hillton, New Tusket and Corbrey. On the main stream, south of Wentworth Lake, the rocks are chiefly mica-schists which are more or less garnetiferous; and similar strata occupy most of the area eastward from this point to the granite, here distant about eight miles on the line of strike. To the south-west again, and southward of the road connecting Wentworth Lake with Hectanooga, are both hornblendic and staurolitic schists, an extension, no doubt, of the metamorphic belt of Brazil Lake, Lake

Annis, etc., in Yarmouth county. On the other hand, Wentworth Lake itself is bordered by quartzites, being a portion of a belt extending eastward to the granite about Barrios Lake and westward to the sources of Salmon River. Along the main line of the Tusket, this quartzite anticline has a breadth of about four miles, which becomes somewhat widened in the direction of the granite and narrowed to the westward, where it is much obscured by drift. It is here that the remarkable kame, known locally as the "Boar's Back," is to be seen, and which, between Wentworth Lake and the head of Salmon River forms the line of the road connecting these points, being just wide enough for this purpose.

Wentworth Lake.

"Boar's Back."

The exposures on Salmon River itself are not numerous, while the course of the stream in its upper part is nearly the same as that of the rocks. In its lower courses, however, its direction is oblique to that of the strata, and here are indications of another narrow quartzite anticline, flanked on either side by corresponding synclines of slate, all of which are traceable from the coast north-eastward to the Metaghan River.

Salmon River.

Metaghan River.

The last-named stream is somewhat larger than that of Salmon River, and the information which it affords is much more satisfactory. Its waters are derived from numerous tributaries, some of which approach quite nearly the waters of the Tusket in Hillton and New Tusket settlements, while others are not far removed from the Sissibou River.

In New Tusket and Corbrey, the rocks are light greenish-gray sandstones and greenish arenaceous slates, such as elsewhere succeed the quartzites of the Cambrian system, and here mark the north side of the Lake Wentworth anticline already described. It is not quite certain whether they connect with the similar rocks of the middle portion of Salmon River; but in the opposite direction they exhibit a well defined syncline, extending to and beyond the Sissibou River, in which direction they also include, in the form of purplish-gray slates and blue and black slates, beds occupying a higher position in the Cambrian succession than those exhibited over most portions of Digby county. These will presently be more fully noticed.

New Tusket.

The highest tributaries of the Metaghan, like those of the Tusket, drain the western end of the New Tusket synclinal. In descending the stream towards the Belliveau road, indications of an approach to a quartzite anticline are clearly indicated in the drift; and, about Metaghan or Victoria Lake, as well as about Belliveau Lake, are ledges of blue quartzite with occasional seams of bluish-gray slate. These beds

Metaghan Lake.

dip S. 25° E. $<$ 62°. The exact limits of this anticline are, as usual, very difficult to determine, owing to the absence of exposures, but it would seem to have, along the Belliveau road and about the middle courses of the Metaghan, a width of about eight on nine miles. Exposures of quartzite may be seen near and south of Beaver Lake, and again at a point one mile and a quarter east of Raymond's mill, or one mile and three-quarters east of the Dominion Atlantic Railway.

Plications.

In the vicinity of Raymond's mill is afforded a good opportunity for the study of the numerous folds by which this part of Digby county has been affected. We have here, apparently, an anticline overturned to the east, the quartzites which mark its centre occurring about half a mile east of the mill, while on either side these are flanked by arenaceous and micaceous slates that gradually pass upward into gray slates, as these do into slates banded with lilac and purple. The dip is nearly the same upon both sides of the anticline, or about N. 50° to 60° W. $<$ 80°, but the beds are repeated in inverse order. It is the same anticline as that already noticed upon Salmon River.

Sissibou River.

We come now to the Sissibou River, the most considerable of all the streams traversing Digby county, as it is also that affording the most complete view of its geological structure.

The sources of the Sissibou are in the granite country, which occupies so large a part of the eastern portion of the county. The western limit of the granite is about half a mile below the Sissibou Forks. The rocks which adjoin the latter on the main stream, as well as about its tributary in Wagner settlement, are, as would be expected, highly metamorphic, consisting in part of quartzites showing traces of granitic dykes, hornblendic slates and hornblende-rock, the latter being much shattered, though massive, while the slates are regularly stratified and continuous. Near the junction of the two streams the hornblendic beds become less frequent, but the rocks are still highly altered, consisting of micaceous slates in which both staurolite and andalusite are abundantly developed. Near the same point the course of the Sissibou, previously westerly, turns abruptly to the north-east, the locality being further marked by a considerable fall. The rocks here are mainly blue slates, finely stratified, with some thin beds of light-gray slates. They are a portion of a rather broad synclinal basin, of horse-shoe form, the axis of which inclines to the eastward. Above the bend the dips are northerly, as they are at the falls, but northward of this, in descending the stream, gradually swing around through east to south-east and south. Similar southerly dips prevail all the way to the mouth of Mistake River, the slates which occupy all the interval

Falls.

exhibiting slight variations in colour and texture, and in places showing a somewhat ribbanded aspect. They also show, sometimes, traces of metamorphism, and are cut by iron-bearing quartz-veins.

Mistake River.

Mistake River is the principal tributary of the Sissibou. It first takes definite form where it flows from Mistake Lake, near the settlement of North Range. The lake in question is bordered in part by granite and in part by quartzites to be presently noticed; but along the whole course of the stream, a distance of five miles, the rocks are slates similar to those of the Sissibou, of which they are the eastward extension. To the south of the stream, however, between the latter and the granite, is a belt of much more recent strata. These are also slates, but are more arenaceous than those of the Cambrian system, and show their comparatively modern origin in containing rotten ochreous layers, abounding in fossils of Lower Devonian type. They are in fact similar to the beds of this age found at Bear River farther east, and with the latter will be more fully considered in the sequel. They are here inclosed in a sort of bay formed by the granite, and probably occupy and mark the centre of the Cambrian syncline. The slates of the latter, as seen along Mistake River, abound in slickensided surfaces, an evidence of extensive movements.

Devonian rocks.

Near the junction of Mistake River with the main Sissibou the slates, some of which are greenish and more or less unctuous, others purplish or greenish with purplish bands, begin to include beds of gray and greenish-gray sandstone, and not far below the junction, at the High Falls, are fine exposures of these beds still dipping southerly. They evidently mark the transition to the quartzites of the lower division of the Cambrian system, which quartzites appear in place immediately below the falls, forming for 200 yards a series of high cliffs, the dip of the beds being S. 16° E. $<$ 80°.

High Falls of Sissibou River.

About a fourth of a mile below Sissibou Falls, hard blue quartzites, with seams of greenish slaty sandstone, again form bluffs with a vertical dip (S. 19° E.), and three-fourths of a mile farther are similar beds with nearly the same dip. There are within this space some indications of an anticline, but the prominence of cleavage planes and numerous variations in the dip either side of verticality, make its determination uncertain. Beyond the quartzites last referred to, the rocks show a mixture of greenish sandstones and slates, with purplish bands, followed by purple slates, the dip being northerly and the beds evidently the same as those near the mouth of Mistake River, now repeated on the other side of an anticline. A furlong below these exposures are bluish and greenish-gray sandstones with little slate,

Quartzites Div. 1 a.

Purple slates.

much contorted, but with an average dip N. 6° W. < 50°, these beds being here probably brought to the surface by a fault. At a distance of another furlong, and about fifty yards from another stream entering the Sissibou from the north-east, are bluish-gray sandstones or quartzites, which also appear at intervals for a quarter of a mile, the dip throughout this distance being uniformly southerly (S. 22° E. to S. 40° E. < 60°). A fault then brings up purplish-gray slates, still with southerly dip (S. 40 to 45° E. < 70°). There is probably here a minor synclinal fold, the succeeding beds, in descending order, being greenish slates, argillaceous slates of dark-gray colour tinged with purple, bluish-gray and greenish-gray sandstones, fine dark-gray sandstones with dark argillites, and finally hard blue quartzites with greenish slaty partings. This is the regular descending Cambrian succession, the breadth of the transition beds from the fault to the quartzites being a little less than a mile, and the southerly dips averaging about 50°.

Fault.

Descending succession.

The quartzites which form the lower division of the Cambrian system are well displayed along the lower Sissibou and in the vicinity of Weymouth, as they are also at various points along the south shore of St. Mary's Bay. On the Sissibou they may be well seen about two miles and a quarter above Weymouth.

Quartzites of Weymouth.

The Sissibou section has been referred to as typical of the structure of a large part of Digby county. This is especially true of that portion of the latter which intervenes between this stream and the shores of Annapolis Basin.

Sissibou section a typical one.

Thus the quartzites and associated beds described as occupying the lower portion of the Sissibou, below Mistake River, similarly occupy a large part of the tract eastward of the first and north of the last-named stream, on either side of the line of the Dominion Atlantic Railway. Much of the tract is indeed, as usual, covered with drift, but exposures are sufficiently numerous to afford, with assistance of the drift, clear indications of the underlying rocks. The best exposures are, as might be expected, upon the coast, and particularly in the vicinity of Gilbert Cove, of which the outer part consists of massive dark-gray sandstones or quartzites, dipping S 20° E. < 20°, while on the high road above the head of the cove are mica-schists carrying small crystals of magnetite. The quartzites are also well exposed along the road connecting the head of St. Marys Bay with the settlement of North Range, as they are between the head of the same bay and the town of Digby, where they again show evidences of considerable alteration. In North Range settlement again, where the Cambrian strata meet and have been probably in part replaced by a northward spur of intru-

Dominion Atlantic Railway.

North Range.

sive granite, the evidences of alteration may be readily seen, particularly about the eastern end of Mistake Lake, where are immense boulders of reddish slaty gneiss which are evidently local; but it is noticeable here, as in Queens and Shelburne counties, that the massive quartzites are but little changed even where the accompanying finer beds are altered into glistening mica-schists.

The section across the isthmus separating St. Marys Bay from Annapolis Basin, in the vicinity of the town of Digby, remains to be described. It is not perhaps so complete as that of the Sissibou, but it is more accessible, and, as again affording an admirable illustration of the Cambrian succession and a comparison with the rocks of that system on the Atlantic seaboard, in Queens and Lunenburg counties, well deserves a somewhat extended notice.

Brighton.

Near the south-east side of St. Marys Bay and in the eastern part of Brighton, the quartzites which form the base of the section may be seen, dipping easterly. They are greenish in tint and more or less micaceous, and are an evident continuation of those of Plymouth and the lower portion of the Sissibou River. Crossing the post-road, they probably form the basis of much, if not the whole, of the high land closely adjacent to the town of Digby, though they are completely concealed from view. Approaching Marshalltown, along the line of section, bands of green slate begin to replace the quartzites, and at last become the prevailing rock. Then, on the high land of Marshalltown, purple slates come in, resembling, even in the most minute particulars, the purple slates holding a similar position in Queens county. Here as there the lower purple slates show numerous light yellowish-green seams which are very characteristic. Wherever seen the yellowish-green seams show faint bedding lines, which here and there are discontinued or replaced by purple slate for half an inch or an inch. Occasionally a very narrow dark green seam is seen in Digby as well as in Queens county. Then come, as in the latter, bluish-gray and lilac slates, then a series of (upper) purple slates without yellowish seams, and then bluish-gray and light-gray striped slates, seen on the north-east end of Marshalltown hill. Finally, on the hills south of Jordantown and up the Lee or Bingeys Brook above the Valley Mills, is seen the transition to the black slates. A fine exposure of the latter may be seen near the railway bridge on the Grand Joggins, while they are also well exposed on the hill above Acacia cottage and along the road leading thence to North Range.

Marshalltown.

Comparison of succession in Digby and Queens.

Grand Joggins.

The above section may be continued beyond the Grand Joggins to Bear River, the eastern border of Digby county, as it is also the natural eastward termination of the great Cambrian tract described above.

Succession on Hollinghead Brook.

On Hollinghead Brook the black and bluish-black slates of the Grand Joggins are again seen, exhibiting the following ascending succession :—

1. Black slates, one-third of a mile. Dip N. 65° W. < 65°.
2. Gray and bluish-gray sandstones. Dip N. 60° W. < 60°.
3. Black slates. Dip N. 50° W. < 60°.
4. Belt of light-gray sandstone. Dip N. 50° W. < 60°.
5. Black slates—about 1000 ft. Dip N. 50 W. < 55°.
6. Striped slates, viz., bluish, light and dark-gray. Dip N. 50° W. < 65° to < 45°.
7. Black slates, for one-third of a mile. Dip N. 55° W. < 45° to < 30°.
8. Striped bluish-gray and light and dark gray slate.

The last-named striped slates have a prevailing south-east dip, and with some wave like undulations mark the centre of a syncline, on the other side of which the beds are reversed for about half a mile, the whole basin being at the same time inclined in the direction of Bear River. The dip on the south-east side of the syncline is in places almost perpendicular.

Diorite dyke.

About a furlong south-east of the above syncline is a dyke of diorite, nearly 100 feet thick, that is probably continuous with a belt of such rock exposed on the west side of Bear River. It protrudes through the almost perpendicular slates and forms a succession of falls over fifty feet in height. South-east of the dyke the slates maintain for a time their vertical dip, then inclining northward at an angle of from 50° to 60°.

A little over a furlong south-east of the dyke is the apex of a minor fold subordinate to the main Weymouth fold. The dip is about N. 30° W. < 65°. Still farther south-east the country becomes covered with drift in which boulders of granite and diorite predominate.

Roach Brook.

On Roach Brook (or Poole Brook), which runs into Smith Cove, are still other exposures of light and dark-gray and bluish-black slates, with bands of blue sandstone. These latter are conspicuously buff-weathering, and thus become very noticeable features in the rocks of this vicinity, the bands being from three inches to one and one-half feet in thickness and standing out above the softer slates. The dip varies from N. 40° W. to N. 55° W., and the inclination from 78° to verticality. A dyke of diorite, similar to that of Hollinghead Brook and in the same range, is also seen here.

Smith Cove.

About the lower part of Roach Brook, at Smith Cove, the dark slates are, as usual, in numerous short folds, dipping steeply to the eastward, the folds themselves being inclined in the same direction at angles from 70° to 80°. The slates are often stained and sometimes permeated for some distance with red, buff and green colouring matter, this being distributed usually not in lines corresponding to the bedding, but in patches. Where these colours are present the slates are softer and apparently more argillaceous than elsewhere. In these respects they resemble the soft slates described on a previous page as occurring on the coast south of Cape St. Mary.

Red slates of uncertain age.

As in the case of the beds last referred to at Cape St. Mary, it is by no means certain that the rocks of Roach Brook and the tract intervening between the latter and Bear River, are of Cambrian age. In some of their features they bear quite as close a resemblance to the rock of Eo-Devonian age, so largely developed to the eastward of this point and to be presently noticed. The apparent total absence of fossils favours the former view, but, on the other hand, beds but little removed from those in question are almost certainly to be referred to the more recent of the systems named. These occur about 100 yards north of the railway bridge at Smith Cove, and embrace a large mass of very soft unctuous and friable slates or shales, of which the prevailing colour, at least upon the surface, is a deep brownish-red, with narrow bands of light and dark bluish-gray and greenish-gray colours. Their dip is well defined N. 10° W. $<$ 78°. They will be referred to again in connection with the consideration of the Devonian system.

Shores of Annapolis Basin.

On the shores of Annapolis Basin, between Grand and Little Joggins, are still other exposures of the black and striped slates of the Cambrian system. They show a succession of small folds dipping steeply to the eastward, and at one point include a three-foot bed of sandstone. At another bend they include a band of vesicular gray sandstone, in appearance not unlike some of the light-coloured traps of the North Mountain, but considerably metamorphosed. The slates, sometimes weathering to a light buff or red, are exposed for about a furlong north-west of the railway bridge, or to within a mile and a quarter of the town of Digby, where they become drift-covered.

Bear River.

It seems altogether probable that of the beds described in the above sections, some if not all extend to and are represented in the strata of the deep valley of Bear River. It is, however, certain that a large part of the beds exposed in that estuary, and more particularly about the head of tide-water, are much more recent, being abundantly filled with recognizable Lower Devonian fossils. The line of separation between the two sets of beds is a more difficult question, and cannot well be considered until the whole character and structure of the Devonian system, as seen to the eastward, has been described.

Summary of conclusions.

It may be of service to close this review of the Cambrian rocks of Yarmouth and Digby counties with a brief summary of the more important conclusions which are apparently deducible therefrom.

1. The wide distribution of the Cambrian rocks in the counties named; no other stratified rocks, except a narrow belt of Siluro-Devonian beds and the Triassic traps and sandstones of Digby Neck, being found within their limits. Their total area within the counties named would probably not fall short of 1000 square miles.

2. The almost exact parallelism in the succession of the Cambrian beds, as seen on the Sissibou and in the section from Marshalltown to the Joggins, with that seen in parts of Queens and Lunenburg counties, a parallelism which is not only a general one, but descends to the minutest details.

3. The great thickness attained by the principal members of the Cambrian system, and the consequent great thickness of the whole system as developed in this region. Mr. W. H. Prest, from a series of careful measurements on the Sissibou, has estimated the aggregate thickness as high as 28,000 feet, but in view of the many possibilities of error among rocks so highly folded and faulted, it seems to the writer that the estimate is considerably too high.

4. The absence of any distinct break between the supposed Cambrian quartzites and slates of Digby county and the associated quartzites and slates of Devonian age, the foldings and metamorphism by which both have been affected having apparently been synchronous and therefore both Devonian or later.

5. The principal anticline or dome recognized in Digby county is that of Weymouth. The quartzite which marks its course can be readily traced from the head of St. Marys Bay (Marshalltown) southwesterly through Brighton and Plympton to Weymouth; and, west of Weymouth, along the line of the Dominion Atlantic Railway, and upon the south coast of St. Marys Bay to Saulnierville. The axis of the anticline is probably in the vicinity of Weymouth Bridge.

The greenish-gray and purple slates which succeed the quartzites curve around the eastern and southern edge of the latter. From a point a little east of the head of St. Marys Bay they run south over the higher part of Marshalltown Hill and are seen in the brook beyond. They then curve gradually around to the south-west and pass through

Bloomfield and North Range, reaching the Sissibou a quarter to one-half a mile below the mouth of Mistake River. Thence extending to the south-west they can be traced to the head-waters of Metaghan River, but here meet and fold around another quartzite dome (that of Metaghan) which thence extends to the head-waters of Salmon River, there to unite with another belt (that of Tusket) stretching east and west either side of Wentworth Lake. A minor belt of quartzite, bordered on either side by green slates, extends from near Metaghan station to the coast at the boundary line of Yarmouth county.

Course of Cambrian folds.

The blue and black slates which form the higher member of the Cambrian succession, beginning near Digby, are first seen near Jordantown and at the Grand Joggins, and can be traced south-westerly, with many contortions, up the Lee or Bingay Brook, striking the granite a little east of North Range. South-west of the granite tongue in the latter settlement and at Mistake Lake the course of the belt is resumed and this is again seen on the Sissibou for three miles above the mouth of Mistake River. South-west of the Sissibou it has been traced to the New Tusket and Weymouth road.

Age of Yarmouth rocks.

6. The approximate equivalency of the micaceous and hornblendic rocks of Yarmouth Harbour and their northward extension with the micaceous and staurolitic rocks of Shelburne county, and therefore with Division I. *b*, with possibly much or the whole of Division II. of the Cambrian system.

The essential correspondence of the rocks of Point Fourchu with those of the Pubnico Peninsula, the resemblance of the latter to the rocks of Jordan Bay and Shelburne Harbour, a resemblance which is repeated in that portion of the hornblendic belt which borders lakes Annis and Brazil, the equally marked resemblance, commented on by Dr. Selwyn, between the beds of Cranberry Point and those of Chebogue Point, clearly prove these beds to be parts of a single system; while their relations to the quartzites of the Tusket on the one hand and to those of Cranberry Head and Hectanooga on the other, as well as to the black slates of Carleton and Arcadia, show as clearly their place in that system. It may be added that the abundance of hornblende which constitutes the most conspicuous feature of this belt, and which has caused it to be referred by several authors to a Pre-Cambrian horizon, is largely confined to beds which appear to be of the nature of dykes. Further, the rocks of Division I. *b*, to which these rocks have been referred, are, even in Queens and Shelburne counties markedly chloritic, and the relative abundance of one or the other of these nearly related minerals may well be only an accident of meta morphism. The conglomerate character of the beds of Point Fourchu and of Pubnico may be only a local feature, but even this finds its counterpart in some of the beds, otherwise strongly resembling those of Pubnico, which occur on the shore of Port La Tour, in Shelburne county.

SILURIAN, DEVONIAN AND ASSOCIATED ROCKS.

GRANITES OF ANNAPOLIS COUNTY.

In tracing the northern margin of the central granitic axis, this has been described as crossing the boundary line between Digby and Annapolis counties not far south of the forks of Bear River. On the east branch of this stream the granites are finely exposed and their contact with Devonian quartzites well exhibited, about two miles above Bear River village. From this point the course of the granitic outcrops runs just south of the settlement of Greenland, and nearly parallel to the road extending from Bear River village to Cod Lake, until, near the latter, it curves more to the northward, and reaches the settlement of Virginia just north of the forks of the Virginia road. The next point to the eastward at which granites have been observed is on the post-road connecting the towns of Annapolis and Liverpool, but here the main body of the granite, of which the exposures above noted are a part, is separated from another considerable area of similar rock, forming the hills in the rear of Annapolis, by a band, about one mile wide, of fossiliferous Devonian rocks. It is believed that these two granitic areas become confluent just east of the highway referred to, as no other rock than granite was observed on the Dalhousie road, only two miles to the eastward, thus giving to the granite hills of Annapolis the character of a spur from the main body of these rocks. On the Liverpool road as well as on the Lequille stream, whose course is here nearly parallel to the latter, the width of the granite tongue is about four miles, and west of the Lequille varies from four to five miles, its border being subject to some fluctuations and not always exposed to view. Extending in the direction of Clementsport, it includes the settlements of Birchtown and Guinea, as well as all the high land between these and Annapolis Basin, but does not quite reach Clementsport, terminating just north of Guinea in the form of two minor tongues, separated by a bay-like flexure.

Distribution of granite from Bear River to Liverpool road.

From the vicinity of the town of Annapolis eastward, the granites, rising rather abruptly from the Annapolis Valley, constitute the range of the South Mountains, the southern border of which, in and near Queens county, has already been traced. The northern border,

South Mountain.

for a distance of about twenty-five miles, lies usually a little south of the more southerly of the highways traversing the length of the valley, (though occasionally, as at Round Hill, crossing this and reaching quite to the waters of Annapolis River), but just south of Lawrencetown this uniformity of outline ceases, another bay similar to that of Clementsport and Bear River, and similarly occupied by Devonian rocks breaks its continuity, and this bay is itself further diversified by projecting dykes and outlying isolated masses of granite, making the tracing of the geological boundaries a matter of some difficulty. Williamston. Just south and west of Williamston, the hills close to the highway, seem to be wholly composed of granite ; but just where this highway is met by that leading from Williamston to Inglesville, an abrupt change of direction occurs. The border of the granite recedes to the south and west until, gradually curving around at a distance of about three miles from its former position, it again extends easterly, thus inclosing the whole of the area occupied by west, middle and east Inglesville. Inglesville. In West Inglesville the contact of the stratified (Silurian) rocks and the granite may be seen on the old Albany road, five miles south of Lawrencetown ; but at Inglesville Centre a northward spur brings the rock up quite to the corner in the middle of the settlement, whence it again recedes, barely reaching the road from East Inglesville to Alpena, and not crossing the latter until within a mile of where the Alpena road crosses that leading to New Albany. From this point the course of the granite is nearly due east, until, at a distance of Cleveland. about two miles and a half, it reaches, in the upper part of Cleveland, the valley of the Nictaux River and the line of the Nova Scotia Central Railway. Here, however, in addition to the main body of the granite referred to above, a belt of similar rock, rather less than a mile in width and separated from the former by a band of slates of nearly similar width, is brought to view, and from the valley of the river and railway stretches for some distance, both east and west. In the latter direction, the country being thickly wooded, its limits have not been fully made out, but from the occurrence of granitic outcrops on the road from Nictaux Falls to East Inglesville, it is thought that the belt may be continuous with the latter. To the north of this latter Jones Brook. road, and in the same general direction, a considerable mass of granite comes into view between Jones Brook and the Albany Road, (being traversed between these points, for a distance of about two miles, by the road connecting Williamston with Nictaux Falls), but this mass is certainly isolated, as between it and the granite belt described above in Cleveland, dark quartzites and diorites of the Devonian system have been found to intervene. On the other hand the Cleveland belt, crossing the Nictaux River at and below its forks, is doubtless connected with similar rocks holding a like position and relations in the settlement of Bloomington, beyond which they have not been followed. Finally, granite veins and masses of various dimensions are found penetrating Silurian slates on the summit of the hills just west of Nictaux Falls.

In the several areas above described, including the settlements of Inglesville, Nictaux, Cleveland and Bloomington, is to be noticed the frequent occurrence in connection with the granite of masses of coarsely crystalline diorite. It is true that such masses are frequently found as dykes penetrating Devonian slates or quartzites, but they invariably increase as the granite is approached, and in many places seem to graduate into or to replace the latter. The contacts of both with the sedimentary rocks are often very intricate and present many features of interest, but these can best be noticed in connection with the Devonian rocks which the granites invade. Diorites.

Of the enormous areas of granite which occupy the larger part of the county of Annapolis, and whose borders, both on the north and south, have been described in preceding pages, but little is at present known, the work of exploration having been hitherto confined almost wholly to those borders and to the adjacent rocks of Cambrian or Devonian age. It is, however, known that at least one area of quartzites is included within the area usually assigned to the granites, and it is possible that others may exist as well. On the line of the Nova Scotia Central Railway, granite appears to be the only rock exposed between Alpena Station and Springfield; it is exposed almost continuously on the Roxbury road, south of Paradise, to and beyond Roxbury settlement; it is similarly found on the Morse or Bloody Creek Road, south of Bridgetown; and finally, on the Annapolis and Liverpool road, it is, with the exception of the small area of fossiliferous quartzites four miles south of Annapolis, the only rock seen as far as the settlement of Maitland, a few miles north of the northern boundary of Queens county. Interior of Annapolis county.

SILURO-DEVONIAN ROCKS OF DIGBY AND ANNAPOLIS COUNTIES.

Earlier Investigations.

The occurrence of rocks of Silurian or Devonian age, or both, at various points along the northern slopes of the central granite axis of the Nova Scotian peninsula has been long known, while these have also been made the subject of study and discussion by various writers.

Among the observations thus made those of Sir J. Wm. Dawson are not only the earliest but the most important, and some knowledge of their Early observations.

substance is a necessary prelude to the right understanding of the later work done in the region.

In a paper on the Silurian and Devonian rocks of Nova Scotia (Canadian Naturalist, April, 1860) Sir J. Wm. Dawson says:—

Beech Hill beds.

"The oldest fossiliferous beds seen [at New Canaan] are the fine fawn coloured and gray clay slates of Beech Hill, in which Dr. Webster, many years since, found a beautiful *Dictyonema*, the only fossil they have hitherto afforded. It is a new species, closely allied to *D. retiformis* and *D. gracilis* of Hall, and will be described by that palæontologist under the name of *D. Websteri* in honour of its discoverer. In the meantime I may merely state that it is most readily characterized by the form of the cellules, which are very distinctly marked in the manner of *Graptolithus*."

Dictyonema slates.

"The Dictyonema slates of Beech Hill are of great thickness, but have in their upper part some hard and coarse beds. They are succeeded to the south by a great series of dark-coloured coarse slates, often micaceous, and in some places constituting a slate conglomerate, containing small fragments of older slates, and occasionally pebbles of a gray vesicular rock, apparently a trachyte. In some parts of this series there are bands of a coarse laminated magnesian and ferruginous limestone, containing fossils which, though much distorted, are in parts still distinguishable. They consist of joints of crinoids, casts of brachiopodous shells, trilobites and corals. Among the latter are two species of *Astrocerium*, not distinguishable from *A. pyriforme* and *venustum* of the Niagara group, and a *Heliolites* allied to *H. elegans*, if not a variety of this species. On the evidence of these fossils and the more obscure remains associated with them, Prof. Hall regards these beds as equivalents of the Niagara formation of the New York geologists, the Wenlock of Murchison. Their general strike is north-east and south-west; and to the southward, or in the probable direction of the dip, they are succeeded, about six miles from Beech Hill, by granite. They have in general a slaty structure coinciding with the strike but not with the dip of the beds, and this condition is very prevalent throughout this inland metamorphic district, where also the principal mineral veins usually run with the strike. The beds just described run with south-west strike for a considerable distance, and are succeeded in ascending order by those next to be described." * * *

Nictaux.

"At Nictaux, twenty miles westward of New Canaan, the first old rocks that are seen to emerge from beneath the New Red Sandstones of the low country, are fine-grained slates, which I believe to be a continuation of the Dictyonema slates of Beech Hill. Their strike is N.

30° to 60° E., and their dip to the south-east at an angle of 72°. Interstratified with these are hard and coarse beds, some of them having a trappean aspect. In following these rocks to the south-east or in ascending order, they assume the aspect of the New Canaan beds; but I could find no fossils except in loose pieces of coarse limestone, and these have the aspect rather of the Arisaig series than of that of New Canaan. In these and in some specimens recently obtained from Mr. Hartt, I observe *Orthoceras elegantulum*, *Bucania trilobata*, *Cornulites flexuosus*, *Spirifera rugaecosta ?* and apparently *Chonetes Nova-Scotica*, with a large *Orthoceras*, and several other shells not as yet seen elsewhere. These fossils appear to indicate that there is in this region a continuance of some of the upper Arisaig species nearly to the base of the Devonian rocks next to be noticed. Fossils.

"After a space of nearly a mile, which may represent a great thickness of unseen beds, we reach a band of highly fossiliferous peroxide of iron, with dark-coloured coarse slates, dipping S. 30° E. at a very high angle. The iron ore is from three to four and a half feet in thickness, and resembles that of the East River of Pictou, except in containing less silicious matter. The fossils of this ironstone and the accompanying beds, so far as they can be identified, are *Spirifer arenosus*,* *Strophodonta magnifica*, *Atrypa unguiformis* [now known as *Orthis hipparionyx*], *Strophomena depressa* [now known usually as *S. rhomboidalis*] and species of *Avicula*, *Bellerophon*, *Favosites*, *Zaphrentis*, &c. These Prof. Hall compares with the fauna of the Oriskany sandstone; and they seem to give indubitable testimony that the Nictaux iron ore is of Lower Devonian age. Iron ores. Fossils.

"To the southward of the ore, the country exhibits a succession of ridges of slate holding similar fossils, and probably representing a thick series of Devonian beds, though it is quite possible that some of them may be repeated by faults or folds. Farther to the south these slates are associated with bands of crystalline greenstone and quartz rock, and are then interrupted by a great mass of white granite, which extends far into the interior and separates these beds from the similar, but non-fossiliferous rocks on the inner side of the metamorphic band of the Atlantic coast. The Devonian beds appear to dip into the granite, which is intrusive and alters the slates near the junction into gneissoid rock holding garnets. The granite sends veins into the slates, and near the junction contains numerous angular fragments of altered slate. Granite contacts.

* Also another and smaller *Spirifer*, believed to be new and eminently characteristic of the Nictaux deposits, to which the provisional name of *S. Nictavensis* was assigned.

West Nictaux "Westward of the Nictaux River, the granite abruptly crosses the line of strike of the slates, and extends quite to their northern border, cutting them off in the manner of a huge dyke, from their continuation about ten miles further westward. The beds of slate in running against this great dyke of granite, change in strike from south-west to west, near the junction, and become slightly contorted and altered into gneiss, and filled with granite veins; but in some places they retain traces of their fossils to within 200 yards of the granite. The intrusion of this great mass of granite without material disturbance of the strike of the slates, conveys the impression that it has melted quietly through the stratified deposits, or that these have been locally crystallized into granite *in situ*.

Moose River. "At Moose River, the iron ore and its associated beds recur on the western side of the granite before mentioned, but in a state of greater metamorphism than at Nictaux. The iron is here in the state of magnetic ore, but still holds fossil shells of the same species with those of Nictaux.

Bear River. "On Bear River, near the bridge by which the main road crosses it, beds equivalent to those of Nictaux occur with a profusion of fossils. The iron ore is not seen, but there are highly fossiliferous slates and coarse arenaceous limestone, and a bed of gray sandstone with numerous indistinct impressions apparently of plants. In addition to several of the fossils found at Nictaux, these beds afford *Tentaculites*, an *Atrypa*, apparently identical with an undescribed species very characteristic of the Devonian sandstones of Gaspé [this is now known as

Fossils. *Leptocœlia flabellites*], and a coral which Mr. Billings identifies with the *Pleurodictyum problematicum*, Goldfuss, a form which occurs in the Lower Devonian in England, and on the continent of Europe."

This description, than which, as regards the general features of the region, no more admirable one could be given, was subsequently represented, in nearly the same form, in the second edition of Acadian Geology, 1868. Eleven years later,* in reply to certain criticisms of Dr. Honeyman, Sir Wm. Dawson again states the observations above

Summary by Sir Wm. Dawson, 1879. quoted, and in a summary of results states that he has recognized, on the evidence of stratigraphy and fossils, in the district extending from New Canaan to Bear River, the following groups of rocks:—

1. The Niagara series, the Wenlock of English geologists, represented by the *Dictyonema* shales and coral-bearing rocks of New Canaan.

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* Remarks on Recent Papers on the Geology of Nova Scotia (Nova Scotian Institute of Natural Science, February, 1879.

This group may be called either Middle or Upper Silurian, according to different classifications in use.

2. The Upper Arisaig series (of Dawson, not of Honeyman,) the equivalent of the Lower Helderberg series of America, the Ludlow of England.

3. The Oriskany series, represented by iron ores, sandstones or slates.

At the same time a list of sixteen species is given of forms found in the Moose River and Bear River beds of which the greater part were either characteristically Oriskany types or very nearly related to well-known Oriskany species.

Collections in 1892.

In 1892 a collection of fossils from Nictaux, Bear River and Mistake settlement was made by the writer and Mr. W.H. Prest, and tended to confirm the conclusions of Sir Wm. Dawson, so far at least as regards the beds of Nictaux and Bear River. They were examined by Dr. H. M. Ami, who states,* as to the two former points at least, that the beds are transitional, being either at the summit of the Silurian or at the base of the Devonian epoch, the weight of evidence being perhaps in favour of the Eo-Devonian. The fossils from Mistake Settlement indicate a Silurian tract.

Observations by Gilpin and MacKay.

The latest reference to this region are contained in the Proceedings and Transactions of the Nova Scotian Institute of Science, Vol. IX., Part I., 1896, in the form of an article by Dr. Gilpin, Inspector of Mines, on the iron ores of Nictaux, chiefly as viewed from an economic standpoint, and a brief description of the geology of the region by Dr. A. H. MacKay. The existence of Silurian as well as Devonian rocks is assumed, but apparently only on the authority of earlier writers upon the subject.

It now remains to see how far these views are likely to be affected by the observations of the writer.

Recent Investigations.

Nictaux-Torbrook Basin.

As the district about the Nictaux River and eastward to Torbrook has afforded the most satisfactory data, it may be first considered.

Nictaux River section.

In ascending the Nictaux River the first rocks disclosed to view, near an old mill-dam a quarter of a mile below the falls, are well-stratified dark-gray sandstones or quartzites, more or less banded, and dipping S. 10° E. $< 60°$. Similar beds form the hills overlooking the village

*Dr. H. M. Ami, in Report (by L. W. Bailey) on South-western Nova Scotia, Vol. VI., Part Q, 1892-93, p. 14.

of Nictaux from its western side, in which direction, as will be presently more fully noticed, they have been traced to the settlement of Inglesville. They have as yet failed to yield any fossils, but as, in the hills referred to, they are penetrated by dykes of diorite as well as by veins of granite, these are, perhaps, hardly to be expected. Their position, however, as will presently appear, is such as to indicate not only that they are the lowest beds of the series here represented, but mark the northern side of a great syncline, of which the northern side is several miles to the southward, near the granite hills.

Quartzites.

Slates.

Next above the quartzites just referred to and occupying the interval between the latter and the falls, or a space across the measures of about 700 feet, the rocks and slates are well exposed in the river and dipping as before. These slates are glossy, mostly gray in colour but sometimes with greenish shadings, and, more commonly, with reddish surface stainings of oxide of iron, a feature in which they resemble the ribboned beds of Deep Brook in the Clements Basin. Similar strata occur also at the falls, and with more conspicuous ribbonding, while, through metamorphism, they sometimes assume a gneissic aspect or are more or less chloritic. The dip remains as above.

Silicious slates.

Ascending the railway track, the next beds exposed, about a quarter of a mile above the station, are very hard and silicious gray slates, with heavy dykes of diorite, closely followed by dark-gray fissile slates of which the surfaces are marked by a network of fine lines, evidences of incipient crystallization. The dip, as before, is S. 10° E. $<$ 40°. Some gray quartzites also occur here, with diorite dykes holding much chlorite and some copper sulphide.

Diorite dykes.

At a culvert a quarter of a mile above the station, the beds exposed are partly coarse-gray, light-weathering slates, with shades of red and purple, and partly black slates, the one passing into the other not only laterally but on the line of strike. The beds are evidently much affected by diorite dykes, but the general dip remains unchanged. Some of the dark slates in this part of the section show branching fucoidal (?) markings, but no recognizable fossils were obtained.

About a quarter of a mile south of the culvert are other coarse, dark gray slates, but the dip is now reversed, or N. 20° E. $<$60°. This change is, however, only local, and apparently connected with the occurrence of a diorite dyke, about 100 feet broad, which is here exposed, and beyond which the southerly dip, S. 10° E. $<$ 60°, is again resumed.

The above-described beds are not far from where the river and railway make a long and deep curve to the westward, at the inner end of which the beds are again dark-gray slates of which the surfaces are stained with red oxide of iron or marked by numerous minute black crystals. These beds are not unlike those of Nictaux Falls, and also resemble the beds of the Torbrook iron mines, a resemblance which is the more important as at this point on the Nictaux, beds of hæmatite are known to occur, and were formerly mined to a limited extent. They also probably mark approximately the centre of the syncline, for the dip is here again to the northward (N. 10° W. $<$ 60°) and continues to be northerly through the remainder of the section.

Iron ores.

In accordance with the view last suggested, the beds which are exposed to the southward of those described above differ from the latter but little in aspect, being probably the same beds reversed. They differ, however, in one respect, *viz.*: that they are here abundantly fossiliferous, even where, as before, minute crystals on the surfaces show evidences of metamorphism. The fossils include many very large and coarse-ribbed shells, as well as some very finely ribbed, but all are difficult of removal. The width of these black fossiliferous slates is about a furlong—beyond which, after an interval of another furlong, are beds of hard, dark-gray, altered sandstone, with which are bands of black hæmatitic rock, resembling the beds to be presently noticed as occurring at Wheelock's iron mine, a few miles to the eastward, on the eastern side of the river. The dip at this point, which is three miles and three-quarters north of Alpena station, is N. 5° W. $<$ 80° to 90°.

Reversal of dip.

Fossils.

For nearly a quarter of a mile beyond and south of the above exposures, the railway track runs on the course of the nearly vertical beds, which, on either side, are dark, rusty and sandy slates, with white quartzose beds, holding ribbed shells and corals. The paler bandings which are very variable in length and thickness, are conspicuously contrasted with the dark lilac-coloured mass of the rock through which they are distributed, and at one point, for a distance of about 100 feet, wholly replace the darker beds, apparently along a line of fault. By similar faults these are in turn abruptly replaced by dark flinty and rubbly beds, the dip throughout being nearly vertical. The whitish beds, as well as the darker, have calcareous surfaces showing corals and shells. The cuttings showing the above features are at or near the No. 12 mile-post, or three miles from Alpena. A furlong beyond this post, the interval being without exposures, there are outcrops of granite.

No. 12 mile-post.

First granites. The granitic exposures last referred to are a portion of the belt, discribed in previous pages, which is, on the Nictaux River as well as for several miles either side of it, separated from the main body of such rocks by an intervening belt of stratified beds. The width of the granite belt as exposed is about half a mile, when, after a furlong without exposures, is a heavy railway cutting, in black coarse-grained

Slates but compact and flinty slates, in which fossils may now and then be found. The length of cutting is over 1000 feet, but largely on the course of the beds, of which the dip varies from N. 10° E. < 90° to N.

Main granites. < 90°. Half a mile beyond this cutting the main body of the granite is reached.

Fossils. The following fossils, determined by Dr. H. M. Ami, were obtained from the railway sections above described, mostly from the light-coloured beds about the No. 12 mile-post :—

1. *Palæophycus (?)* sp. indt. Very obscure fucoidal remains.

2. *Zaphrentis* or *Streptelasma*, sp. indt.

3. *Orthis* sp. Very large form, with very numerous and fine thread-like radiating costæ, recalling the species described by Hall as *O. deformis.*

4, 5, 6. Obscure remains of lamellibranchiate bivalve shells, probably referable to the genera *Goniophora*, *Cypricardinia* and *Modiolopsis.*

In addition to the above, the black indurated siliceous slates near the culvert, half a mile above Nictaux station, yielded a specimen of a *Bythotrephis.*

In a collection made by Dr. A. H. MacKay, and labelled "Railway near Cleveland, Nictaux, N.S., Oct. 25, 1894," were found large crushed species of *Spirifer*, too imperfect for determination, and a *Bellerophon* or *Bucania*-like gasteropod. The rocks containing these are described as being partly micaceous and arenaceous slates, and partly light yellowish-gray and greenish cherty limestones (?). They are probably the beds near the No. 12 mile-post.

Torbrook section. About five miles east of the above section, on the Nictaux River, the valley of the Torbrook stream, in connection with one of its tributaries, affords a parallel section, which still further tends to throw light upon the structure of the whole region under review.

As in the Nictaux section, the structure appears to be synclinal, and here, as there, the lowest beds exposed are quartzites or hard sandstones. These latter are the first rocks seen to the south of the flat sandy beds of the Annapolis valley, about a mile north-east of the Torbrook mines, and in some of the beds could hardly be distinguished from the hardest and most compact quartzites of the Cambrian system. They have, however, a pale, pinkish tint, some times becoming almost red (though weathering white), which is peculiar, and in addition contain, here and there, beds charged with fossils, which remove all uncertainty as to their true position. In collections made in these sandstones by the author of this report, Dr. Ami has identified the following species :—

Fossils

1. Crinoidal fragments. Impressions of large columns.
2. Branching *Monticuliporidæ.*
3. *Stropheodonta* sp. cf. *S. Beckei,* Hall.
4. *Stropheodonta,* sp. cf. *S. Blainvillei,* Billings.
5. *Orthis* sp. cf. *O.* (*Rhipidomella*) *oblata,* Hall.
6. *Orthis* sp. cf. *O.* (*Rhipidomella*) *circulus,* Hall.
7. *Trematospira* (*Rhynchospira*) *formosa.*
8. *Rhynchotreta* sp. cf. *R. cuneata,* Dalman.
9. *Rhynchonella pyramidata,* Hall.
10. *Rensellœria* (*Beachia*) *Suessana,* Hall.
11. *Meristella arcuata,* Hall.
12. *Merista lata ?* Hall.
13. *Spirifer tribulis,* Hall.
14. *Spirifer* sp. cf. *S. lamellosus,* Hall. Or *S. Nictavensis,* Dn.
15. *Amphigenia.* sp.
16. *Pterinea,* sp. indt. type of *P. macerata.*
17. *Pteronitella,* sp. indt.

Age.

Dr. Ami remarks that the above fossils appear to indicate an horizon at the extreme summit of the Silurian system, or possibly at the base of the Devonian. They are for the most part preserved as casts of the interior, and present some very interesting features from a biological as well as a palæontological standpoint.

Red slates

Immediately succeeding, to the south-west, the pink and red sandstones or quartzites noticed above, is a series of beds of widely different character. These consist of bright red shales or slates which, for about a furlong, form a series of bluffs on the left bank of the stream or show in ledges in its bed. These red rocks are partly coarse and sandy, partly fine and fissile, while they also contain layers which, both by their dark colour and by their weight, reveal the presence of iron or manganese, or both. A small bed of hæmatite has indeed been laid bare here, and the series as a whole is no doubt an extension, on the line of strike, of the strata of the Torbrook mines, but while the latter, so far as known to the writer, have yielded no fossils, these abound in the former, the coarse beds showing many large Spiriferas, while the finer or more shaly beds abound in smaller brachiopods and crinoid stems.

Fossils.

From collections made here by the writer (1896), Dr. Ami has obtained the following forms:—

1. *Stropheodonta* sp. cf. *S. varistriata.* Conrad. Placed in the subgenus *Brachyprion* by Hall and Clarke.
2. *Stropheodonta* sp. Pedicle valve of a species showing the mode of intercalation of costæ along the anterior margin. There are about 40 costæ or striations, which are fainter along the posterior portion of the shell.
3. Obscure and imperfect impressions of what appears to be a large *Orthis*, of the type of *O. eminens* and *O. oblata,* referable to the subgenus *Rhipidomella.*
4. *Spirifer* sp., with large and rugose costæ cf. *S. rugæcostus* and *S. Nictavensis*, &c.
5. *Spirifer* sp. indt. cf. *S. arrectus.* Hall.

The dip of the beds is nearly vertical, but usually with a southward inclination (S. 10° E. < 80°.)

The section above described is included between the road running east from Meadowvale, where this is crossed by the main stream of the Torbrook, and the nearly parallel road running north-east from the corner near the Torbrook mines. Between the latter and a third parallel road south of the last, the Torbrook is joined by a tributary from the south-east, by which the same section is continued and completed.

As seen in the road and ravine between the two thoroughfares last referred to, the rocks are much like those which have been described above, consisting largely of red shales, with some red sandstones, but with these are also many black slates (the latter becoming more predominant as the stream is ascended), while the dip, though still high, is now to the northward, making probably the southern side of a synclinal fold. In connection with these slates, though not observed in the stream itself, is a bed of magnetite.

To the south of the roadway last referred to, which is intersected by the Torbrook tributary near the school-house, about a mile and a half east of Torbrook Centre, we have not directly ascended this brook, but at about the same distance to the eastward and near the county line of Kings, a road running southward and known as the McGinty road, crosses the same tract and with numerous exposures completes the section in this direction. McGinty road.

Between the school and the corner of the McGinty road, the road running east from Torbrook crosses obliquely a series of slates and sandstones, in connection with which, but a little north and east of the junction with the McGinty road, is the Messenger mine, containing a six-foot bed of hæmatite, that was mined to a depth of ninety feet, the ore being similar to that of Torbrook. Other sandy beds, which are more or less hæmatitic, occur on the McGinty road, but as these are followed southward they become more massive and more crystalline, assuming first the aspect of quartzites and then that of coarse gneisses. This change invariably indicates an approach to granite, and accordingly this rock begins to make its appearance about a mile southward of the Torbrook road, at first in the form of small veins and later in larger masses, until eventually, at a distance of about two miles from the road last named, the only rocks seen are granites, associated with dark green crystalline hornblendic rocks, which are obscurely stratified. The attitude of the beds along the McGinty road is very variable, especially near their contacts with the granite, where in places may be seen the most complicated twists, but where most regular, the dip is northerly at an angle of about 70°. Messenger mine. Granite.

We may now notice some of the exposures to be seen in the area intervening between the two parallel sections above described, those of Torbrook and Nictaux, and which help to connect the one with the other.

Commencing at Nictaux, the roads which, from the Falls, ascend the eastern side of the river, show little beyond beds of coarse diorite, the best exposures being upon the older and now little used of these two thoroughfares. On the summit of the hill, however, where these roads unite with those leading eastward to Torbrook, and southward to Bloomington, dark coloured slates are exposed and are to some extent fossiliferous. Southward of this point, on the Bloomington road, similar slates and dark lilac-gray sandstones are found as far as the forks of the road about a mile north-west of Armstrong's mill on the Torbrook stream, and about midway between these two points have yielded the following fossils :— East Nictaux. Bloomington. Fossils.

1. *Favosites*, sp.
2. *Zaphrentis*, sp., allied to *Z. rugatula*, Billings.

3. *Zaphrentis*, sp. indt.
4. *Polypora*, cf. *P. Psyche*, Billings.
5. *Leptæna rhomboidalis*, Wilckens.
6. *Orthis* (*Rhipidomella ?*) *Lucia* (?), Billings.
7. *Spirifer*, cf. *S. cyclopterus*, Hall.
8. *Athyris*, or *Meristella*, sp. indt.
9. *Actinopteria*, cf. *A. textilis*, Hall.

The horizon indicated, according to Dr. Ami, is about the summit of the Silurian.

All of these beds are evidently the continuation of those described above on the Nova Scotia Central Railway, in the upper part of the Nictaux valley, and like them dip northerly. At Armstrong's mill are good exposures of rather fine, dark-gray quartzites, with some slate, dipping regularly N. $<$ 70°. Just south of this point is a considerable ridge separating the two branches of the Torbrook, but here quartzites are gradually replaced by granites, the two being at first confusedly intermixed, but subsequently with granite predominant. This granite belt is evidently an extension of the one-mile belt described on the railway section, and like the latter is followed southward by another small belt of stratified rocks, consisting first of quartzites of dark-gray colour, and then of slates, dipping S. 10° E. $<$ 90°. The occurrence at the same point of many boulders of fine, pink, white-weathering quartzite, similar to that near the Torbrook mines, as well as to beds to be presently described at Inglesville, west of Nictaux, is very interesting, as bearing upon the general structure of the region, but the beds from which they were derived are concealed from view.

Quartzite.

Granite.

In connection with the above observations, it will be of interest to give here the results of collections of fossils made in the same vicinity by other geologists, who have courteously placed these collections at the disposal of the Survey.

Collections of Fletcher and MacKay 1894.

The following forms were obtained by Mr. Hugh Fletcher and Dr. A. H. MacKay from the Bloomington road (not far north of the school-house) 25th October, 1894 :—

1. *Streptelasma* or *Zaphrentis*, sp.
2. *Monticuliporidæ*, sp.
3. *Orthis* (*Rhipidomella*) sp., cf. *O. oblata*, Hall.
4. *Orthis*, cf. *O.* (*Dalmanella*) *perelegans*, or a closely related species.
5. *Orthis* (??) sp.
6. *Spirifer*, sp., cf. *S. Nictavensis*, Dawson.

7. *Spirifer*, cf. *S. macropleura*, Hall.
8. *Pterinea*, sp.
9. " sp., cf. *P. textilis*. Hall.
10. Eye of *Dalmanites* or other genus of trilobite.
11. *Orthis multistriata*, or an allied species.

The collection is regarded by Dr. Ami as probably near the summit of the Silurian, but contains no typical species.

Collections of Sir J. Wm. Dawson.

Through the kindness of Sir J. Wm. Dawson, the interesting collections made by him in the Nictaux district, and now in the Peter Redpath Museum, Montreal, have been re-examined by Dr. Ami, and are referred in part to the Silurian and in part to the Lower Devonian.

I.—The following are classified as Devonian:—

Devonian.

1. Crinoidal fragments.
2. *Favosites*, sp. [1926]*
3. *Zaphrentis*, sp.
4. *Pleurodictyum problematicum*. [1925]
5. *Stenopora*, sp.
6. *Leptostrophia magnifica*, Hall. [1912]
7. *Leptæna rhomboidalis*, Wilckens.
8. *Orthis Hipparionyx* (= *H. proximus*, Vanuxem. [1906]
9. *Spirifer arenosus*. Conrad. [1910, 1916, 1917]
10. " *Nictavensis*. [1922]
11. " *arrectus*.
12. " cf. *S. perlamellosus*.
13. " indt.
14. *Rensselaeria ovoides*. [1911]
15. *Leptocœlia flabellites*. [1913]
16. *Actinopteria*, cf. *A textilis*. [1901]
17. *Megambonia* (?) *lamellosa*. [1893]
18. *Tentaculites arenosus*. [1900]
19. *Bellerophon*, sp. [1902]
20. *Bucania*, sp. [1905]
21. *Orthoceras*, sp. indt.
22. *Homalonotus*, sp. [1899]

The horizon indicated is probably equivalent to the Lower Oriskany, or base of the Devonian system, the Eo-Devonian of the classification of Prof. H. S. Williams.

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* The numbers inclosed in brackets correspond to the numbers on the specimens in the Peter Redpath Museum.

Silurian.

II.—The following are referred to the Silurian, and are described as "fossils from the Nictaux limestones":—

1. Crinoidal fragments.

2. *Stenopora*. A very small fragment of what appears to have been a branching or ramose bryozoary.

3. *Chonetes (?)* sp. A small *Chonetes*-like brachiopod, which, however, does not show all the characters of *Chonetes*.

4. The above form (*Chonetes*) is associated with an obscure *Rhynchonella*.

5. *Bellerophon*, sp., allied to *B. plenus*, but not determinable.

6. *Pleurotomaria Arisaigensis*. This is a low-spired gasteropod, preserved as the cast of the shell. No band nor impression of the band is visible. Volutions four. Possibly a *Pleurotomaria*, but resembles some of the Guelph Cyclonemas.

7. *Murchisonia*, sp., very nearly related to *M. Arisaigensis*, Hall.

8. *Murchisonia aciculata*, Hall. Five volutions preserved, a very small form.

9. *Megambonia*, sp. very obscure.

10. *Goniophora*, sp. indt.

11. *Orthoceras*, sp. Two specimens, one preserved as a cast, the other as a mould. Both are clearly allied to *Orthoceras rigidum* Hall. One specimen—the larger, and about five inches and a half in length—shows some fifteen septa in the space of five inches.

The precise localities within the somewhat extensive area known as "Nictaux" from which the above fossils, both those referred to the base of the Devonian and those regarded as Silurian, have been obtained, are not known to the writer of the present report. The only beds exposed in the railway section on the Nictaux River which at all approach the character of limestones are the light-coloured beds near the 12th mile-post, and these, though calcareous, are very impure and cherty. Between this section and Inglesville, however, to the west of the Nictaux River, somewhat more distinct limestones do occur, which will be presently noticed.

Geological Survey collections.

In the Geological Survey collections, and not included in those already noticed, is the following small group, labelled "Nictaux, Nova Scotia" but the precise locality and collector are not known.

1. *Eatonia*, sp.

2. *Spirifer arenosus*, Conrad.

3. *Spirifer*, sp., cf. *S. arrecta*, Hall.
4. *Megambonia*, sp.
5. *Tentaculites*, sp., cf. *T. arenosus*, Hall. This is probably only a variety of *Tentaculites elongatus*, Hall.

Horizon, probably Lower Oriskany or Eo-Devonian.

The following collection (marked No. 12, between Bloomington School and Nictaux River, Annapolis Co. was made by Dr. A. H. MacKay, 25th October, 1894. Collection of Dr. MacKay, 1894.

1. Coral, too imperfect for identification.
2. *Monticuliporidæ*, sp.
3. *Orthis* (*Rhipidomella*) cf. *R. oblata.*
4. *Spirifer*, sp. A large coarsely ribbed variety, crushed and twisted by pressure.
5. *Spirifer*, sp. Too imperfect for determination.
6. *Stropheodonta* (?) sp.
7. (?) *Pentamerus (Anastrophia) Verneuilli*, Hall.
8. *Renssellaeria* (??) sp. Very imperfectly preserved.
9. *Tentaculites* (?) sp. Too imperfect for identification. Horizon, probably summit of Silurian system.

Returning to the forks of the Bloomington road with that leading east to Torbrook, we come, at a distance of three-fourths of a mile from the corner, to what is probably the most interesting locality in the whole region, the Wheelock mine. This interest arises partly from the nature of the ore here found, and partly from the number and preservation of the organic remains of which it is the repository. The ore-bed, Fletcher Wheelock's, is about five feet in thickness, and has been trenched on its course for a distance of 200 yards or more, the material removed being partly hæmatite and partly magnetite, but mostly the latter. It is locally known as "shell ore," a name suggested by the great number of fossil shells found on the bedding planes, and which, by the retention of much of the lime of which they were originally constituted, are still nearly white, and thus in contrast with the black rock in which they are imbedded. From collections made here by the author of this report, Dr. Ami has noted the following species :— Wheelock mine. Collections of L. W. Bailey, 1897.

1. Branching *Monticuliporoid.* Gen. and sp. indt.
2. *Fenestella*, sp.
3. *Stropheodonta*, sp., cf. *S. varistriata.* Conrad.
4. " , sp. indt., possibly an *Orthothetes.*
4*a*. " , sp., cf. *S. perplana*, H.

5. *Orthis* (*Rhipidomella*) *oblata*, Hall.

6. " " sp. indt. Large crushed and distorted species.

7. *Rhynchotrema* (?) sp.

8. *Leptocœlia*, sp. Crushed individual.

9. *Spirifer concinnus*, Hall.

10. " *arenosus*, Conrad.

11. " sp. cf. *S. arrectus*, Hall.

12. " sp. cf. *S. cyclopterus*, Hall.

13. *Pentamerus*, sp. Dorsal valve of an imperfect individual.

14. *Sieberella galeata*, Dalman. (=*Pentamerus galeatus*, Dalman.)

15. *Amphigenia* (?) or *Newberria*, sp., too imperfect for determination.

16. *Tentaculites elongatus*, Hall.

17. *Bucania*, sp., allied to *B. profunda*, Conrad.

18. *Megambonia*, sp. nov.

19. " sp., cf. *M. aviculoidea*.

20. *Cypricardinia* sp., large species.

21. Trilobite remains, too imperfect for identification.

22. Fish spine allied to *Machœracanthus*, sp.

This collection appears to be somewhat transitional in facées.

Age.

Collections of Fletcher and MacKay, 1894.

From the same vicinity the following were obtained (October, 1894) by Mr. Fletcher and Dr. MacKay.

1. *Monticuliporidæ*. Undeterminable.

2. *Spirifer* sp., too imperfect for identification.

3. " sp., resembling *S. Niagarensis*, Hall.

4. *Bellerophon* (or *Bucania*) sp., not unlike the species found in the red shales of Sunny Brae, East River, Pictou Co., N.S.

5. *Platyceras*, sp., cf. *P. sinuatum*, H.

6. *Murchisonia*, sp. A short-spired species with concave portion on upper part of volutions.

Collections of T. C. Weston, 1879.

To the above lists may be added species obtained by Mr. T. C. Weston in 1879. These include the following, contained in two slabs of rock, one of which consists of a brownish-weathering light-coloured sand-rock, with fossils preserved as casts of the interior; the other a low-grade iron ore or hæmatitic sand-rock with casts of the exterior of *Spiriferæ*, etc. These slabs are numbered (*a*) and (*b*) respectively, and present the following assemblage of Eo-Devonian forms :—

(*a*.) 1. *Stropheodonta*, cf. *S. Blainvillei*, Billings.

2. *Leptostrophia magnifica*, Hall.

3. *Schizophoria*, sp., cf. *S. multistriata*, Hall.
4. *Hipparionyx proximus*. Vanuxem.
5. *Rhynchotrema* sp. indt., cf. *R. formosa*, Hall.
6. *Leptocœlia* (?) sp.
7. *Renssellaeria*, sp.
8. *Cyrtina ?* sp. indt.
9. *Spirifer*, cf. *S. duodenarius*, Hall.
10. " cf. *S. arrecta*, Hall.
11. " sp.

(*b*.) 1. *Spirifer Nictavensis*, Dawson.

The course of the beds at the Wheelock mine is about N. 65° E., the dip being nearly vertical, and this course, if continued, would, in a westerly direction, connect them with the similar ore-beds of Cleveland, as to the eastward it would make them continuous with the hæmatites of the Torbrook mines. On this supposition, if confirmed, the ore-beds of the Wheelock mine would, like those of Torbrook, occupy a low position in the series of rocks here represented, while the section on the Nictaux would mostly represent a syncline to the westward or north-westward of that of Torbrook. Neither the red slates nor the pale quartzites of the latter have, however, been observed here, and it is probable that careful instrumental surveys of the whole region will be required before correlation of its beds can be fully made out.

Torbrook mines.

It only remains to notice here the rocks of the Torbrook mines and of the tract lying south-east of the latter. The ore-bed at the mines is at the surface about six feet wide, increasing, however, below to a width of eleven feet, and is wholly hæmatite, of deep red colour, soiling the fingers, and with a tendency to break into rhomboidal blocks. There is no magnetite. There are also no fossils, although at a point only sixty feet removed from beds that continue those of the mines, are beds of "shell ore" abounding in fossils. The dip of the beds is southerly, but, while nearly vertical at the surface, is found, at a depth of 280 feet, to have so far declined as to allow of walking on the foot-wall. The bed is then cut off by a fault. Further facts as to the nature of the ore and the operations here carried on will be found in the sequel. The rocks bordering the hæmatites on either side are gray and red shales, similar to those exposed in the bluffs on the Torbrook stream a mile or so to the northward, and which, between the two are also exposed on the road from Torbrook to Meadowvale. In this vicinity Mr. T. C. Weston, in 1879, collected the following fossils, contained in two slabs of iron ore ; one (*a*) a bright red hæmatite rock, the other (*b*) a dark bluish-gray impure ore.

Collections of T. C. Weston.

(*a*.) 1. *Orthis* sp., cf. *O. hipparionyx* (= *Hipparionyx proximus*,) Vanuxem.

2. *Spirifer*, cf. *S. Nictavensis*, Dawson ; very closely related to *S. concinnus*.

3. *Actinopteria*, sp. A very obscure form probably referable to this genus.

(*b*.) 1. *Orthis* (?) sp.

2. *Rhynchonella* sp. indt.

3. *Spirifer arenosus*, Conrad.

4. ? ? *Megambonia* or *Mytilarca*. Too obscure for identification.

Both (*a*) and (*b*) are regarded as probably referable to the Lower Oriskany or Eo-Devonian.

Collections of J. E. Leckie, 1894.

Another collection made in this vicinity, east of J. E. Leckie's (collector J. E. Leckie, 1894) contains the following forms :—

1. *Orthis* (*Rhipidomella*) cf. *O. oblata*, Hall. Very large specimens, very much flattened, but fine.
2. *Rhynchonella ?* sp. indt. Resembling somewhat *R. plicatella* L.
3. *Stropheodonta* sp. S, Becke.
4. *Leptocœlia ?* sp. indt.
5. *Spirifer*, cf. *S. perlamellosus*, Hall ; or new species, very large.
6. *Megambonia* or *Pterinea* sp.

Horizon, about the summit of the Silurian.

Magnetite.

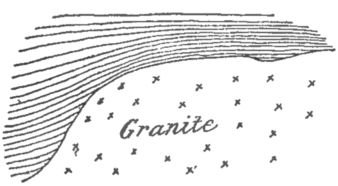
From the centre of Torbrook village, a road leads to the southward ascending the high ridge which, with an elevation of fully 600 feet here overlooks the Annapolis Valley. Near the top of this eminence, on its northern side, a bed of black granular magnetite has recently been opened and several hundred tons removed, the inclosing beds being dark and slaty, with much iron, and with obscure remains of shells. The dip of the beds is S. 25° E. < 80° to 90°, and their course therefore such as to indicate continuity with similar beds on the tributary of the Torbrook described on a previous page. A little south of these iron ores, are ledges of quartzite and diorite, dipping northerly (N. 10° W. < 70°), and below these, beds of slate. Still farther south, and in a valley beyond the ridge above noticed, are still other slates, but of a more siliceous character and darker colour, as well as somewhat micaceous, resembling in these respects the beds of Cleveland as they also do some of those in the lower portion of the Nictaux Valley. The dip of these slates is like the last northward (N. 10° W. < 60°).

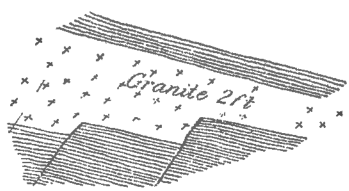
Beyond them the country is uncleared, but is believed to be mainly occupied by granites, which are exposed in ledges on Fales Brook, two miles below Allen Lake, as well as about Wheelocks meadow. Granite.

To complete the consideration of the Torbrook-Nictaux basin, it will now be necessary to make some further references to that portion of the basin to be found on the western side of Nictaux Valley.

Allusion has already been made to the very irregular distribution of the granite in this direction and the difficulties attending its delimitation. These difficulties apply equally to the stratified rocks, with the additional one that, through the invasion of the granite, these have been so far altered that fossils are wanting and means of identification also for the most part lost. Fortunately, however, the course of the beds and the stratigraphy in general has been but little affected by these intrusions, and, with the assistance of some easily recognizable beds, the general structure can be made out.

The first road traversing the region westward of the Cleveland road (which latter by its proximity to the railway presents no new features), is about a mile and a half westward of Nictaux and half or three-quarters of a mile eastward of Jones Brook. Jones Brook. The rocks which cross this road are gray sandy slates and sandstones, sometimes becoming quartzites with pink and lilac tints, and associated with dykes of diorite, the dip of the beds being very regular S. 20° E. < 70°. They thus show, both by their character and trend, that they are the same with the beds forming the hills near and north-west of Nictaux station. With the same course they extend to Jones Brook, and beyond to Inglesville, thus separating the granite dome which skirts the lower part of Jones Brook (and which extends thence to Williamston), from the similar rocks in East Inglesville. Similar beds, with similar dip, are exposed all the way to the cross-road on the summit of the hill leading thence to Nictaux Falls, as well as on this latter road; Granite contacts. but here the beds are more highly altered, evidently through the invasion of granitic as well as dioritic veins. Some of the exposures seen on this road and illustrating such invasion are very remarkable, and are represented in the accompanying figures.





Granitic intrusions similar to the above are again seen to the southward of the latter on the road connecting Nictaux Falls and East Inglesville, and may be connected eastwardly with the one-mile belt of such rocks seen in the upper part of Cleveland, though this has not been ascertained. However this may be, it is certain that a considerable area of stratified rocks, belonging to the system under review, occurs to the south and west of this belt, occupying a tract which in all previous geological maps and descriptions of the region has been represented as granitic. This tract includes the whole of the settlements of East, Centre and West Inglesville, as well as a considerable area along (but mostly eastward of) the road connecting the first-named settlement with Alpena. One exposure upon this latter road is most important, as probably representing the beds from which came the blocks of fossiliferous limestone referred to in the description of Sir J. Wm. Dawson. It is on the farm of Henry Whitman, and just west of where the road crosses a considerable brook, probably Jones Brook. The rocks here seen are mostly dark-gray, fine-grained and somewhat micaceous sandstones, similar to many of the beds in the upper as well as the lower part of the railway section, but include also beds of coarse and impure crystalline limestone, some of which contain ribbed shells and other organic remains. The fossils are few, poorly preserved and difficult to remove, but among them have been recognized a *Spirifer*, sp. indt., an *Orthis*-like shell, too imperfect for specific determination, and what is probably a *Stropheodonta*, but also too imperfect for identification.

Inglesville.

Limestones.

Fossils.

The dip of the beds at this locality is S. 20° E. $<$ 60°. They occupy a bay or sinus in the granite, but can have but a very limited distribution, the position which they should hold on the parallel road one mile westward of that described, showing nothing but granite.

The granite tongue which cuts off, across their strike, the beds last described, extends north-westerly quite up to Inglesville Centre. To the west and south-west of the latter another and much more considerable sinus in the granite includes the settlement of West Inglesville, and reveals some beds of interest. Through most of the settlement the rocks are quartzites and diorites, the former of the usual dark-gray colour and micaceous aspect, a continuation evidently of the beds on Jones Brook, and of the hills overlooking Nictaux Falls; but about half or three-quarters of a mile south or south-east of the road traversing the settlement, is a rather conspicuous ridge, also composed of quartzites, but in which these are of quite a different character. Perhaps their most noticeable feature is the absence of colour, for while usually exhibiting in the interior a pale pinkish tint, sometimes tending towards red, this is apt to be wanting on weathered surfaces, leaving the latter nearly white. Another striking feature is their hardness and purely siliceous character, well brought out by glacial action in the wonderful polishing of exposed surfaces; a polishing so complete as to readily reflect light, and to cause their surfaces, especially when wet, to be slippery to the foot. Finally these same surfaces are in places covered with jet-black coatings of oxide of iron.

West Inglesville.

Quartzites.

The whole aspect of the above quartzites is suggestive of very ancient rocks, yet their characters are so peculiar and so readily recognizable that no doubt can exist as to their identity with the loose blocks referred to on a previous page as found, with similar associations, north of Alpena on the railway section, and yet again below the red slate bluffs on the Torbrook stream. Were it not for the fossil layers found in the latter case, but which were not discovered in Inglesville, both might, on lithological grounds, be well referred to the Cambrian system. It will presently appear that precisely similar beds, which again contain fossils, occur in the Clementsport and Bear River basin. The dip of the above-described quartzites is southerly, in which direction, at a distance of a little over a mile from the main road, they give place to granite. A similar southerly dip prevails throughout West Inglesville and along the roads leading thence to the Annapolis Valley.

Com pariso

On the old Albany road, as well as that to the westward of it, the stratified rocks are soon cut off, across their strike, by the granites south of Lawrencetown; but between the latter and the Jones Brook granites, the first-named rocks come quite down to the valley south of Williamston. As exposed on the highway in this settlement, half a mile eastward of the road from Lawrencetown to Albany, they are purplish-gray imperfect gneisses, dipping S. 10° E. $<$ 60°. The course of the beds both here and in Inglesville is more nearly east-and-west than in Nictaux. In but few cases does the granite appear to have any influence on the trends, though profoundly altering the nature, of the strata it invades.

Williamston

We may conclude this review of the east Nictaux district by reference to some further collections made by other observers. The rocks containing these fossils are much altered and most of the specimens are consequently obscure.

Fossils collected by Dr. MacKay, 1894.

Locality No. 1. Gates limestone quarry, Inglesville, at Lawrencetown and Alpena roads, Annapolis county. October, 1894. Dr. A. H. MacKay.

1. Large Bryozoary, obscurely preserved and crushed, too imperfect for identification.

2. *Monticuliporidæ.*
3. Crushed *Fenestella*-like frond, too imperfect for identification.
4. *Stropheodonta*-like sp. very imperfectly preserved.
5. " cf. *S. Beckei.*
6. *Spirifer*, sp., cf. *S. macropleurus.*
7. *Orthis* or *Rhynchonella*, sp.
8. Obscure coral-like remains.

Locality No. 2. At and near ridge or Boars-back, north of Jones Brook, East of Inglesville. October, 1894. H. Fletcher, A. H. MacKay.

1. *Pleurodictyum problematicum*, Goldf; showing the Serpula-like stage very well. Referable to the genus *Michelinia.*
2. Coral-like fragment too imperfect for determination.
3. *Streptelasma*, sp., with fifty larger and fifty smaller or intermediate septæ or radiating lamellæ.
4. *Crinoidea*, fragments of columns.
5. *Monticuliporidæ* sp. Branching species.
6. Crushed fragments of Brachiopoda, too imperfect for identification.
7. *Orthis*, cf. *O.* (*Rhipidomella*) *hybrida*, Sby.
8. " sp. too imperfect for identification.
9. *Strophomena* (?) sp.
10. *Meristella* (?) sp. indt.
11. *Spirifer perlamellosus* or *S. macropleurus*, or closely related species.
12. *Spirifer* or *Rhynchonella*—crushed and twisted beyond recognition.
13. *Rensselæria* (?) sp.
14. *Leptocœlia* sp.
15. *Anastrophia*, cf. *A. Verneuilli*, Hall; imperfectly preserved.
16. *Atrypa*, cf. *A. reticularis*, L.

The horizon indicated, appears again to be a transitional one. The locality has not been visited by the author of this report.

Another small collection is marked as from north of Jones Brook, on a meadow-road east of G. W. Gates, on Lawrencetown road. October, 1894.

1. *Monticuliporidæ.*
2. *Orthis*, sp., cf. *O.* (*Rhipidomella*) *hybrida*, Sowerby.
3. *Stropheodonta*, sp.
4. *Atrypa*, cf. *A. reticularis*, Linné.
5. *Spirifer*, sp. indt. Doubtful.
6. *Leptocœlia*, sp. indt. Doubtful.

The horizon is referred to the Silurian system.

These fossils might be referred to the Silurian.

From a review of the facts which have been presented in the Torbrook-Nictaux section, some conclusions of more general application may be drawn. Conclusions.

I. The succession of Strata.—This, in ascending order, is believed to be as follows:— Succession of strata.

a. Dark-gray, dark-weathering quartzites, associated with numerous dykes of diorite and veins of granite, becoming, when metamorphosed, more or less micaceous or hornblendic, with shades of lilac and purple. Thin bands of fossiliferous limestone.

Loc. West Nictaux and Inglesville, Jones Brook, Bloomington, McGinty road, *etc.*

b. Pale gray to pink, sometimes reddish, white-weathering quartzites, in places highly fossiliferous.

Loc. Inglesville Centre, Cleveland (in boulders only), Torbrook stream.

c. Dark-gray, green and reddish argillites, with beds of iron ore, and highly fossiliferous.

Loc. Torbrook stream, Torbrook mines, Nictaux Valley below the falls.

d. Dark-gray argillites, often silicious, with bands of quartzite and beds of hæmatite or magnetite. Fossils abundant.

Loc. Railway section in Nictaux Valley, Wheelock mine, Cleveland.

e. Dark-gray argillites, banded with paler layers, and holding beds of buff-weathering sandstone. Fossils abundant.

Loc. Railway section in Nictaux Valley, *etc.*

Note.—This scheme is only tentative and may require modification as the result of further study.

II. Structural Relations.—The nature and disposition of the beds as seen on the lower Torbrook stream, its tributary, and the McGinty road, near the Kings county border, leave little doubt that the general structure here is synclinal, the axis of the syncline being about midway between Torbrook Centre and the county line last-mentioned, and its course about north-east. On either side of the line the beds are probably repeated in inverse order, but through metamorphism the hæmatites of the one are represented by the magnetites in the other. The fossils of the more northerly beds are rare or wanting nearer the granite, and colours due to contained iron change from red to black.

Torbrook.

The structure on the Nictaux and along the line of the Nova Scotia Central Railway is also apparently synclinal, but that of a syncline which as a whole is more northerly than that of Torbrook. On this supposition, (which, however, is not fully established) the ore-beds of Wheelock's farm, the direct continuation of those of Torbrook mine, mark at once the northern side of one syncline and the southern side of the other. This is not clearly seen in the railway section, but to the westward, in Cleveland, are quartzites which probably represent the base of the system, while still farther west, but on the same general line, are the black and pink quartzites of Inglesville.

Nictaux River

The Torbrook syncline, in its western extension, would thus seem to be cut off by the Cleveland and Alpena granites (though reappearing to a limited extent to the south of the first or one-mile granite belt), while the Nictaux syncline is similarly cut off, across the strike, by the granites south of Lawrencetown.

Relations to granite.

The uniformity in the strike and general relations of the different groups of rocks described, in spite of their numerous and extensive granitic invasions, is most remarkable, especially when taken in connection with the position and relations of the similar beds in the Clementsport,—Bear River basin, and that of Mistake settlement in Digby county yet to be described.

III. Age.—The collections of fossils referred to here are about twenty in number, some seventeen being from the Nictaux-Torbrook basin, and the remainder mostly from that of Clementsport and Bear River. It will be convenient to consider those of both basins together. Of these collections, six are regarded by Dr. Ami as being of Lower Oriskany or Eo-Devonian age, and among these are the large collections made by the writer from the Wheelock mine at Nictaux, and by Dr. MacKay from Inglesville, the former including twenty-two and the

Age.

latter sixteen species, mostly well-preserved. Several collections, including one by the writer from Bear River, with twenty-one species, and that of Mr. Weston, from Wheelock's farm, with eleven species, are described as being either at the summit of the Silurian or base of the Devonian, with, in some instances, a marked transitional character. Five collections are referred to the summit of the Silurian, but one of these is from beds at and near Wheelock's, which other and better collections show to contain Devonian forms; while another from Blooming ton is evidently a continuation of the same beds as the last, though containing no typical species. It would seem, therefore, to be tolerably certain that a large part of the deposits in the two basins under review occupies a geological horizon at or near that of the line of demarcation between the Silurian and Devonian systems.

In the five collections which have been definitely assigned to the Silurian, some indicate a horizon near the very summit of the system, while others present forms somewhat older or lower down in the Silurian.

One part of the Redpath Museum collection of Sir J. Wm. Dawson, has been classified as Devonian, including twenty-two species, and another portion including eleven species, has been referred to the Silurian, the latter most probably equivalent to Division D of the Arisaig series of Nova Scotia (=Lower Helderberg=Ludlow). The writer, as already stated, is not aware of the exact locality from which this collection was made, or whether, indeed, the specimens were all from the same locality. In view, however, of the fact that several collections are at or near the boundary line between the Silurian and Devonian, great probability is given to the view that the collection is, in part at least, of a decided transitional character, with perhaps a little stronger development of Silurian aspects than usual.

The conclusion arrived at from the fossils at hand from the Nictaux-Torbrook and Clementsport and Bear River basins, that the beds hold forms referable, some to the Silurian, some to a transitional series, and others to a horizon at the base of the Devonian (Eo-Devonian), is in accordance with the stratigraphy of the district, which indicates a perfectly continuous and conformable series of beds. Conclusion.

It only remains to add that no *Dictyonema* or graptolitic forms have been found in either of the basins, and therefore no definite proofs exist of the equivalency of any of the beds of the latter with those of New Canaan.

The fossils from Mistake settlement are too few and too imperfectly preserved to fix with certainty the horizon of the beds containing them, but little doubt can be entertained that this is near the summit of the Silurian.

Clementsport and Bear River Basin.

The granites which abruptly cut off, on their western side, the Eo-Devonian rocks of the Nictaux basin have in earlier pages been described as occupying all the area thence to Annapolis. On the Basin front they extend, indeed, beyond Annapolis and almost to Clementsport, but this is only a tongue, to the south of which, separating this from the main body of the granite, stratified rocks again appear, marking the beginning of an area which, rapidly widening, extends thence to Bear River, and beyond the latter into the county of Digby.

Annapolis.

The most easterly exposures of the rocks in question are to be seen on the post-road connecting Annapolis and Liverpool, five miles south of the fort in the first-named town. They here form a belt about a mile in width, but probably do not extend much farther to the eastward, no sign of their presence being seen on the Dalhousie road, only one mile distant. On the Liverpool road the belt is represented chiefly by loose blocks, but partly by outcrops, of dark-gray, sometimes purplish or lilac sandstones, with some more slaty beds, both resembling closely the rocks in the upper part of the railway section at Nictaux, or those of Wheelock's mine, and like the latter carrying fossils. These are mostly found in ochreous crumbling layers and are but poorly preserved, but shells of brachiopods (*Spirifer*, etc.) and stems of crinoids are readily recognizable.

Liverpool road.

Fossils.

To the westward of the Liverpool road, the area occupied by the group of rocks under review rapidly widens, but for a considerable distance exposures are few. Thus, on the road from Annapolis to Virginia, four miles distant from the Liverpool road the only ledges seen are where the first named road passes the outlet of Bela Lake, and consist of dark-gray quartzite evidently greatly altered by the granite near by. Along the course of the east branch of Moose River exposures are more frequent, and on this stream, as well as by the main stream of Moose River and by Bear River, admirable sections of the whole area are shown.

Virginia.

Clementsport.

The most northerly beds exposed on Moose River proper, are those of Clementsport, but between the latter and the granite spur in Upper Clements are rocks which are geologically beneath those of the village first-named and form the real base of the system in this direction. These are best seen in the vicinity of Balcoms Corner, about three miles east of the bridge in Clementsport and along what is known as the Pickett road, extending a mile or so further east. A quarter of a mile from the corner, on this latter road, are ledges of dark-gray to lilac hard sandstones or quartzites, which are identical with those of the Annapolis and Liverpool road, and like the latter have something of a gneissic aspect. No fossils were, however, detected here, a circumstance readily understood from the fact that the beds are not more than 100 yards removed from the granite, a mass of which runs directly across their strike. The dip at this point is northward at a high angle, but a little farther to the east and south, where a bay or sinus occurs in the granite spur, similar rocks present great diversity of attitude, some dipping S. 40° W. < 40°, others N. 20° E. < 80° and still others S. < 90°. The quartzites are coarsely laminated and contain numerous white quartz veins, some of which, it is asserted, have yielded gold.

Other quartzites of like character may be seen on the Guinea road where this descends to the village of Clementsport, but in proceeding in this direction the beds become more slaty and less micaceous. They still show, however, evidences of alteration in the occurrence of numerous minute crystalline prisms on their cleavage-planes. These slates are admirably exposed on a small brook crossing the Frazertown road half a mile south of the Guinea road, forming here a picturesque fall, probably a hundred feet in height, though of no great volume. Along both branches of Moose River they are similarly exposed, and, with the exception of some beds of diorite, are the only rocks seen between the mouth of the river and Clementsvale. In the more northerly part of the section, as at Clementsport and near the Guinea road, the prevailing dips are southerly, but of very variable amount, from verticality to 30° or less, indicative of many subordinate flexures. On the other hand, towards the southern side of the basin, as in Frazertown and south of the Hessian line road, the dips are northward, the border of the syncline being further indicated by a change from slates to quartzites. These latter rocks are well exposed on either of the roads leading south from the Hessian line to Round Lake mill, and are of special interest in that some of the beds exactly resemble the pink white-weathering quartzites of Inglesville, while, like the similar beds of the lower Torbrook, they are fossiliferous. In collections made on the Potter road, the most easterly of the two roads referred to, Dr. Ami has found the following species:—

inea road.

Hessian line.

Potter road.

1. Crinoidal fragments.
2. *Orthis* (*Rhipidomella*) sp. crushed and distorted.
3. *Stropheodonta* sp.
4. " " cf. *S. varistriata*, Conrad.
5. " " " *S. Blainvillei*, Billings.

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6. *Camarotœchia*, sp. indt.
7. *Spirifer* sp. with from 6 to 8 costæ on each side of mesial fold.
8. *Spirifer* sp. of the type of *S. cycloptera.*

These are probably referable to the Lower Devonian.

The beds at this point are about half way between the Hessian line road and the granite hills.

Iron ores of Clementsvale.

Another feature of special interest in the Moose River section, is the occurrence of iron ores similar to those of the Nictaux basin. The most impartant of these are found in Clementsvale, a mile or so west of the main stream of Moose River, and a little north of the Hessian line road. This is the locality from which the ores formerly worked at Clementsport were obtained, and the long and deep trenches there, testify to the amount of material removed. The rocks inclosing the ore are slates which are dark and more or less chloritic, and in a nearly vertical attitude, while the ore is a dark granular magnetite. Like the beds at the Wheelock mine in Nictaux, they are fossiliferous, and while quarrying operations were in progress many fine specimens of broad-winged spirifers and other forms were obtained here, but these are not now accessible, while the fossils which are found in the associated slates are few and not well preserved.

Fossils.

Among them is a *Tentaculites* like *T. arenosus*, Hall, which is closely related to *Tentaculites elongatus* of the same author.

It is interesting, in this connection, to note that towards the northern side of the Moose River basin, indications of ore-beds have been recently observed which may be the equivalents of the Clementsvale beds on the other side of the syncline. These indications occur near the top of the hill south of Clementsport, where the east-and-west Waldeck road meets the road leading south to Clementsvale, and in the form of blocks of magnetite derived from bluish argillite ledges near by. The beds, however, are not well exposed.

Bear River section.

We have now to consider the section, parallel to that of Moose River, furnished by Bear River and its tributaries.

The occurrence of fossiliferous strata in and about Bear River village has long been known. It could not indeed well be otherwise, for there is hardly a slab of slate in the thickly scattered drift or in the stone walls constructed of the latter which does not teem with organic remains. Of the rocks *in situ*, the most prolific are a series of gray and dark-gray slates, which form low bluffs about the head of tide-water, and about the mill-pond on the east branch just above.

From a collection made by the author of this report in 1892, twenty-one species were obtained by Dr. Ami, which, as identified by him, are given below :— Fossils from Bear River.

1. *Psilophyton* (fragments). Crinoidal fragments.
2. *Pleurodictyum problematicum*, Goldfuss.
3. *Polypora* or *Fenestella* sp.
4. *Dicranopora ?* Sp.
5. *Bryozoa.* Sp. indt.
6. *Calamopora* or *Favosites* sp.
7. *Strombodes* or *Pleurodictyum.*
8. *Favosites* allied to *F. Gothlandicus.* Lam.
9. *Orthis*, cf. *O. Davidsoni*, de Verneuil.
10. " " *O. oblata.* Hall.
11. " allied to *O. hybrida*, Sowerby.
12. " *elongatula*, Dalman.
13. *Stropheodonta* sp.
14. *Leptocoelia flabellites*, Conrad.
14. *Spirifer rugicostus*, Hall.
15. " cf. *S. arenosus*, Conrad.
16. " *cyclopterus*, Hall.
17. " *Nictavensis* (?) Dawson.
18. *Pterinea textilis* var.
19. *Cypricardinia sublamellosa*, Hall.
20. *Tentaculites* sp. cf. *T. elongatus*, Hall.

It is noticeable that the fossils are mostly brachiopods and include no trilobites, though corals and crinoid stems are not uncommon.

The horizon indicated by the above fauna is that of a transition series. Some of the species have a decided Lower Devonian or Oriskany aspect, whilst others appear to belong to a somewhat lower horizon. The presence of such forms as *Leptocoelia flabellites*, *Spirifera arenosa*, *S. Nictavensis*, *Stropheodonta*, *etc.*, point to the Lower Devonian age of the fauna, whilst upon the whole, the bulk of the collection has considerable affinity to rocks of Silurian age. Geological horizon.

In ascending the main stream of Bear River from the Forks, at the head of tide, the rocks are fairly exposed in the bed of the stream and in the adjacent hills for about two miles, and for a little more than half this distance they are fossiliferous. The fossils, however, gradually become less abundant at the same time that the beds become more arenaceous, the approach to the granite being at the same time indicated by the development of a gneissic aspect in the coarser beds, and the spotting of the finer ones with incipient crystals. The last fossils seen were at a distance of 1450 paces south of the uppermost bridge, at the mills. Finally, at the head of the section, are finely laminated gneissoid sandstones which directly abut against the granite, just below a series of falls. These quartzites are remarkable for the extremely fine layers of which they are composed, and not so less for the wonderfully complicated contortions into which they have been thrown, but neither in these respects nor in others do they bear any resemblance to the massive quartzites of the Cambrian system, and they doubtless represent the base of the Devonian. In this connection, it may be added that reefs of quartzite are exposed to view about two miles north-eastward of those last noticed, *viz.*: on the Jefferson road connecting the Hessian line with the Negro line road, and a little south of the Middlesex road. These, however, are probably a little higher in the series, being evidently the westward extension of those already described on the Potter road, exhibiting, like the latter, the peculiar pale-pink tint and brightly polished glaciated surfaces so conspicuous in Inglesville, or, indeed, wherever this particular set of beds is exposed to view. This comparison is also confirmed by their fossiliferous character, layers in the otherwise massive rock containing shells in considerable numbers. The fossils found here are similar to those of the Potter road.

Jefferson road

Fossils.

In this connection the following list of species, as determined by Dr. Ami, etc., obtained from the drift along the Middlesex road, is not without interest.

1. *Pleurodictyum problematicum*, Goldfuss.
2. *Favosites* sp. Small branching species allied to *F. polymorpha.*
3. *Fenestella* sp. Showing both the celluliferous and poriferous sides, but preserved as impressions of both.
4. *Stropheodonta* sp.
5. *Leptæna rhomboidalis*, (Wilckens.)
6. *Orthis*, of the type of *O. Livia*, Billings, evidently a *Rhipidomella* and allied forms.
7. *Rensselæria* sp., cf. *R. ovulum* or *R. Cayuga*, probably a new species.
8. *Atrypa* (?) sp., cf. *A. hystrix.* Too imperfect for determination.
9. *Spirifer* sp. several species with smooth fold and sinus, with rugose costæ, regularly and evenly disposed.

10. *Pterinea* sp., cf. *P. textilis.*

11. Crinoidal columns and rings, apparently belonging to two distinct genera and species.

The horizon indicated is Lower Devonian.

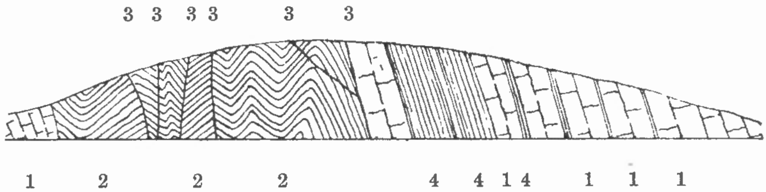
It has already been stated, in the sections of this report relating to the Cambrian rocks of Digby county, that the line of separation between the latter and Eo-Devonian strata has not been definitely made out. The uncertainty as to identity of the two groups begins to be felt in the lower part of the Bear River section. Separation of Cambrian and Devonian.

In descending the estuary from the head of tide, the rocks continue to be mostly slåtes, not obviously different from those of the village, but in which fossils become gradually less abundant, until, at a distance of three-fourths of a mile from the upper bridge, they fail altogether. At about this point also the strata change their character, the slates being replaced by heavy beds of quartzite, while both have a southerly dip—(S. 20° E. < 80°). They therefore probably represent the northern side of a syncline of which the southern side is represented on the east branch and on the Negro line road, while the axis of the syncline would be not far south of the forks of Bear River. The quartzites here exposed have, it is true, no great thickness, but this may be the result of faulting, the beds which occupy the remainder of the distance to the railway bridge affording abundant evidence of the dislocations to which they have been subjected. Alternations of slates and quartzites occupy the whole interval of nearly a mile, but these are in places so abruptly folded as to look like the teeth of a gigantic saw. The slates are dark-gray to black in colour, sometimes showing a banded or ribboned aspect, while the sandstone or quartzites are laminated, in some beds acquiring by the action of the water a reddish-brown tint, and in others becoming ochreous and buff-coloured. The last beds seen above the railway bridge are quartzites. Bear River syncline.

To the north of the bridge, in the railway cutting between the latter and the station, on the west side of the river, the influence of intrusive diorites is well exhibited. These latter, which chiefly occupy the eastern end of the cutting, are slightly amygdaloidal, but shade into light-gray sandstones which are associated with black iron-stained slates. Not less than fourteen small folds may be counted upon one side of the cutting, the prevailing dip, however, being south-easterly. No fossils have been seen, though the beds bear much resemblance to those which, near Bear River village, are so highly charged with organic remains. Bear River station.

Section near Bear River station.

The subjoined section of the railway cutting has been made by Mr. Prest :—



1. Diorite.
2. Black slate with 12 or 13 folds.
3. Faults.
4. Gray arenaceous slate.

Diorites.

The diorite of the above section is apparently an arm, nearly 1000 feet wide, of a more considerable mass of such rock forming the core of the high hills on the west side of Bear River, whence it has been traced westward, through the hills south of the Grand Joggins,* to Lee or Bingay Brook, two miles south-west of the railway bridge. It here becomes slightly vesicular and more nearly resembles the trap of North Mountain, than a true diorite. On Lee Brook it is cut by a large quartz veins.

Before passing to the further description of the west side of the river, it is necessary here to make brief reference to the sections afforded by some of the smaller streams which, between Moose and Bear rivers flow northerly to the Annapolis Basin. Of these Deep Creek, nearly midway between the two rivers last-named, is the most important.

Deep Creek.

Just below the crossing of this brook by the highway connecting the towns of Digby and Annapolis is a series of bed, quite unlike anything ordinarily found elsewhere in the Bear River basin, but which forcibly recalls some of the rocks seen in the northern portion of the Nictaux section, and especially on Torbrook River. They consist of bright red slates, which are rather soft and somewhat ribboned, dipping regularly N. 10° W. < 80°. At two points only have strata resembling these been seen in the area under review, *viz.* : at the mouth of Moose River, north of the railway bridge, and at the mouth of Smith Cove, in a similar relation to the railway. At the first-named locality, however, the red beds alternate with green and black slates exhibiting great irregularity of dip, while at Smiths Cove the deep brown-red colour seems to be largely a surface one, and alternates with narrow bands of light and dark bluish-gray and greenish-gray colours, the dip

Red slates.

*The localities known as the Grand and Little Joggins, referred to in this report, are indentations of the coast-line on the south side of Annapolis Basin, and should not be confounded with the better known Joggins at the head of the Bay of Fundy.

here being northward at an angle of 75°. It will be noticed that the three localities are on the same general line, and the beds referred to doubtless occupy about the same horizon, which, if they are the equivalents of the Torbrook beds, would be near the base of the Eo-Devonian. If this latter comparison is correct, it would also go far to establish a similar age for all the rocks of Bear River and those of a somewhat extensive tract to the westward as well as to the eastward of the latter. At none of the points referred to, however, though the beds are but little metamorphosed, have we been able, after prolonged search, to find any fossils.

To the south of the post-road, at Deep Creek, there are no exposures for a quarter of a mile, but beyond this distance they are of frequent occurrence for a further distance of three-quarters of a mile, or to where the creek is crossed by the Waldeck road. The first rocks met with in ascending the brook are rather dark-coloured slates, exhibiting a succession of low folds, but farther up these become conspicuously marked by narrow alternate bands of lighter and darker colour, the former being also of coarser texture and from one-quarter to one-half an inch in thickness. Thin beds of quartzite also occur, the dip throughout being northerly, usually at high angles, but sometimes as low as 20°. The last beds seen at the crossing of the Waldeck road, were black slates. At several points the rocks are intersected by and more or less altered by diorite dykes. Deep Creek

A quarter of a mile east of Deep Creek station, another small brook, known as Purdy Brook, shows another section parallel to the above and with essentially similar features, the rocks being slates with included beds of sandstone. The slates are mostly gray, but often surface-stained with red, or sometimes red throughout, giving them a conspicuously banded or ribboned appearance, and in this, as in other respects, bearing much resemblance to the beds seen in the lower part of the Nictaux Valley, below the falls. The sandstones, on the other hand, are hard and massive, of a bluish colour within, but weathering deeply with an ochreous-brown surface. The dip of the beds, as on Deep Creek, is northward (N. 10° W. <70°). In the lower part of the stream the slates include many purplish beds, not unlike those of the Cambrian system, but these become less frequent as the stream is ascended. Purdy Brook.

Still another section, parallel to the above but on the other side of Deep Creek, is afforded by Ditman Brook, but the only noticeable feature is the occurrence of diorite dykes, carrying veins of asbestus.

We have now to consider the area lying to the westward of Bear River, in the county of Digby.

West Branch of Bear River.

Fossils.

In tracing the fossiliferous belt from Bear River village westward, exposures resembling those already noted at the head of tide on Bear River inlet, are seen on several of the streams which are tributary to the latter. Thus, on the west branch, above Bear River forks, and about a quarter of a mile west of the fossiliferous beds on the East Branch, is a dark seamy and crumbling fossiliferous rock, well stratified, with slaty and arenaceous layers, and dipping N. 70° W. < 85°. Two hundred yards farther up the same stream, are grayish-blue slaty rocks, with similar brown, crumbling, fossiliferous layers, and with the same dip. Also, on another brook, half a mile or more northwest of the last (a brook which empties into the main river half a mile above the centre of the village), similar beds again occur, and, besides brachiopods, contain corals and crinoids, the latter sometimes three-fourths of an inch in diameter. Farther up, on this brook, the the dark slates and friable brown sandstones gradually change to finely laminated, wavy, light-gray and bluish-gray sandstones and arenaceous slates. These beds, except in being less contorted, resemble those in the upper part of the West Branch, while, unlike the latter, but like those of the Jefferson road, they are abundantly fossiliferous. On the same brook, one-eighth of a mile below the road from Morgantown to the Weymouth road, and about one mile and three-quarters from Bear River village, are light-blue slates with thin seams of gray sandstone, the former being to the latter in the proportion of six or seven to one. A few rusty-brown seams contain fossils. These rocks exactly resemble those of the upper part of the West Branch, and, as upon the latter, begin to show metamorphism as the granite is approached. Fossils are sometimes found in the most crystalline parts of the sandstone or quartzite. The fossiliferous beds are finally cut off by the granite about

Granite.

a mile west of the road mentioned above, or three miles and a quarter from Bear River village. Near the granite the blue slates which underlie the fossil beds seem to have been converted into finely stratified gneiss. Boulders of similar gneissoid material, finely laminated, large and angular, are profusely scattered over the country to the south of the Morgantown and Weymouth roads for several miles, and no rocks not metamorphosed are seen in this direction. Where seen *in situ* the dip is southerly (S. 5° E. < 85°).

Uncertainty as to age.

While the undoubted Siluro-Devonian rocks are thus clearly traceable westerly from their exposures at and above Bear River village until cut off on their strike by the granites in the vicinity of the Weymouth road, the same uncertainty as to the age of the rocks in the tract intervening between this road and the foot of Annapolis Basin exists, as in the corresponding tract east of Bear River. This much, however, appears to be certain, that whatever the age of the beds described above as occurring above the lower part of Bear River, on Deep Creek and Purdys Brook, the same age must be assigned to the tract intervening between the same part of Bear River and the inlet of the Grand Joggins, south of the town of Digby; for among the beds disclosed upon the various streams which flow northward from this elevated tract into Smith Cove and the Grand Joggins respectively, are some as to the identity of which with those of the streams first enumerated there cannot be any doubt.

On Roach Brook (or Poole Brook) which runs into Smith Cove, the rocks exposed are light- and dark-gray and bluish-black slates, with bands of blue sandstone. These latter are conspicuously buff-weathering, the bands being from three inches to a foot and a half in thickness and standing out above the softer slates. They thus become a very noticeable feature in the rocks of this vicinity, at the same time that they recall the similar beds observed on Deep Creek and elsewhere east of Bear River. Their dip varies from N. 40° W. to N. 55° W. and the inclination from 78° to vertical. The upper part of this brook is crossed by a dyke of diorite which appears to be an extension of a large mass of such rock forming the core of the hills overlooking Bear River Inlet, and has been traced in a westerly direction as far as Hollinghead Brook, to be presently noticed. About the lower part of Roach Brook the dark slates are, as usual, in numerous short folds, dipping steeply to the eastward, the folds themselves being inclined in the same direction at an angle of from 70° to 80°. The slates are often stained and sometimes permeated for some distance with red, buff and green colouring matter, this not being distributed usually in lines corresponding to the bedding, but in patches. Where these colours are present the slates are softer and apparently more argillaceous then elsewhere. In these respects they recall the green and red slates noticed above as found on the shore of the basin at the mouth of Bear River, but perhaps bear equal resemblance to certain soft, coloured slates, described in connection with the Cambrian system as occurring on the coast south of Cape St. Mary.

Roach Brook

The soft red shales found to the north of the railway bridge at Smith Cove have already been referred to.

About a mile and a half west of Smith Cove, as measured along the highway, is the mouth of the Grand Joggins, the western side of which inlet has been described on an earlier page of this report as consisting of a series of black pyritous slates, supposed to be the upper member of the Cambrian system. On the southern side of the same indentation, not far from its mouth, it receives the waters of Hollinghead Brook, on which may be seen the following succession of beds, in ascending order:—

Succession on Hollinghead Brook.

1. Black slates, one and one-third mile. Dip N. 55° W. < 65°.
2. Gray and bluish-gray sandstones. Dip N. 40° W. < 60°.
3. Black slates, 500 feet. Dip N. 30° W. < 60°.
4. Bed of light-gray sandstones. Dip N. 30° W. < 60°.
5. Black slates, about 1000 feet. Dip N. 30° W. < 60°.
6. Striped slates, bluish, light- and dark-gray. Dip N. 30° W. < 65°, 45°.
7. Black slates, one and one-third mile. Dip N. 35° W. < 45°, 30°.
8. Striped bluish-gray and light- and dark-gray slates.

Striped slates.

The last-named striped slates have a prevailing south-east dip, and with some wave-like undulations mark the centre of a syncline, on the other side of which the beds are reversed for about half a mile, the whole basin being at the same time inclined in the direction of Bear River. The dip on the south-east side of the syncline is in places almost perpendicular.

Diorites.

About a furlong south-east of the above syncline, is a dyke of diorite nearly 100 feet wide, being the westward extension of that already noticed on Roach Brook. It protrudes through the almost perpendicular slates, and forms a succession of falls over fifty feet in height. South-east of the dyke the slates maintain for a time their vertical dip., then inclining northward at an angle of from 50° to 70°. A little over a furlong south-east of the dyke is the apex of a minor fold, the dip being N. 30° W. < 65°. Still further south-east the country becomes covered with drift in which boulders of granite and diorite predominate.

Difficulties of separation.

From the above observations it will appear that the line of separation between the Siluro-Devonian and supposed Cambrian rocks has not yet been definitely ascertained. On the one hand there would seem to be little doubt that to the latter system must be assigned all the rocks to the south and south-west of Digby town as far as the Grand Joggins and the head of Bingay Brook; this belief being based on the similarity of the succession no less than on the minute details of these beds as compared with the supposed Cambrian rocks of Queens and Lunenburg counties; while on the other hand, where the beds are fossiliferous, definite proof as to the occurence of more recent rocks is at hand. Between these two, however, is a considerable area in which, along with an entire absence, so far as known, of any fossils, the rocks, consisting chiefly of slates, with some sandstone beds, are of such a character as might allow of their being referred to either of these systems. When, further, metamorphism comes in to obscure any distinctive differences which otherwise exist, the task of separation becomes a most difficult if not a hopeless one. For the present, as a provisional arrangement, the line of the Grand Joggins and Bingay Brook may be accepted as best according with the observed facts; but should it hereafter turn out that the beds in the hills south of the latter are to be assigned to the Cambrian system, a like conclusion must follow as regards a large section lying on the south side of the Annapolis Basin, and either side of the estuary of Bear River.

Provisional boundary.

Mistake Settlement.—It remains to notice one other locality or basin of fossiliferous rocks, of presumably Silurian age, *viz.*, that of Mistake settlement, this being about nine miles west of the Bear River basin, from which it is separated by a northward spur of granite in the settlement of North Range.

Mistake Settlement.

A good locality for the study of these rocks is the farm of Benj. Sabean, one mile and a quarter south of South Range. They consist of a mixture of slate and sandstone, and are similar in every way to those previously described as occuring on the West Branch of Bear River, and like them hold crumbling seams carrying numerous but poorly preserved fossils. Among these *Orthis oblata* may be mentioned as especially common, but with this are *Spiriferi*, strophomenoid shells, crinoidal joints and corals resembling *Favosites.*

Fossils.

It is remarkable that these beds should be almost exactly upon the line of strike of those of Bear River, notwithstanding the intervening tongue of granite, and that their attitude as well as their characters should be so nearly identical. It would seem as though the granite had simply melted its way across the course of the Devonian beds, in the manner referred to in the description of the Nictaux-Clementsport basin by Sir J. Wm. Dawson, or that these had themselves been in part converted into granite. It would also appear further, as long since maintained by the author last-named, that the granites are of intrusive or aqueo-igneous origin, and that the period of their intrusion was during the latter portion or at the close of the Devonian age.

Relations to granite.

Limits.

In attempting to fix the limits of the Mistake settlement basin, the same difficulty is met with as in that of Bear River. Exposures are few and of those which do occur it cannot always be said that they are not Cambrian rather than Devonian. From what has already been said, however, regarding the Cambrian rocks in the Sissiboo section and on the Mistake River, as well as from the comparatively small area over which fossiliferous boulders are found, it is probable that the belt is of no great extent.

Triassic (?) Rocks of Digby and Annapolis Counties.

In the earlier portion of this report, as well as in other publications referring to the same region, reference has been frequently made to the rocks which respectively underlie the Annapolis valley, with its natural extension in St. Marys Bay, and the long but interrupted ridge forming the North Mountain of Annapolis county, Digby Neck, Long and Briar islands. It has been usual, also, to regard the rocks of the valley, consisting mostly of coarse sediments of a red colour, as being of Triassic age, while those of the mountainous ridge separating the latter from the Bay of Fundy have been regarded as of more, recent origin, though still referable to the same division of the geological scale. I have now to show that, while these references may in part be true, there are also, among the red sediments of the valley, deposits of wide distribution, which if not positively more recent than the traps of the North Mountain can at least not antedate them, though possibly of contemporaneous origin.

It will be convenient to consider the sedimentary formations first.

FRAGMENTAL ROCKS.

Sea Wall St. Marys Bay.

Red Sandstones of St. Marys Bay.—By far the best exposures of the red sandstones heretofore regarded as of Triassic age to be found within the area under review, occur not far from the head of St. Marys Bay, and about six miles distant from the town of Digby. They are in the form of a series of bluffs which, beginning a few rods south of the post-road at the so-called "Sea Wall" with a height of only a few feet, rapidly rise into such prominence as to make them, both by their height and bright red colour, a conspicuous feature in the landscape. The plane of the section is nearly in the line of the dip of the beds, which is to the north or north-north-east at an angle of from 5° to 8°, and its total length about half a mile, the precipitous bluffs for much of this distance attaining a height of nearly 100 feet and exhibiting many curious illustrations of marine sculpture. Though the prevailing colour is, as stated, a brick-red, it includes both light and dark shades, while at intervals are interstratified bands, from half an inch to five or six inches in thickness, in which the red is replaced by light-green and gray tints. These green and gray beds are mostly beneath the reddish ones, and from this position form the larger part of the ledges which, at low water, are seen extending out into St. Marys Bay for a hundred yards or more. The layers thus exposing their nearly flat surfaces, afford some very fine illustrations of fossil ripple marks, as they do also of dendritic crystallizations, but the only organic remains found were a few branching fucoidal stems and what appeared to be the cast of a tree-trunk several feet in length, but without definite markings. The lower beds are distinctly more arenaceous than the upper, and are made up largely of small quartz Faults. pebbles and coarse sand, while on the neighbouring beach are large boulders of red conglomerate unlike anything in the cliffs, but of which the origin is unknown. The dip of the beds referred to above, would gradually carry the gray and green bands out of sight, were it not that they are repeatedly brought to the surface by faults, the latter having an upthrow on the north side of from one to ten feet. Some of the red layers are very micaceous, and through others run veins of calcite, in the forms both of Iceland and of dog-tooth spar.

To the west of the bluffs at the Sea Wall described above, similar red sandstone beds occur at intervals along the north side of St. Marys Bay as far as the vicinity of Johnston's mine in Waterford. Along this part of the shore they are in much nearer proximity to the trappean rocks, forming in fact a narrow fringe at the base of the trappean ridge, and dipping towards the traps, but nowhere showing any instance of the superposition of the latter, or of any alteration therefrom.

Compared with the rocks of Blomidon and Minas Basin, the red Comparison with Blomidon. sandstones of St. Marys Bay differ chiefly in the absence of the gypseous layers so conspicuous in the latter. In their texture and consistency, however, as well as in their colour, these do not differ markedly from the Blomidon beds, and no facts are known which would tend to show that they are not the equivalents of the latter. They differ at the same time in all these respects from some of the beds to be presently noticed.

Red Sandstones of Annapolis Basin.—The extent to which the red sandstones, *etc.*, occupy the isthmus separating St. Marys Bay from Annapolis Basin is not easily determined, the exposures being few and the soil indications obscured by the abundant drift from the neighbouring trap ranges. They may, however, be seen at several points, as where the post-road crosses a small brook flowing into St. Marys Bay, about three miles from Digby, and again on the slopes of the trap range where this is ascended by the road leading from Digby to Broad Cove. Their elevation at this point is about the same as that of the higher bluffs near the Sea Wall, and the inference is therefore justified that all portions of the isthmus not exceeding 100 feet, were covered by the waters in which these sandstones were deposited. As, however, the "Racquette Hill," which lies between this point and the town of Digby, has an elevation of 175 feet, and the hill in the rear of Digby 225 feet, there being in neither case any indication of derivation from red sediments, it is altogether probable that this high land is underlain by Cambrian strata, and that any direct connection between St. Marys Bay and Annapolis Basin in Triassic times, if existing at all, was narrow and shallow.

Elevations.

The first exposures of rocks more recent than those of Palæozoic age found on the shores of Annapolis Basin are those revealed along the shore in the town of Digby. In the more northerly portion of the town these may be well seen on the bottom and sides of the bay commonly known as "the Racquette." They present here considerable diversity both of attitude and character, for while most of the beds, consisting of reddish-gray sandstones, are not less firm than those of St. Marys Bay, others are quite soft and incoherent. The dip at the same time varies within a few rods from N. 20° E. < 30° to N. < 10°, with some appearances of unconformity. Other and still more interesting beds occur just below the railway in the more southerly part of the town, the most noticeable feature being the inclosure between the compact reddish-gray sandstone beds, of irregular layers of pebbles, among which, in addition to a few of granite and quartzite, are many *which cannot possibly be distinguished from the trap of the North Mountain.* One of these coarser beds is nearly five feet in thickness, the trappean blocks imbedded in it being from a few inches to a foot or more in length, but is continuous for a few yards only, gradually passing into the sandstones, which at the same time exhibit much false bedding. It seems hardly possible to avoid the inference that these strata are more recent than the traps which form so large a proportion of their inclosed pebbles.

Digby.

Trap conglomerates.

Facts very similar to the above may again be seen on the opposite or northern shore of Annapolis Basin in lower Granville. In passing along this shore in the direction of Digby Gut, the first rocks met with, forming a series of low bluffs, are bright red sandstones, with which in places are associated very soft red shales. Similar beds are exposed for

Granville.

about half a mile, or to within a short distance of the base of the high trappean hill, which, denuded by a landslide, marks the southern entrance of Digby Gut. About here the beds become more pebbly, and while as a whole nearly horizontal, show an abundance of false bedding. Still farther north, but at a distance of only a few yards, the beds become very coarse, of a chocolate-brown colour mottled with light-gray, and at the same time soft and clayey, while imbedded in them are numerous blocks and some large fragmentary columns of the readily recognized North Mountain trap. One such columnar block has indeed been left by erosion projecting fully two feet from the face of the bluff of which it forms a part. These coarse beds are exposed for a short distance only, but beyond them the finer beds extend for some little distance, becoming at the same time harder, of a purplish colour and somewhat vesicular. Finally, these terminate abruptly along what appears to be a vertical line of fault, beyond which a small interval, occupied by loose blocks of trap, separates them from the main body of this rock.

Trap conglomerates.

It is of course barely possible that these trap-conglomerates, which form the uppermost beds of the section here exhibited, may be of Pleistocene origin; but apart from the fact that between them and the regularly bedded sandstones below, which can hardly be Pleistocene, there is no clear line of separation, their similarity to the conglomerates above described upon the Digby shore point strongly to the view that, while newer than the traps, they long antedate the last-named epoch. Other facts pointing in the same direction remain to be noticed.

Age.

The next beds to be referred to in this connection are found on the southern side of Annapolis Basin, near the foot of one or more of the streams emptying into the latter. One of these is Deep Creek, midway between Moose and Bear rivers, wherein, near the mouth, or just below the high-road, is exposed a series of bright red slates, dipping at a high angle and supposed to be of Devonian age. Directly overlying the latter, however, is another series of reddish beds, evidently of much later origin. Of these the most noticeable feature is their soft and unctuous character, they seeming to consist indeed of a paste which is hardly firmer than a bed of ordinary clay, but which, by its irregularly mottled colour, its sandy texture, and the inclined position of its beds, differs wholly from any of the ordinary Pleistocene beds of the region. Like the red slates on which they rest, these beds dip northerly, but while the inclination of the older set is 80°, these have a dip of only 20°. Beyond the facts stated no direct clue to their age is afforded.

Deep Creek.

Red sandstones of Annapolis Valley.—Of the sediments underlying the Annapolis Valley, as distinct from Annapolis Basin, we are in position to say but little, it being for the most part outside the limits of the region to which this report relates. A few observations, however, made incidentally, are of interest as related to those already noticed.

Bridgetown.

The first locality requiring mention is that locally known as "Hell's Kitchen," a gulch on the south side of the North Mountain, not far from Bridgetown. Here are red and gray sandstones exposed on the mountain side at least 350 feet, probably 400 feet, above the river level. The upper beds, as described by Mr. Prest, are greenish-gray, and these overlie red beds. Here again the very fine-grained, almost soapy, character of the beds seen on Deep Creek reappears, the red rocks being so soft as to be readily cut with a knife, while interstratified with them are bluish-green layers, from a quarter of an inch to one inch in thickness, which are similarly unctuous. Compared with the beds of Rossway, at the head of St. Marys Bay, they differ in having the greenish beds above instead of below the red beds, as well as in being of much finer texture; but the upper greenish-gray beds correspond fairly well with the lower greenish-gray beds at Rossway. The beds at this point are perfectly horizontal, and in this position form a junction with the trap, veins of iron ore being seen, near the latter, to penetrate the slightly altered soft red sandstone.

Lawrencetown.

A second locality is Lawrencetown. Here, at the eastern end of the village, a cutting for the passage of the railway shows a series of horizontal sandstones, which, both in their colour, (red mottled with paler blotches,) and in their soft and unctuous character, nearly resemble the beds already noticed.

Kentville.

Finally, in Kentville, just below the mill on Black River, the gray and red slates which there represent the Devonian system, are, like the similar red slates at Deep Creek, unconformably overlain by a second set of beds, strongly contrasted with the latter. These newer beds are mostly of a bright red colour, but alternate with layers which are pale-gray or white, both being so soft as to crumble between the fingers. They almost exactly resemble the beds of Lawrencetown and Deep Creek, while they lack the firmness of the beds both of Minas Basin and St. Marys Bay. Their attitude is nearly horizontal and their exposed thickness about thirty or forty feet.

Scott Bay.

It only remains to notice the observation of Dr. Ells as to the occurrence at Scott Bay, near Blomidon, of green sandy shales and sandstone, with limestone, resting upon the traps, and therefore of more recent origin.*

Reviewing all the facts above set forth, it is reasonable to believe that a large part of the reddish sediments underlying the Annapolis Valley, and which it has been customary to regard as older than the traps of the North Mountain, are newer than the latter, though no data are at present available whereby their exact age can be determined. The supposition that the beds at Digby containing blocks of trap are of the nature of agglomerates and contemporaneous with the traps, is opposed by the fact that with the trappean fragments are others of granite and quartzite which are well rounded. Review.

TRAPS AND ASSOCIATED ROCKS.

The general features of the trappean rocks which intervene between the Annapolis Valley and the Bay of Fundy, with their extension westward in Digby Neck, Long and Brier islands, have been the subject of frequent description by earlier writers, among whom in particular may be mentioned Dr. A. Gesner (1836) and Sir J. Wm. Dawson (1868 and 1878). It is only recently, however, that the rocks have been subjected to close petrographical examination. Traps.

Regarded macroscopically, the most abundant and characteristic rock of the range is a compact crystalline admixture of augite and felspar, of a dark greenish-gray tint and a granular texture, but very hard, without stratification and with a tendency, which is sometimes very marked, to exhibit a jointed or columnar structure. On flat or slightly inclined surfaces, the divisional planes which produce this structure often give to these surfaces the aspect of a tesselated pavement; while in vertical bluffs or when exposed to the wearing action of the sea, they determine scenic effects resembling, though on a much smaller scale, those of the Palisades of the Hudson or of the Giants Causeway. The same joint-planes are also frequently marked by the presence of minute quartzose veins, while across the whole mass run much more considerable veins of a like nature, but more variable in coloration, producing agates and jaspers often beautifully clouded and banded. With these, at a number of points, are veins wholly or in part composed of magnetite or of octahedral hæmatite (martite) probably a pseudomorph of magnetite. Macroscop character.

*Notes on Recent Sedimentary Formations on the Bay of Fundy Coast. Trans. Nova Scotia Institute of Science. Ser. 2, vol. I., p. 416.

While massive and more or less columnar beds predominate, they are frequently associated with less compact beds which are ashy, scoriaceous or amygdaloidal. These latter, especially when viewed from a distance, show a much more distinctly bedded arrangement, and are disposed in parallel sheets which are sometimes horizontal, but more commonly dip seaward at a moderate angle. These latter beds also vary much in colour, exhibiting various shades of gray, green, red and purple, the amygdules being commonly white and consisting of zeolites, often with thin incrustations of green chloritic matter. Instead of quartzose veins, these beds usually contain veins of a zeolitic nature, thompsonite being one of the most common minerals, but associated sometimes with stilbite or analcite. The occurrence of soft and easily decomposable substances like these, helps greatly in the disintegration of the rocks containing them, which are rarely found exhibiting the prominence that marks their harder and more massive associates.

Minerals.

In both the hard and the soft rocks, indications of copper, in the form of green stainings, are not uncommon, while in places minute grains or in some instances strings of native copper are met with.

The petrographical description of these rocks to which reference has been made, is contained in a paper by Mr. F. V. Marsters.* His remarks refer particularly to those found to the eastward of Digby Gut, but doubtless apply equally to those occurring to the west of this channel, and are as follows:—

Microscopic character.

"Under the microscope the rock proves to be composed chiefly of plagioclase, with generally irregular and scattered masses of augite, magnetite, sometimes showing perfect octahedral forms, but in the main massive, and a brownish mineral probably resulting from the decomposition of the augite. The plagioclase, which presents little evidence of decomposition, consists of lath-shaped crystals exhibiting very good crystallographic terminations. They are almost universally twinned, but seldom exhibit marked zonal structure. These sections approaching the zone of the axis of symmetry show a decided fracturing as if subjected to great pressure or some mechanical disturbance subsequent to the completion of their crystalline form. It makes up the most prominent component of the rock. Augite exhibits irregular small masses, with brightly polarizing centres and muddy dark brown peripheries. The brownish product, which is of secondary origin, extends along the cracks so universally present in augite, presenting a

* Triassic Traps of Nova Scotia, American Geologist, March, 1890.

net-like appearance. Whenever a crystal occurred sufficiently fresh and regular in form for orientation, it proved to be twinned on the orthopinacoid. Magnetite occurs for the greater part in irregular aggregates which may be of secondary origin, but not presenting a titaniferous aspect. The perfect octahedra are undoubtedly primary and were probably the first to form during the cooling of the fused mass. Compared with sections of Triassic traps from New Jersey, I find a marked resemblance both as regards the optical characteristics of the individual minerals and the relative quantities of each component."

The specific gravity of the more compact columnar trap is given as 2·93.

Among the localities in which the peculiar features of this group of rocks may be most conveniently studied, may be enumerated the shores of Digby Gut, Broad Cove, Sandy Cove and the Petite Passage.

Digby Gut, east side.

The eastern side of Digby Gut, about the entrance, shows well both the more solid and columnar traps and the softer bedded amygdaloids. The cliffs are from 60 to 100 feet high, and show from five to seven layers or beds, the lower mostly gray or purple and vesicular, while the upper are dark-gray, compact and ashy. In places the beds are nearly horizontal, but in general they have a distinct northward or seaward dip of 5° to 10°. The amygdaloids have numerous veins of thompsonite, or show surfaces over which incrustations of this mineral are spread in circular radiating sheafs. Analcite and native copper have also been obtained here.

Digby Gut, west side.

On the western side of the passage the exposures are similar, except that the columnar crystalline trap is more augitic than usual, and that this type of rock is here found above as well as below the amygdaloids, forming the promontory of Cape Prim. Surfaces a yard in diameter are here covered with white sheafs of thompsonite crystals, a mineral which is also very abundant at Broad Cove.

Sandy Cove.

At Sandy Cove, the most interesting feature is the occurrence of precipitous bluffs, nearly midway between the two bays, and the information these give in regard to the structure of that portion of the Neck which lies to the westward of this point. As seen from the more prominent of these eminences the fact that the whole peninsula is composed of successive sheets or lava-flows is very clearly seen in the curiously serrated outline thereby caused. Each great bed has its highest portion to the southward and slopes thence at a gentle angle northward until it reaches and is abruptly covered by the next succeeding flow, which but repeats these features.

Petite Passage.

Finally, in and about the Petite Passage, are afforded the most remarkable illustrations of columnar structure. This is quite conspicuous about the wharfs in the little fishing village of Tiverton, but much more striking at Israel Cove, a little below the village, and on the south shore of Long Island. Here the cliffs are not only very bold and high, but so perfectly jointed and upon so large a scale, as to present an extremely rugged front, the columns or groups of columns, isolated by the action of the sea, being left standing in prismatic or needle-like projections, often ten or fifteen feet in height.

While the bedded arrangement referred to above appears to be the result of several successive outpourings or overflows of igneous rock, it is possible that a part of the peculiar topography indicated may be due to repeated down-throws by faulting. No indications of any special line of extrusion have been observed, and it is altogether probable that the main lines of fracture giving vent to the igneous outflows or fissure-eruptions, lay beyond the present line of coast, and nearer the centre or axis of the great trough by the sinking of which the fractures may have been produced.

Further remarks upon the iron ores of Digby Neck and their associated minerals will be found in the sequel.

ECONOMIC MINERALS.

In the course of the preceding pages, references have from time to time been incidentally made to the occurrence of minerals of economic value in the several regions described. These may now be made the subject of more particular consideration.

List of minerals.

The minerals and rocks to be thus noticed include gold and copper, in the native state ; oxides of iron, such as magnetite, hæmatite, martite, ilmenite and limonite ; metallic sulphides, such as pyrite, arsenopyrite and molybdenite ; tungstate of lime or scheelite ; ornamental stones, as quartz, amethyst, jasper, garnet, tourmaline, *etc.*; building stones, including granite and slate ; brick- and fire-clays ; rocks suitable for road construction ; sand, and infusorial earth.

Gold.

Gold.—This is, of course, by far the most valuable mineral met with in the area under consideration, and the one around the existence of which cluster the most important interests. It is therefore desirable that the fullest possible information should be had regarding both the extent and the circumstances of its occurrence.

The fact of the existence of gold in connection with the so-called Cambrian coast-belt of Nova Scotia, was made known in Lunenburg and Halifax counties some years prior to its discovery in the south-western counties; and, though numerous reports and papers relating to the above-mentioned counties have appeared, the only one based upon observations in the south-western counties known to the writer, is that by his assistant, Mr. W. H. Prest.* The general conditions are, however, very much the same in all these districts, and hence it will be unnecessary here to do more than describe the particular localities in which mining operations have been entered upon, and to state such facts and conclusions as they may suggest. The following particulars are based partly upon the writer's own observations, partly upon information courteously afforded by the managers of different properties, and partly upon facts contributed by Mr. Prest, whose intimate and extended practical knowledge of gold mining in Nova Scotia has been of the greatest service.

List of gold districts.

The following are localities, within the limits of this report, in which the gold found has been thought sufficient to justify the commencement of mining operations and the erection of stamp mills:—

Queens County.

(1.) Malaga gold district.
(2.) Whiteburn gold district.
(3.) North Brookfield gold district.
(4.) Westfield gold district.

Yarmouth County.

(1.) Kempt gold district.
(2.) Carleton gold district.
(3.) Chegoggin gold district.

In addition to these, gold has been reported at Fifteen-mile Creek, north of Middlefield; near Mill Village, on the Port Medway; on Broad River, and near Grafton Lake; all of these being in Queens county. Reports have also been made of discoveries in Shelburne, Digby and Annapolis counties, but most of these have not as yet been fully verified.

Malaga gold district.

Malaga gold district.—Until recently, this has been the most important of the Queens county gold districts, there being here not less than five mining properties, on each of which large expenditures have been made. These are:—

1. The Parker-Douglas mine, with mill of twenty stamps.
2. The Caledonia mine, ten stamps.

*Proc. and Transactions, Nova Scotia, Inst. of Sc. Vol. I. Series 2. 1890-94.

3. The Minneapolis mine.
4. The McGinn mine, twenty stamps.
5. The Ballou mine.

History and development.

The first discoveries in this district were made in 1886, one year after similar discoveries in Whiteburne, and were of such a promising character that, within a very brief period, what had been a wilderness of forest and huge boulders, became the seat of a busy and thriving mining community, with a population of over 600 souls. Besides residences for the managers, comfortable houses were erected for the workmen and their families, a commodious school was provided, stores and hotels were opened, and, together with the smoke of chimneys, the moving of cars on the tramways, and the hum of machinery, everything betokened a prosperous future. Such was the condition of affairs at the time of our first visit in 1891. Two years afterwards, on the occasion of a second visit, a great change had taken place. The largest of the mills previously at work, and the most thoroughly equipped, that of the Parker-Douglas Company, had ceased work. But little was being done at the other mines, though the Ballou Company was obtaining some very encouraging returns. The hotel and boarding-house had been burned, and a large part of the population had removed elsewhere. What causes were chiefly instrumental in contributing to this result, the writer is unprepared to say, but the fact that, more recently, work has been resumed at several of the mines previously abandoned, including that of the Parker-Douglas Company, together with facts to be presently noticed in regard to the Brookfield mines, would seem to indicate that other circumstances besides the quantity of gold present might have something to do with the result.

The leads at Malaga are all in quartzite with interbedded slates, representative of Division I. of the Cambrian system, and forming part of an anticlinal dome lying between Malaga and Ponhook lakes. There are but few exposures at the surface, and underground plans, if made, have not been open to our inspection.

Whiteburne.

Whiteburne.—This district is situated about twelve miles to the westward of Malaga, but geologically at about the same horizon in the Cambrian system, *i.e.*, in the quartzite division, not far below where the rocks of the latter graduate into greenish arenaceous slates. The beds are much better exposed than at Malaga, and over the greater part of the district dip northerly (N. 10° W. $<$ 40°) with great regularity. The leads vary from five inches to ten inches in width, and are said to yield, upon an average, about $20 to the ton in gold.

The first discoveries made here were in 1885, it is said by an Indian, on the property of the Whiteburne Mining Co., when work was begun in the following year, with the erection of a five-stamp mill. This mill was subsequently doubled in capacity and a force of from 50 to 100 men was employed, a shaft being sunk to a depth of 100 feet. At the same time several other companies commenced operations close by, one of these being the Queens County Mining Company, with a plant of ten stamps, air compressors, *etc.*; another, the Rossignol Mining Company, working the so-called Cushing vein, with a mill of ten stamps; and finally the Gammon mine, at one time owned by the Parker-Douglas Co., and on which Gammon and others proposed to erect a Wiswell mill, with revolving rollers instead of stamps. History and development.

North Brookfield Gold District.—The vicissitudes of gold mining, remarked upon in the case of the Malaga district, find an equally striking illustration here, but fortunately in the reverse direction, of greater returns and an enlarging prospect. North Brookfield.

Our first visit to this neighbourhood was made in the year 1890. Two mines had then been opened, both a little to the south of the main road through the settlement, and distant about half a mile from each other. Of these the first or Maguire mine was idle, work having been stopped from a failure to obtain remunerative returns, while the second, known as the Philadelphia mine, was giving employment to about forty men and a mill of ten stamps, with, as represented, a good output of gold. On the occasion of a second visit, made in the summer of (1896), this condition was found to be almost reversed. Work was indeed still in progress at the Philadelphia mine, but only in a small way, while the previously idle site of the Maguire mine had now become a scene of bustling activity. Not only had the old mill been again brought into action, and the homes of the workmen been reoccupied, but a far larger mill, to include not only a battery of fifty stamps but the necessary plant for a combined amalgamation and chlorination process, was in course of rapid erection. About fifty men were found to be employed as miners and as many more in various occupations connected with the mines. History and development.

The explanation of this gratifying change, so far as the Maguire mine is concerned, is of course to be sought in the record of its more recent workings, which, as given in the returns of the Mines Office, is as follows :— Returns of yield.

	Rock crushed. Tons.	Yield of Gold. Ounces.
1894.		
December	150	127
1895.		
January	375	144
February	380	128
March	390	151
April	300	140
May	318	205
June	268	231
July	272	211
August	202	183
September	364	303
October	450	321
November	458	394
December	465	561
1896.		
January	390	350
February	427	424
March	425	330
April	445	352
May	476	565
June	452	385
July	470	396
August	431	376

Auriferous tailings.

An interesting circumstance in connection with the development of these works, is that of the yield afforded by the re-working of the tailings of former operations. I am informed that a ton and a half of the latter, sent to North Carolina for treatment, yielded $75 ; and it has been in part with a view to subjecting the whole mass of these tailings to a similar process that the new works are erected.

The company working this property is known as the North Brookfield Mining Company, its managers being Messrs. Libby and Maguire.

The main lead at this mine is a fissure lead, from four inches to four feet in width, with a dip about N. 45° E. < 70° to 80°, while the rock is partly quartzite and partly a highly chloritic slate, which is easily crushed. The main lead is intersected by several "angulars," and it is at the junction of these with it that the greatest quantity of gold is found. The gold is mostly carried in the sulphides with which the rock is highly charged, the free gold not being more than fifty per cent of the whole, if as much. Nature of leads.

The following additional particulars of this mine, based on observations by Mr. Prest, are reproduced here from the authors preliminary report, published in 1895. (Annual Report, Geol. Surv. Canada. Vol. VI.)

"In the case of the Brookfield leads, it has been further noticed (1) that only those bedded leads which dip towards or intersect the cross or fissure leads contain gold ; (2) that those bedded leads which dip away from or do not intersect the said cross leads do not yield gold ; (3) that those bedded leads which do carry gold become more and more barren as we recede from the neighbourhood of their junction with the cross leads ; (4) that those bedded leads which are found in the western part of the district, although in the same geological horizon as those intersecting the cross leads, have thus far proved barren, and (5) that those bedded leads which intersect the cross leads contain the same metal. From these several facts the conclusion is suggested that, in the case of the Brookfield area at least, the bedded leads have been mineralized from the great fissure or cross leads upon which nearly all the work in this vicinity has been done. Productiveness of leads.

"It may be added that while the bedded leads all dip away from the apex of the anticline, the cross leads dip towards it. Thus the bedded leads often intersect the cross leads. The former curve with the quartzite and slate belts of the dome, but dip away from it at an angle of from twelve to thirty degress, according to their position around the anticline.

"The general course of the anticline at Brookfield is S. 60° W., and it seems to be subsidiary to the great Malaga dome or fold.

The Philadelphia Company's mine is situated on the south-easterly extension of the Maguire vein, and has a dip about N. 40° E. $<$ 80°. Its width varies from a few inches to four feet. The gold is reported to be irregularly distributed by those having no interest in it; but it is certain that rich as well as poor spots occur, and as in the case of the Maguire mine it is probable that much gold may yet be recovered from the tailings. The workings have reached a depth of over 200 feet. Philadelphia Company's property.

West Caledonia Gold District.—The structure here seems to be that of an oblong fold which flattens out towards the east, and turns into a series of undulations south of DeLong settlement. The beds to the north and south succeed each other regularly, the gray or greenish-gray slate, however, occupying on the north more than the usual amount of space. The purple slates are seen about two miles and a quarter south of the anticline. The latter slates seem to continue east to McGowan Lake on the Port Medway River, while the greenish-gray slates circle around the eastern end of the quartzites in Kempt and meet the northern gray slates.

West Caledonia.

The gold occupies a higher horizon than that of Malaga, but lower than that of North Brookfield. Its distribution is extremely irregular, and success in prospecting, which is all that has been yet attempted, is a matter of much uncertainty. Some money has been spent here but without success.

Westfield.

The Westfield Gold District.—This district is situated about three miles north-west from North Brookfield, and not far from the southern extremity of Tupper Lake. It includes, as far as known, but a single property, locally called the "Jumbo mine," and known rather for the unusual size of the quartz reefs there exposed, and the magnitude of the expectations based thereon, than for its actual gold contents.

The rocks of this vicinity are somewhat higher in the Cambrian system than those of the districts previously noticed, consisting chiefly of the black slates of Division III., together with some coarser and more sandy beds. Through these, and coincident with the bedding, run reefs of white quartz from twenty to thirty feet in thickness, much of the mass being white and vitreous, while other portions are gray or stained with oxide of iron. The rock contains both iron and mispickel, the latter abundantly, and from these sulphides it is stated that gold has been obtained to the extent of two pennyweights to the ton, with sixteen of silver. For its removal a mill of twenty stamps was erected and fully equipped, but to be almost immediately abandoned, with the removal of the machinery elsewhere. It is said that not less than $30,000 was expended upon the property, while its subsequent sale realized only $1,500. It is, however, the opinion of many that this mine, like that of Brookfield, has a future before it.

The Kempt Gold District.—(Yarmouth county.) It is an interesting confirmation of the reference of the Yarmouth county rocks to the Cambrian system that, like those of the latter age in Halifax, Lunenburg and Queens counties, these should also be auriferous.

The horizon of the beds in which the Kempt mine has been opened is the same as that of the mines at Brookfield, *i. e.* in greenish arenaceous slates overlying the quartzites of Division I. As at Brookfield, the veins are chiefly fissure veins, crossing the bedding-planes at various angles. As far as known, however, they are much less productive. We were informed by the manager that about $25,000 worth of gold had been obtained here, but at a cost considerably greater. At the time of our visit, (1896) no work was being done, but it was thought that it would be at once resumed. Kempt.

The ledges holding the leads were not exposed at the surface, and, as far as we could judge, the work of excavation had been largely haphazard. The property includes a good 50 horse-power engine and a battery of ten stamps.

Half a mile south-west from the Kempt mine is the Cowan mine, opened in rocks similar to those of the former, and with similar results.

Carleton Gold District.—The work carried on here is only exploratory, and little or no return has yet been realized. A mill of eight stamps, worked by a branch of the Tusket River, has been erected at Carleton, the rock, which is similar to that of the Cowan and Kempt mines, being obtained from beds but little removed. Some good "finds" are said to have occurred in the vicinity, but the outlook at present can hardly be regarded as encouraging. Carleton.

It is noticeable that the beds carrying the auriferous leads at the several localities above referred to, all occur on the northern side of a single anticline traversing a considerable portion of Yarmouth county in a south-westerly direction.

Chegoggin District.—In the description of the coast section north of Yarmouth Harbour given in preceding chapters, reference had been made to two localities as having been the site of gold mining operations.

Of these the first is Chegoggin Point, where, in the year 1890, a mill of ten stamps was erected for the purpose of crushing quartz from a series of large reefs of this rock exposed upon and near the shore-cliffs. The rocks composing the latter are partly coarse sandstones approaching quartzite in character, and partly gray slates, both of which exhibit short and sharp corrugations, though with a general south-easterly dip of 45°. With the above dip, but apparently in inferior position, are micacious, staurolitic and hornblendic rocks, and Chegoggin.

all are probably the altered equivalents of the green chloritic sandstones and slates of Division 1 *b*, the same in which occur the auriferous veins of Brookfield and Kempt.

One of the masses of quartz exposed at this locality is not less than twenty-six paces across, and others occur of scarcely smaller dimensions. A considerable quantity of this quartz has been removed and crushed, but no reliable data as to its yield could be obtained. At the time of our visit in 1892, all work had been abandoned, without prospect, so far as we could learn, of its renewal.

Cranberry Head.

The second locality on this coast is that of the Cream Pots at Cranberry Head, about five miles north of Chegoggin Point. Here the rocks exposed on the shore in high bluffs, are more slaty than at the headland last named, but the near association with them of quartzites, micacious and hornblendic schists, would seem to indicate that their geological position is not greatly different. In this case again the original find of gold seems to have been sufficient to justify considerable expenditure in the erection and furnishing of a mill, but with the same result as at Chegoggin Point, that of its speedy abandonment. The works have been recently reopened (1897) and operations renewed, but we have no information as to the results.

Copper of Digby Gut.

Copper.—In the traps cf the North Mountain, and of Digby Neck, it is not an unusual thing to find the rock more or less stained by small quantities of the carbonate of copper. These stainings are, no doubt, due to secondary products derived from native copper, of which small grains and irregularly branching strings also occur. The latter were observed in some of the amygdaloids which form the bluffs just east of the entrance of Digby Gut, and it is said that deposits of considerable size have been found in this neighbourhood. On Brier Island, also, native copper was observed in isolated grains in amygdaloid. But in no case have any real veins of this metal, or anything which would seem to justify expenditure in the search for it, come to our notice.

Iron ores.

Iron.—The oxides of this metal found within the region under review and constituting ores, are referable to two widely separated systems of rocks, and are as strongly contrasted in their nature, mode of occurrence and conditions of origin.

a. Iron ores of the Nictaux-Torbrook and Clementsport Basins.—In connection with the discussion of the geological structure of these basins, in earlier pages of this report, frequent reference has been made to the occurrence therein of extensive deposits of hæmatite and magnetite, and the view has been expressed, from the nature of the fossils with which at many points they are filled, that they belong to the lowest portion of the Devonian system.

The fact of the occurrence of such ores has been known for many years, and more or less detailed accounts of their nature, composition and extent, as well as of the attempts made to work them (the earliest, at Clementsport, being in 1831) have been given by various authors.* Accordingly, only such facts will be referred to here as seem to throw additional light upon their possible future development. It should be added that as the study of the Nictaux-Torbrook basin was undertaken chiefly with a view to ascertain what light it might afford in the investigation of doubtful points in the geology of Digby county, and as that study was neither exhaustive nor accompanied by instrumental measurements, the observations which follow must be accepted as only partial and tentative.

Clementsport.

In the discussion of the structural relations of the different parts of the Nictaux-Torbrook basin, an attempt has been made to show that this structure is that of a broad syncline, or more correctly of two synclines, which are parallel and overlap. In this view the principal ore-belts are repetitions, more or less complete, of the same sets of beds, successively brought to the surface by folding. It is certain that these ore-belts stand in such relations to the associated strata that one familiar with the character and succession of the latter may predict, with considerable confidence, where these ores are to be found, and that with few exceptions their occurrence is strictly in accordance with this view. It is also certain that ore-beds of essentially the same character and thickness persist upon the strike for long distances, though from causes which are not always obvious, what is a "shell ore" at one point, abounding in organic remains, may be nearly or quite destitute of fossils at another; while an ore which is ordinary hæmatite at one point may at another be more or less magnetic. Such variations do indeed occur within a distance of a few yards in what are evidently

Relations of ore-belts.

* Haliburton—History of Nova Scotia, 1829.

Genser—Remarks on the Geology and Mineralogy of Nova Scotia, 1836.

Dawson—Acadian Geology, 1868.

Harrington—Notes on the Iron ores of Canada, Report of Progress, Geol. Surv. Can., 1873-74.

Gilpin—Mines of Nova Scotia, 1880.

Gilpin—Proc. and Transactions, Nova Scotia Institute of Science, vol. IX., part 1, 1896.

continuous ore-beds—a fact which must be constantly borne in mind in any attempt to trace out these beds across the country. In illustration of the wide distribution of these ores, the following list of lots upon which they have, according to reliable authority, been found, is given :—

List of ore-deposits.

LIST of Farms in the Nictaux-Torbrook Basin, containing deposits of iron ore.

1.	Mrs. Jeannette Banks	Meadowvale	Hæmatite.
2.	David Banks	"	"
3.	Eaton	Torbrook Road	"
4.	Nealy	"	"
5.	Ezekiel Barteau	Torbrook Centre	"
6.	R. J. Lecky	"	"
7.	Saml. Barteau	Torbrook Mines	"
8.	Capt. Burns and J. H. Banks	"	"
9.	Banks	Torbrook	"
10.	Wm. Nealy	"	"
11.	Parker	"	"
12.	Stanley Brown	"	"
13.	Holland	"	"
14.	Banks	Canaan Mountain	"
15.	Stearns	(Ore first found here)	"
16.	Benj. Wheelock	Canaan	"Shell ore" magnetite.
17.	Foster	"	" "
18.	Fletcher Wheelock	"	Magnetite and hæmatite.
19.	Banks	"	Shell ore.
20.	Hanley Wheelock	"	"
21.	Edward Martin	"	"
22.	James Allen	"	"
23.	Mrs. John Ward	Nictaux River	"
24.	Danl. Armstrong	Bloomington	
25.	Page & Stearns	Cleveland	Magnetite.
26.	John Heately	"	"
27.	S. B. Willet	"	"
28.	Abner Saunders	"	"
29.	Whitman Wheelock	Canaan Mountain	"
30.	Benj. Wheelock	"	"
31.	Banks	"	"
32.	Foster	"	"
33.	Foster	"	"
34.	Messenger	"	Hæmatite.

Torbrook ores.

The ore worked at the Torbrook mine is a bed of red hæmatite, from five to seven feet thick, massive and fine-grained, with a tendency to break in rhomboidal blocks, and in parts containing considerable pyrites, from which, however, the greater part is free. This bed has been traced in an easterly direction for about two miles, to the county line, and has been supposed to connect in a westerly direction with beds of similar character near Nictaux Falls. A reference, however, to the strike of the rocks, in connection with the general structure of the basin, renders it probable that, while occupying geologically the same horizon, as indicated by their similar associations, the Nictaux beds mark a line forming the rim of a more northerly basin, there cut off from view by the sandstones of the Annapolis Valley, while the real extension of the Torbrook beds is to be found along a line, which is their line of strike, connecting Torbrook with Wheelock's farm, and the latter with the ore-beds of the upper part of the Nictaux valley and of Cleveland. Similarly, the beds which are exposed at the Messenger mine, on the McGinty road, and on the hills south of Torbrook Centre, and in Bloomington, may be regarded as representing another repetition of the same strata, brought to the surface and more or less metamorphosed in connection with the extrusion of the adjacent granite. Until, however, careful instrumental surveys shall have fixed the position of all available outcrops, and possible errors due to folding and faulting have been duly considered, these conclusions can hardly be looked upon as final.

It is interesting in this connection to notice that the ores of Clementsvale occupy, both geographically and geologically, a position similar to that of the principal ore-belt at Nictaux. As, moreover, the structure of the region south of Kentville, although not yet fully worked out, seems to be but a repetition of the Nictaux and Clementsport basin, it is reasonable to expect that iron ores similar to those of the latter locality will be found to have a wide distribution in the intervening district.

b. Iron ores of the North Mountain and of Digby Neck. While, as stated above, iron ores have a wide distribution along the southern side of the Annapolis Valley, the hills which overlook the same valley from the north and their extension westward beyond Digby Gut are also at many points the repositories of ores of the same metal.* But while the former are always of the nature of *beds*, running with and conformable to the course of the strata which inclose them, and often characterized by accumulations of fossil shells, the latter are in the form of veins, intersecting trappean rocks, and with courses usually transverse to such bedding as these rocks exhibit. They are of course without fossils, being instead usually highly crystalline, and having associated with them a variety of other crystalline minerals, such as quartz and zeolites.

Digby iron ores.

The only locality of such ores known to us, to the east of Digby Gut, is one referred to by Dr. Harrington in his report on the Iron ores of Canada, as found two miles north of Middleton, in An-

*The existence of iron ores in Digby Neck was first discovered by Sieur de Monts, Lieutenant-General of Nova Scotia under Henry IV. of France, in the year 1604.—Pioneers of France in the New World. Parkman.

napolis county, and said to be from six to nine inches thick. To the west of Digby Gut their occurrence is more frequent.

A pit or trench from which a considerable quantity of ore was at one time taken is to be seen about three miles north of the town of Digby, near the road to Broad Cove. Fragments of the ore piled by the road-side consist partly of red and brown hæmatite and partly of magnetite.

The thickness of some of the blocks is as much as a foot, indicating veins of somewhat greater thickness than those to be next noticed, though apparently of inferior quality. Barytes was present in the vein, though not in large quantity. At present the trenches are filled with water and rubbish and no very definite information is available.

Nicholl's mine, Rossway.

The next locality to the westward is that of "Nicholl's mine" in Rossway. The veins here, as elsewhere in this range, consist mainly of magnetite, or of hæmatite having the crystalline form of magnetite (martite). The ore is mostly in lenticular masses, but occurs also in irregular pockets or in veins dipping in various directions. The widest parts of the veins usually form geodes, which are often lined with amethysts, and very beautiful specimens of this mineral, either alone or associated with calcites and zeolites, have been obtained here. Other cavities are filled with crystals of pure limpid quartz, sometimes showing double terminations; while still others contain a very soft unctuous or clayey material, which both in colour and consistency may be compared to brown soap. The latter substance is also found filling every seam and crack in the rock, as well as lying beneath the surface next the solid trap.

We have been unable to obtain particulars as to the amount of ore taken from this locality, its percentage composition or the cost of its removal. Only a small trench was opened on the vein, and this is now largely filled with rubbish.

Johnson's mine, Waterford.

About four miles westward of "Nicholl's mine" is "Johnson's mine," in Waterford. This is a much broken deposit of magnetic iron, partly massive or micaceous and partly in the form of isolated octahedral crystals, of which fine specimens, either alone or in association with quartz and zeolites, may be obtained. A considerable amount of rock and ore had been removed, but evidently at too great a cost to justify a continuance of the work. Nothing has now been done for several years.

Of other points at which ores similar to the above occur, may be mentioned the "Moorehouse vein," about one mile east of Sandy Cove on the shore of St. Marys Bay, where fine octahedral and dodecahedral crystals abound; the same shore, just below Mink Cove, the veins here being more compact and from three to four inches in width; and the hills overlooking the Lobster Ponds at Long Beach. Mink Cove.

It should be added that loose blocks of magnetic iron ore, sometimes a foot or more in diameter, are met with at other points in the same range, as between Rossway and Digby Gut, and seem to indicate the presence of veins as large as or larger than any heretofore opened; but notwithstanding the comparative purity and richness of the ores, they being in these respects much superior to the deposits of Clementsport, Nictaux and Torbrook, it is doubtful whether, they can ever be profitably worked, in view of the large amount of very hard rock requiring to be removed at the same time.

We have been informed of the occurrence of spathic iron in the cliffs on the coast south of Metaghan, in a vein said to be six feet wide, and have seen a specimen of excellent ore of this character, stated to have been derived therefrom, but no such ore was observed by us in our examination of this well-nigh inaccessible shore, and we can say nothing regarding it from personal knowledge. Spathic iron.

Titanic Iron.—It has been stated in the description of the rocks about Yarmouth Harbour and the extension of the same belt northeastward to Digby county, that the hornblende which is so conspicuous a feature of this belt is sometimes accompanied by crystals of ilmenite or menaccanite. This has especially been observed to be the case at Chegoggin Point and the vicinity of Brazil station, on the Dominion Atlantic Railway, but is probably true to a greater or less extent of the rocks lying between these two somewhat distant points. At the former locality, a dyke or vein of mixed hornblende, mica and garnet, showed black and lustrous tabular scales of ilmenite an inch or more in diameter, and others as large or larger were observed just east of Brazil. Titanic iron.

Metallic Sulphides.

Pyrite or sulphide of iron is a mineral so abundant in the upper or black slate division of the Cambrian system, as properly to be regarded as one of its distinctive features. At many points these black slates are literally studded with cubic crystals of this mineral, while its presence is no less strikingly shown by the result of its decomposition, in the excessively rusty weathering of many of these rocks, a feature indeed of almost universal occurrence; also by the not unfrequent consolidation of beds of drift, derived from such pyritous slates, into Pyrite.

hard ferruginous conglomerates. Striking instances of this latter effect may be seen in the town of Bridgewater, and others, scarcely less remarkable, in the beds, already noticed, which cap the slate bluffs on the southern side of Cape Cove in Yarmouth county.

It would seem not improbable that some of the more highly pyritous of the slates in question, might be profitably used as the basis of sulphuric acid and alum manufacture.

Arsenopyrite. *Arsenopyrite* or *Mispickel* is a not uncommon mineral in connection with the quartzites of the Cambrian system, but apart from the fact of its frequent association with gold, and being to some degree a favourable indication of the presence of the latter, has little economic value.

Molybdenite. *Molybdenite* or *Sulphide of Molybdenum.*—A small vein of this mineral was observed in a brook, tributary to Jordan River, about six miles above Jordan Falls, in Shelburne county, and it has been reported at other localities.

Ornamental Stones, Etc.—The following substances, valued chiefly for their beauty or as mineralogical specimens, occur within the region discussed in this report.

Quartz. *Quartz* or *Rock Crystal.*—This mineral is of common occurrence in connection with the veins traversing the traps of the North Mountain and Digby Neck, but especially so in connection with the magnetite veins in Rossway and Waterford, Digby county. Both isolated crystals, sometimes doubly terminated, and groups of crystals occur here, exhibiting many interesting modifications. In the same vicinity, large veins and loose boulders often yield very curious examples of mammillary, saccharoidal, drusy and stalactitic quartz, sometimes clear, sometimes opaque, but pure white; in other cases pale pink or amethystine in various degrees.

Specimens of similar variety and beauty were observed among the loose blocks strewing the shores of the Petite Passage near Tiverton.

Amethysts of great beauty were formerly obtained from the iron mines of Digby Neck (especially the Nicholl's mine in Rossway) while this was worked, but similar specimens can now only be secured at these points by blasting. The beauty of these specimens was often much enhanced by their form, and by the association of various minerals together, nodules or cavities of amethyst being bordered by parallel or concentric layers of agate, jasper of red and yellow tints, yellowish calcite, stilbite and black iron crystals. Veins of amethystine quartz, unaccompanied by iron, also occur, but rarely, and good specimens are difficult to obtain.

Agates, Chalcedony and Jaspers.—The trappean rocks of the North Mountain and of Digby Neck, abound in these, as in other varieties of quartz, and specimens may be readily had in great variety and beauty. As with the minerals above noticed, the finest specimens have been found in the vicinity of the iron veins. Thus, on the hillsides near the Johnson mine in Waterford, Digby county, are found large numbers of loose blocks, consisting wholly or chiefly of these minerals, and sometimes exhibiting cloudings and bandings of great beauty. The cliffs overlooking the northern entrance of Petite Passage, between Digby Neck and Long Island, are also remarkable for the number and variety of the agate veins which traverse them. At Gulliver Cove, on Digby Neck, interesting specimens may be had in the coastal cliffs, as well as in the blocks with which the shore is strewn.

Zeolites.—The species of this group of minerals observed by us in the trappean range of Annapolis and Digby counties, are the same as those so long known as occurring in the more easterly parts of the same range, and particularly about Blomidon, but are rarely found in specimens comparable with the latter in size or beauty. Stilbite, of unusual forms and colours was noticed and collected at Johnson's mine in Waterford, but the species is not of common occurrence. Thompsonite is much more abundant, especially about the entrance to Digby Gut and at Broad Cove. On the east side of the latter, a vein attaining a thickness of five or six inches and composed of what had once been very beautiful sheafs of very large crystals, was observed, but from long exposure to the air and sea these had lost both lustre and firmness, crumbling at the touch. At Digby Gut the thompsonite was in some instances found to be accompanied by cubical crystals of analcime, and still more rarely, of natrolite. Heulandite crystals of small size, associated with stilbite, were observed at the Waterford iron mine. A considerable cavity in the face of the amygdaloidal bluff, half a mile east of Margaretville, in Annapolis county, was found to be lined with clusters of laumonite crystals, of great beauty when removed, but which rapidly crumbled, upon drying, to an amorphous powder. Fine natrolite has been found in the same vicinity.

Zeolites.

Garnet, Staurolite, Andalusite and Tourmaline.—These minerals, excepting the last, are all of very frequent occurrence in the more metamorphosed portions of the Cambrian system, but especially of those of Division I. *b*. Thus they abound in the mica-schists of Shelburne county, more especially on either side of Shelburne Harbour and

Garnets, etc. about Jordan Bay and River; as they do again in Yarmouth county, about Pubnico Harbour, at Chegoggin Point and in the belt of metamorphic strata extending thence to and beyond Brazil. As seen along the coast of Shelburne county, the garnets, though clear, are small, rarely attaining the size of a pin's head, and often requiring a glass for their detection. In the interior, near the granite, they are larger, sometimes with a diameter of half an inch or more, but these are usually coarse and opaque. In Yarmouth county, some of the strata exposed in the fields near Brazil station are thickly studded with large garnet crystals, but without lustre or transparency. Perhaps the most interesting specimens seen by us were on the Atlantic shore near the gold mine at Chegoggin Point. Here are veins or dykes of mixed mica, hornblende and garnet, so largely charged with the latter mineral that some of the rock has been removed for abrasive purposes; and in this, along surfaces of fracture or jointing, layers of pure garnets are sometimes found, which, though opaque, are sharply defined and brilliantly lustrous, making, as illustrated in the Survey museum, very handsome specimens.

Staurolite. The best localities for the collection of staurolite are Jordan Falls, the shores of Shelburne Harbour (on the eastern side, opposite McNutt Island, and on the western, in Carleton settlement), at St. Anne Point in Pubnico, and above Lake Annis, in Yarmouth county. They vary in colour from gray to dark brown or black, and in shape from right rhombic prisms to various secondary forms, the prisms being sometimes half an inch in diameter. Crossed crystals occur, but are not common, while all the specimens seen were opaque.

Andalusite. Andalusite occurs in the same rocks as the staurolite, and is, indeed, in some instances very curiously blended with the latter. While less common than the staurolite it is often more conspicuous from the larger size of the crystals, which are as much as six inches long and an inch in width. The crystals are, however, usually very imperfectly formed, the prismatic shape being only roughly outlined, and the surface usually obscured by small mica and staurolite crystals, similar to those of the surrounding matrix, from which they are not easily removed. Occasionally bright cleavage surfaces of a pale-pink or rose colour are met with, but no distinct macles were observed. Port La Tour is a good locality in which to collect specimens, especially on Goose-neck Point.

Tourmaline is of much less common occurrence than the minerals previously mentioned. It is, however, sometimes met with as a contact mineral along the lines of junction of the granite and gneiss or mica-schist. It was thus observed by Mr. Prest in the region above the head-waters of Bloody Creek, a branch of the Clyde, in Shelburne county, and by the writer near Pubnico Lake, in Yarmouth county. It has also been observed in Broad River, in Queens county. Finally it has been long known as occurring near the town of Paradise in Annapolis county, where quartz veins penetrating granite are, in some instances, filled with black lustrous prisms of this mineral. Tourmaline.

Building Stones.

Granite.—The distribution of this rock in south-western Nova Scotia has been fully described in earlier pages of this report, as well as represented in geological maps, and no further details as to such distribution are needed here.

The granitic rocks present much variety of texture, but less of colour, being of light-gray to pinkish tints, rarely dark, and, so far as known to the writer, never very red. Their use for purposes of construction would seem to have been determined as much by their facilities for removal as by any distinctive features possessed by them. The largest quarries which have been yet opened are those of Shelburne Harbour, where, at the time of our visit in 1891, about fifty men found employment. The rock here is a light-gray granite, and is obtained partly from ledges and partly from huge boulders. Portions of the bed-rock show a strongly laminated appearance, and to this structure in part is no doubt due the ease with which it is removed, as well as its adaptation to special uses. Among the latter may be mentioned the manufacture of cubical blocks for paving, of which 1500 were made in a day, and of which two or three ship-loads were, at the date referred to, being sent off every week. There are, however, constant fluctuations in the demand for this as for other purposes. The quarries are admirably situated and any possible demand for that particular type of rock could be easily met. Granite.

Another locality at which quarries have been opened in granite is that of West Nictaux. These were first opened to obtain stone for the culverts of the Nova Scotia Central Railway, about six or seven years ago. Subsequently the material, like that of Shelburne, was used for the making of paving blocks, and three or four car-loads were removed. Two car-loads of large blocks were also sent to St. George, N.B. The rock is very fine, and easily split, though hard. The work, under the direction of John Kline, is carried on with the aid of steam drills.

Still other quarries of less importance occur along the line of the Central Railway, near Springfield, Annapolis county.

Slates.

Slates.—In a country in which argillites are of such common occurrence as in south-western Nova Scotia, it may reasonably be supposed that some of these would be suitable for roofing or writing purposes. No attempt has, however, as yet been made to discover any such beds, still less to open up any quarries therein. In the case of the black slates of Division IV. of the Cambrian system, the amount of pyrites with which these are charged would seriously interfere with their value, but the underlying blue and ribboned slates are free from this disadvantage, while their low inclination in many instances, together with their highly pronounced cleavage, would seem to recommend their use. Rocks of this character occur in the northern part of Queens county, about Fairy Lake in Annapolis county, as well as in different parts of Digby county. Slates of more recent age also occur in the Bear River and Nictaux-Torbrook basins, in Annapolis county.

Clays.

Clays.—Materials suitable for the manufacture of bricks and tiles have probably a somewhat wide distribution in south-western Nova Scotia, but have only been utilized in a few instances. We are without definite information as to their occurrence in Queens, Shelburne or Yarmouth counties, though we believe that in the first-named county bricks have been manufactured to a limited extent in the vicinity of Liverpool. In Digby county a deposit apparently suited for the making of fire-brick has recently been found about one mile south-east of the church in Marshalltown. Some 500 acres of land have here been leased by Mr. J. Lonergan, over which a white clay occurs with a depth of three to twelve inches, with clays of other kinds beneath. A specimen of the white clay sent to the Survey office was found to be fusible with difficulty.

Clays of marine origin, probably underlie a considerable part of the Annapolis Valley. They are well exposed three miles west of Middleton station, where operations for the manufacture of bricks have for some years been in progress. The clays used here are very pure and tough, but, as indicated by their brick-red colour even before burning, contain much iron, and are therefore unsuitable for fire-bricks. As they hold shells of mollusca, as well as fossil starfishes, the lime derived from these would further unfit them for such use. The clays are covered with beds of sand, but neither the extent nor depth of the clays is known. Wells sunk to a depth of 65 feet at Kingston failed to reach solid rock.

HILL OF BLOWN SAND, EAST SIDE OF BARRINGTON BAY, N. S.

Sands.—In addition to the red sands referred to above in the Annapolis Valley, there are with these, at various points, beds of very white sand, which might be suitable for glass-making or other purposes. Far more extensive as well as purer deposits of such material have, at different points upon the Atlantic coast, been piled up by the action of the winds. Of these deposits of drift sand the most remarkable are those on the west side of Port Mouton Harbour and the east side of Barrington Bay. In each case they cover considerable tracts along the shore, and are annually marching inland. In places they attain a depth of fifty or sixty feet, and are so situated as to be capable of easy removal. They are almost snow-white in colour, and purely silicious. Sands.

Rocks suitable for Road Construction.—In view of the increased attention now being given to the construction of highways, and the need felt in some portions of south-west Nova Scotia, especially in the Annapolis Valley, for the use of some road-making material having greater binding power than the sands there so widely distributed, it may not be out of place to refer here to the inexhaustible supplies of the very best material for such purposes afforded by the trappean rocks of the North Mountain and Digby Neck. So admirably indeed are these adapted for such use and so favourable is their situation for removal, that they have already attracted the attention of strangers and have been referred to in recent reports of the United States Geological Survey, as a possible future source of supply in connection with the macadamizing of the roads of New England. Tests carried out by officers of that survey in connection with the Highway Commission of Massachusetts, have fully shown the high relative value of diabase rock for road purposes, and there is no reason to suppose that the qualities of such rock, as found abundantly in the ridges which skirt the south shore of the Bay of Fundy, will be less valuable than those of similar rock found elsewhere. Road-metal.

APPENDIX A.

List of Glacial Striæ in South-western Nova Scotia.

1.—Queens County.

1. Moose Point. Coastal. On gneiss. S. 20° E.
2. Somerville Centre. Coastal. On granite. S. 18° E.
3. Mink Island. Port Mouton. Coastal. On granite. S. 5° E.
4. Massacre Island. Port Mouton. Coastal. On granite. S. 5° E.
5. Port Jolie Harbour, east side. Coastal. On gneiss. S.
6. Cadden Bay. Coastal. On granite. S.
7. Port Jolie Head. Coastal. On gneiss. S. 5° E.
8. Port L'Hebert. Coastal. On gneiss. S.
9. Shore opposite Coffin Island. Coastal. On mica-slates. S. 20° E.
10. Eagle Head Breakwater. Coastal. On gneiss. S. 10° E., S. 15° E.
11. Port Medway Harbour, west side. Coastal. On gneiss. S. 10° E., S. 15° E.
12. Buckfield. Interior. S. S. 20° W.
13. Pleasant River road. Interior. On quartzite. S. 35° E., S. 60° E.
14. Hills near Round Lake, on summit. Interior. S. 20° E.
15. South Brookfield. On quartzite. S. 10° E.
16. North Brookfield. On quartzite. S. 20° E.
17. Rosette. On slates. S. 40° E.
18. Port Medway River at crossing of Kempt Road. On slates. S. 20° E., S. 30° W.
19. Kempt, near Annapolis post-road. On slates. S. 10° E.
20. Westfield. On slates. S. 10° E.
21. Pleasant River settlement, at crossing of New Elm road. On slates. S. 34° E.
22. Dean Lake. Port Medway River. On flat slates. S.
23. North Brookfield. On slates. Exposures north. S. 7° E.
24. Port Medway River below Dean Lake. On flat slates. S. 15° E.
25. " " " " " " Further south. Two sets of striæ (1) on surface sloping to lake. S. 10° W. (2) on level surfaces only. S. 18° E.
26. Port Medway River, south of McGowan Lake, in Westfield, same as course of river. S. 3° W.
27. Horse Lake, one mile east of Port Medway River and one mile and a half south of Westfield River. S. 2° W., S. 4° W.
28. Rosette road. S. 22° E., S. 2° W.

2.—Shelburne County.

1. Near Jones Harbour. Coastal. On gneiss. S. 5° E.
2. Lockeport. Coastal. On quartzite. S. 10° E.
3. Jordan Ferry, half a mile below. S. 10° W.
4. Shelburne, on road to Ohio. Interior. On quartzite. S. 10° W.
5. Between Ohio and Clyde. Interior. On quartzite. S. 70° W.
6. Negro Harbour, east side. Coastal. " S. 10° W.
7. Purgatory Point. Coastal. On mica-slate. S.
8. Port La Tour, opposite Jones Island. Coastal. S. and S.E.
9. " " " on road to Bàccaro. Coastal. On quartzite. S. 10° E., S. 15° W.
10. Baccaro Point. Coastal. On mica-slates. S.
11. Shag Harbour, at church. Coastal. S. 20° E.
12. Shelburne Harbour, above Sand Point. Coastal. On mica-slate. S. 30° W.

13. Villagedale. Barrington Bay. On gneiss. S. 15° W.
14. Upper Port La Tour, opposite John Island. On quartzite. S. 20° W
15. Cape Negro Island, eastern end. On mica-schist. S. 25° W.

3.—Yarmouth County.

1. Wellington. On gray mica-schist. S. 50° W.
2. Yarmouth city. " " S. 35° W.
3. Pubnico Harbour, at head. On gray mica-schist. S. 40° W.

4.—Digby County.

1. Digby Neck, on road to Broad Cove. South side of trap range. S. 5° E.
2. Petite Passage. On side of bluff looking east. S. 50° W.
3. " " at Israel Cove, crossing top of trap columns ten feet above high-water. S. 60° W.

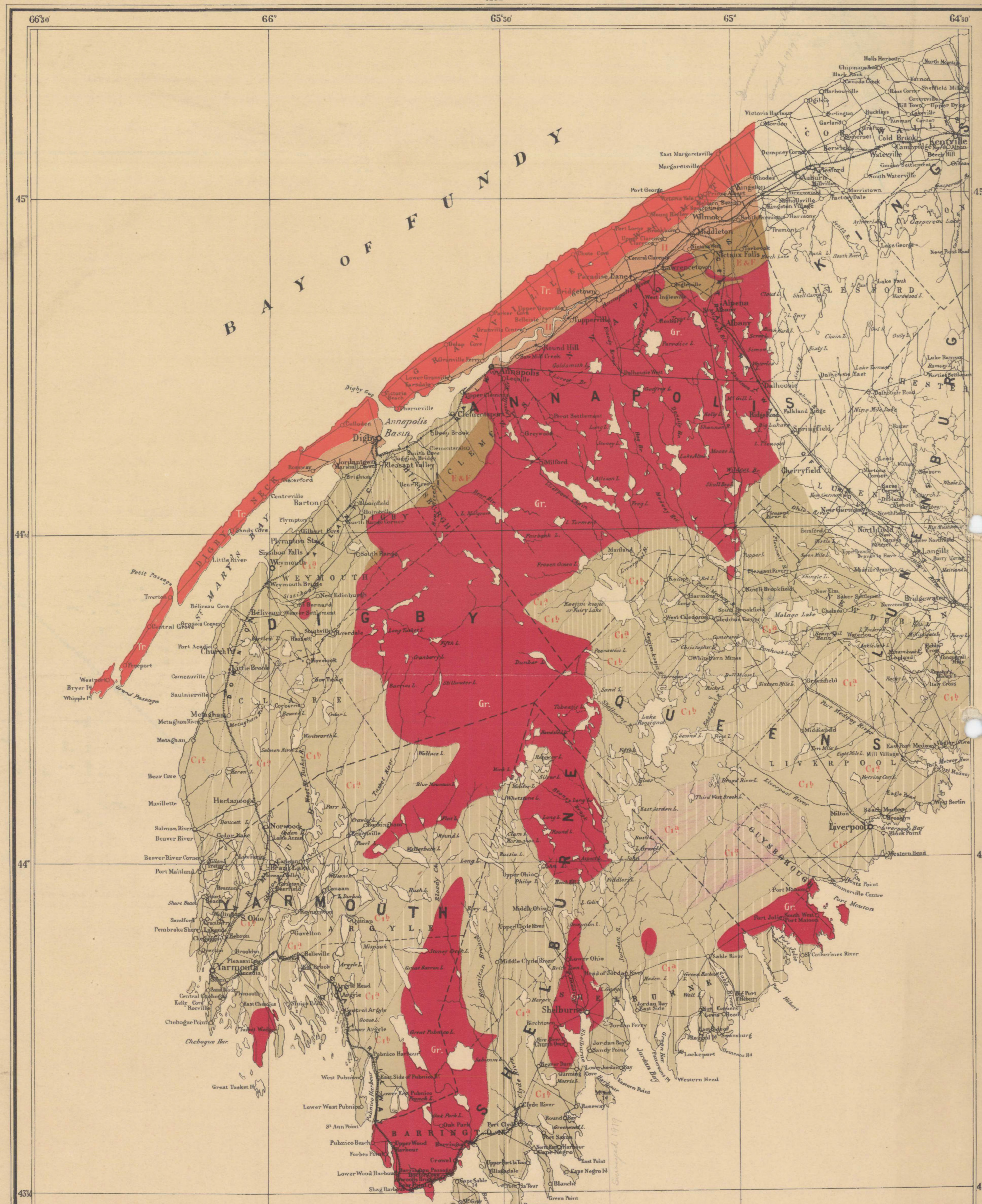
5—Annapolis County.

1. Fairy Lake, at the Pictured Rocks. S. 2° W., S. 10° W. (The first record is in small lines, the second in furrows.)
2. Fairy Lake, at Mill Cove. On slates. S. 10° W.
3. Fairy Lake. On shore. S. 6° W. (General course of lake.)
4. West Nictaux. On slates. Exposures north. S. 10° E.
5. Roxbury. (South of Lawrencetown.) On summit of South Mountain. Rock granite. S. 20° W.
6. Virginia settlement. On Silurian slates. N. 4° W.

Geological Survey of Canada

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

1898



Legend

Red sandstone	Triassic
Quartzites, sandstones, slaty and shaly argillites; grey, blackish, green and pink; with iron ores	Devonian and Silurian
Ribbon slate and black slate	Cambrian
Green slates and their metamorphic equivalents, mica-schists, staurolite-schists, etc.	Cambrian
Quartzite	Cambrian
Trap (Triassic)	
Granite	

J. White, Chief Draughtsman, L.N. Richard, Draughtsman.
Geographical outlines from Church's Map of Nova Scotia, 1888.

Accompanying Part M, Vol. IX 1895
Geologically surveyed by L.W. Bailey, LL.D.

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MAP
OF THE
WESTERN PORTION OF NOVA SCOTIA

Scale 8 Miles to 1 Inch

Natural Scale 1/506880

5 4 3 2 1 0 5 10 15 Miles

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

REPORT

OF THE

SECTION OF CHEMISTRY AND MINERALOGY

BY

G. CHRISTIAN HOFFMANN, LL.D., F.I.C., F.R.S.C.,
Chemist and Mineralogist to the Survey.

Assistants

F. G. Wait, M.A., F.C.S.
R. A. A. Johnston.

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

To

G. M. Dawson, C.M.G., LL.D., F.R.S.

Director of the Geological Survey of Canada.

Sir,—In laying before you the accompanying report, I should mention that it does not by any means cover all the work carried out in this Laboratory during the year which it embraces—indeed scarcely half, a considerable number of mineral determinations, qualitative examinations, and partial quantitative analyses, the results of which possess but little or no interest—save to those immediately concerned, having been altogether excluded.

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

G. CHRISTIAN HOFFMANN

Ottawa, 30th June, 1898.

TABLE OF CONTENTS.

REPORT

OF THE

SECTION OF CHEMISTRY AND MINERALOGY

COALS AND LIGNITES.

[Continued from page 18 R, of the Annual Report of this Survey for 1895.]

88.—ANTHRACITIC COAL.—From the neighbourhood of Moose Mountain, on the north side of Elbow River, north-east quarter of section 8, township 23, range 6, west of the fifth initial meridian, district of Alberta, North-west Territory. Seam said to be upwards of five feet in thickness. Geological position—Cretaceous. Sent to Mr. William Pearce by Mr. Daniels.

Anthracitic coal from near Moose Mountain, district of Alberta, N.W.T.

Structure, somewhat coarse lamellar, made up of irregularly alternating layers of grayish-black, somewhat bright, and dense jet-black coal of brilliant lustre, with an occasional interposed film of mineral charcoal, contorted, shows slickensides in an eminent degree—compact; firm; fracture, irregular; powder, brownish-black; it communicates a pale brownish-yellow colour to a boiling solution of caustic potash.

An analysis by fast coking, gave:

Hygroscopic water	2·74
Volatile combustible matter	18 62
Fixed carbon	75·52
Ash	3·12
	100·00
Coke, per cent	78·64
Ratio of volatile combustible matter to fixed carbon	1 : 4·05

It yields, by fast coking, a non-coherent coke. The gases evolved during coking burn with a yellow, slightly luminous, almost smokeless flame. The ash, which is of a reddish-white colour, remains unaffected at a bright red heat, but at a most intense red heat it becomes fritted.

Coals and Lignites—*Cont.*

Lignitic coal, from a stream flowing into Tooya River, Cassiar district, B.C.

89.—Lignitic Coal.—From a seam on a small stream flowing into Tooya River from the west, some sixteen miles above the confluence of the latter with the Stikine, Cassiar district, province of British Columbia. Received from Mr. W. T. Jennings, C.E.

The material examined answered to the following description—structure, fine lamellar, compact; made up of alternating layers of a grayish-black, dull, and bright black coal. It is, here and there, intersected by thin plates of gypsum, and contains, in parts, a few particles of honey-yellow, translucent resin; fracture, uneven; powder, blackish-brown; it communicates a brownish-red colour to a boiling solution of caustic potash.

An analysis by fast coking, gave:

Hygroscopic water	4·59
Volatile combustible matter	33·77
Fixed carbon	42·67
Ash	18·97
	100·00
Coke, per cent	61·64
Ratio of volatile combustible matter to fixed carbon	1 : 1·26

It yields, by slow coking, a non-coherent coke; by fast coking, a slightly fritted coke. The gases evolved during coking burn with a yellow, luminous, smoky flame. The ash has a light brownish-white colour—exposed to a bright red heat it becomes very slightly agglutinated, at a most intense red heat it becomes slightly fritted.

Lignite from Coal Creek, Yukon district, N.W.T.

90.—Lignite.—From a seam discovered by Mr. William Ogilvie, Dominion Land Surveyor, some seven miles up Coal Creek, a stream flowing into the Yukon five miles below the mouth of Forty-mile River, Yukon district, North-west Territory. Seam twelve feet six inches thick.

The material forwarded was found, at the time of its receipt, to be completely disintegrated. It had evidently lost a certain proportion of its hygroscopic water, hence the following analysis must be regarded as more nearly representing the composition of the fuel in an air-dried condition, than as it occurs in its natural state. The material examined, and which ought perhaps to be considered a selected sample, answered to the following description—structure, fine lamellar; colour, velvet-black; lustre, sub-resinous; in parts coated with a film of ferric hydrate; contains, here and there, particles of a pale brownish-yellow, translucent resin; fracture, uneven—occasionally verging on the sub-conchoidal; powder, brownish-black; it communicates a dark brownish-red colour to a boiling solution of caustic potash.

Coals and Lignites—*Cont.*

Lignite, from Coal Creek, Yukon district, N.W.T. —*Cont.*

An analysis by fast coking, gave :

Hygroscopic water	7·24
Volatile combustible matter	41·45
Fixed carbon	48·91
Ash	2·40
	100·00
Coke, per cent	51·31
Ratio of volatile combustible matter to fixed carbon	1 : 1·18

It yields, by slow coking, a non-coherent coke; by fast coking, a slightly fritted coke. The gases evolved during coking burn with a yellowish, luminous, somewhat smoky flame. The ash has a brownish-yellow colour—when exposed to a bright red heat it becomes very slightly agglutinated, at a most intense red heat it becomes fritted.

MISCELLANEOUS MINERALS.

1. Baddeckite (A New Variety of Muscovite).

Baddeckite, from Baddeck, Victoria county, N.S.

This interesting variety of muscovite was met with about half a mile from the town of Baddeck, Victoria county, in the province of Nova Scotia, where it occurs in the form of minute isolated scales, small scaly aggregations, and thin scaly layers, distributed through a highly plastic clay; which also contains a large proportion of fine crystalline, white, pearly scales of kaolinite, some minute crystals of white quartz and small particles of pyrite and calcite.

The mineral has a fine copper-red colour; a pearly lustre; and affords a tile-red streak. With water it forms a highly plastic mass. Its specific gravity, at 15·5° C., is 3·252. Before the blow-pipe it fuses, at about 4·5, to a shiny black slag, which on continued heating in the reducing flame becomes magnetic. It is decomposed by strong hydrochloric acid, with separation of slimy silica.

An analysis by Mr. R. A. A. Johnston, upon very carefully prepared and apparently perfectly pure material, showed it to have the following composition:—

Silica	48·96
Alumina	13·85
Ferric oxide	25·82
Lime	1·17
Magnesia	2·65
Potassa	3·47
Soda	0·22
Water (direct estimation)	3·78
	99·92

Miscellaneous minerals—*Cont.*

Baddeckite, from Baddeck, Victoria county, N.S. —*Cont.*

These figures afford a ratio for $RO : R_2O_3 : Si\ O_2 : H_2O$ closely corresponding to 1: 3: 8:2 giving the formula $H_4\ (Ca,Mg,K_2Na_2)\ (Fe_2Al_2)_3\ Si_8O_{28}$ and, assuming the hydrogen to be basic, the quantivalent ratio for $R' : R'' : Si$ of 3 : 9 : 16 or for bases to silicon of 3 : 4 agreeing with that required for some varieties of muscovite. The mineral is therefore a hydro-muscovite in which a very large proportion of the alumina ordinarily present is replaced by ferric oxide, and to this may be ascribed its exceptional behaviour before the blowpipe; its comportment with strong acids; as likewise its noticeably high specific gravity.

The name "Baddeckite," is given by the writer to this mineral from the above mentioned locality where it was first found.

2. Chalcanthite.

Chalcanthite, from Bonaparte River, Lillooet district, B.C.

This species, not previously noticed as a mineral occurring in Canada, has been met with, in some quantity, as a result of the alteration of tennantite, associated with other decomposition products of copper minerals, in the upper part of a quartz vein carrying tennantite, small quantities of pyrite, occasionally a little chalcopyrite, and some coarsely crystalline galena, at the Avoca claim, on the west side Bonaparte River, two miles and a half above Hat Creek, Lillooet district, in the province of British Columbia.

A fine large specimen of the mineral from this locality has been examined by Mr. R. A. A. Johnston. It is in the form of finely crystalline, sometimes stalactitic, masses of a Berlin-blue colour and vitreous lustre, associated with some bluish-green, massive and botryoidal, at times also earthy, chrysocolla, a little ferric sulphate, and a very little native sulphur, in a skeleton aggregate of angular fragments of white quartz still containing, in parts, a little unaltered tennantite and a few particles of iron and copper-pyrites.

3. Epsomite, and Fibroferrite?

Epsomite, and Fibroferrite?, from the district of Alberta, N.W.T.

The material here referred to, a saline incrustation, occurs, according to Mr. A. O. Wheeler, D.L.S.,—by whom it was collected, as a deposit around the source of a small stream which issues from the base of high cliffs of limestone and flows into the Cañon branch of the Elbow River, in the foot-hills of the Rocky Mountains, district of Alberta, North-west Territory.

It is in the form of straw-yellow, very fine-crystalline masses. Before the blow-pipe, on charcoal, it fuses with difficulty to a black magnetic globule: in the closed tube, gives off a large amount of water which reacts acid: is readily soluble in water, to which it imparts a brownish-yellow colour and strongly acid reaction: taste, acid, astringent, and metallic.

Miscellaneous minerals—*Cont.*

Epsomite, and fibroferrite?, from the district of Alberta, N.W.T.—*Cont.*

Its composition, as shown by Mr. R. A. A. Johnston's analysis, is as follows :—

	I.	II.	Mean.
Sulphur trioxide	36·374	36·486	36·43
Ferric oxide	13·115	13·180	13·15
Ferrous oxide	0·942	0·910	0·93
Alumina	5·617	5·525	5·57
Magnesia	......	5·920	5·92
Water (direct estimation)	37·057	36·915	36·98
Insoluble residue	0·453	0·505	0·48
			99·46

This would correspond to a mixture of epsomite and a hydrous basic sulphate of iron, in which part of the iron is replaced by aluminium, having the formula of amarantite, but which, by reaso of its solubility, would appear to be referable to fibroferrite.

4. Tennantite.

Tennantite, from Bonaparte River, Lillooet district, B.C.

A somewhat argentiferous variety of tennantite, associated with small quantities of pyrite—at times more or less well crystallized, and coarsely crystalline galena, as likewise, occasionally, a little chalcopyrite, has been met with in some abundance at the Avoca mineral claim, on the west side of Bonaparte River, two miles and a half above Hat Creek, Lillooet district, in the province of British Columbia.

The mineral is, on the whole, compact, massive; in one instance, however, a fairly perfect tetrahedron, with the solid angles replaced, was observed occupying a small cavity. It has a dark grayish-black colour; a metallic lustre; and affords a cherry-red streak. In thin splinters it is subtranslucent and deep ruby-red by transmitted light. In addition to the essential constituents—sulphur, arsenic, and copper, it was found by Mr. R. A. A. Johnston to contain small quantities of antimony, silver, lead, zinc, and iron. An estimation of the copper and silver in a sample of this ore afforded him the following results:—copper 35·65, silver 0·2045, insoluble residue (quartz) 14·26 per cent. The metalliferous portion of the ore would therefore contain—copper 41·51 and silver 0·2385 per cent, the latter being equivalent to 69·562 ounces of silver per ton of 2,000 pounds.

5. Xenotime.

Xenotime from the township of Calvin, Ont.

A very remarkable occurrence of what, on examination by Mr. R. A. A. Johnston, proves to be xenotime—a mineral not previously

Miscellaneous minerals—*Cont.*

Xenotime, from the township of Calvin, Ont.—*Cont.*

identified as occurring in Canada—has somewhat recently been observed by Mr. C. W. Willimott, in the township of Calvin, district of Nipissing, in the province of Ontario. Here, in one part of a coarse granite vein of some twenty feet in width—cutting a reddish fine-grained hornblendic gneiss, and composed of quartz, microcline, albite or oligoclase, muscovite and biotite—he found, embedded in the microcline, a mass of the mineral in question weighing not less than 312 grammes. This is made up of a closely compacted aggregation of more or less divergent long slender prisms, among which, however, a few stout individuals are observable, one of which measures seven millimetres in diameter. It has a prismatic cleavage; an uneven fracture; a dark reddish-brown colour; a resinous lustre; and a light flesh-red streak. Its hardness was found by Mr. Johnston to be about 5, and the specific gravity, at 15·5° C., 4·395. Small quantities of an altered magnetite and somewhat small crystals of a reddish-brown garnet—most probably spessartite—are found accompanying the mineral; and a fine specimen of yellow beryl has been received which is said to have come from this vein.

MINERALOGICAL NOTES.

Almandite, from Hudso Strait, N.E.T.

1.—Almandite. A noteworthy occurrence of garnetiferous schist has been observed by Mr. A. P. Low on the south side of Whitley Bay, twenty-five miles south of Cape Prince of Wales, Hudson Strait, North-east Territory, and a fine specimen of the same was collected by him, which is now in the mineralogical collection of the Museum of this Survey. It consists of large, although somewhat imperfect, dark cherry-red rhombic dodecahedral crystals of almandite, of from fifteen to thirty millimetres in diameter, freely disseminated through a brownish-black mica-schist.

Chalcocite, from Cumberland county, N.S.

2.—Chalcocite, copper-glance or vitreous copper. Specimens of this have been received which were found on the farm of Mr. Amos Blenkhorn, on the east side of the road between Maccan and Nappan, Cumberland county, in the province of Nova Scotia, where, according to Mr. H. Fletcher, it occurs in considerable quantity, with some pyrite, a little chalcopyrite, and carbonized trunks and leaves of trees, in a highly shattered, dark gray, fine-grained calcareous sandstone of Lower Carboniferous age, which is also occasionally cut by small veins of barite and veinlets of coal.

Native Copper, from Yale district, B.C.

3.—Copper, Native. This has been met with in the form of thin laminæ, freely scattered through a calcareous brecciated conglomerate, with some chalcocite and brown hematite, at the Pot Hook claim, about a mile and a quarter north-west of Sugar Loaf Hill, or some six miles and a half west by south of Kamloops, Yale district, in the province of British Columbia.

Mineralogical notes—*Cont.*

Corundum, from various localities in Ontario.

4.—Corundum. This mineral has been found by Mr. G. Bennett in a mica mine on the fourteenth lot of the ninth concession of the township of Methuen, Peterborough county, in the province of Ontario. A specimen of the mineral from this locality, presented to the Museum of this Survey by Mr. Archibald Blue, consists of a fragment of a rough hexagonal pyramid showing three faces, the largest of which measures, approximately, fifty-seven by thirty-eight millimetres in its greatest dimensions, in a matrix composed of felspar and mica. It is of a bluish ash-gray colour, mottled with violet-blue, and translucent. Specimens of corundum have also been received which were obtained at a point due north of the above-mentioned locality, namely, the north-west corner of the township of Cardiff, in Haliburton county. Mr. R. S. James has likewise presented specimens of this mineral to the Museum, from the fourth lot of the eighteenth concession of the township of Raglan, in the more easterly county of Renfrew, in the same province. These are in the form of cleavable masses and large rough hexagonal crystals, which are subtranslucent, have a clove-brown colour, and exhibit a bronzy sheen. A small rolled fragment, not exceeding seven millimetres in its greatest diameter, of a transparent, light celandine-green variety of corundum—which was found by Mr. Johnston to have a specific gravity, at 15·5° C., of 3·957, has been received by Mr. R. G. McConnell from Mr. F. Fletcher, P.L.S., who stated that it had been found in washing for gold on the Pend d'Oreille River, in the West Kootenay district of the province of British Columbia.

Gahnite, from the township of Raglan, Renfrew county, Ont.

5.—Gahnite, or zinc-spinel. Crystals of this mineral have been found by Mr. W. F. Ferrier—who was the first to make known its occurrence in Canada—lining cavities in a dark hair-brown laminated massive corundum, occurring on the second lot of the eighteenth concession of the township of Raglan, Renfrew county, in the province of Ontario. The form of the crystals is that of the octahedron, with the interfacial edges replaced by the dodecahedron. They are blackish-green by reflected, and green-blue-green by transmitted, light; are translucent on the edges, and have a vitreous lustre.

Gersdorffite, from near Rossland, West Kootenay district, B.C.

6.—Gersdorffite. This mineral has been observed in the form of small octahedral crystals distributed through specimens of an intimate

Mineralogical notes—*Cont.*

association of massive pyrrhotite and chalcopyrite, from the Columbia-Kootanie property, Kootenay Mountain, a mile and a quarter north-east of the town of Rossland, in the southern part of the West Kootenay district of the province of British Columbia.

Graphite, from Alkow Harbour, Dean Canal, B.C.

7.—Graphite. A very interesting occurrence of this mineral—which, however, was mistaken by the finder for molybdenite—was discovered by Mr. W. Downie, in 1860, at Alkow Harbour, Dean Canal, on the coast of British Columbia. Several fragments of the material were received from him. The largest of these measures ten inches in length by six inches in width, has a maximum thickness of close on three inches, and weighs six pounds twelve ounces. It consists of minute, lustrous, dark steel-gray coloured scales and scaly layers of graphite, together with small quantities of pyrite, disseminated through a matrix consisting almost wholly of heulandite. An analysis of what was regarded as a fair average sample of the material showed it to contain 23·17 per cent of graphite.

Grossularite, from the township of Coleraine, Megantic county, Q.

8.—Grossularite. A very pretty specimen of this mineral has been received by Mr. C. W. Willimott, from Mr. J. Obalski, which was found at the P. P. Hall chromite mine, near Black Lake, block A, of the township of Coleraine, Megantic county, province of Quebec. It consists of small, brilliant, pale hyacinthine-reddish-brown transparent dodecahedrons of grossularite—the specific gravity of which, at 15·5° C., was found by Mr. Johnston to be 3·600—implanted upon a fragmental rock made up of a chromite-bearing quartz and white crystalline calcite.

Molybdenite, from the township of Egan, Ottawa county, Q.

9.—Molybdenite. This, as pointed out in my last report (Rep. Geol. Surv. Can., Vol. viii., p. 14 R, 1895), is found in considerable abundance, in the form of foliated masses, which are sometimes of large dimensions, and not unfrequently more or less thickly coated with molybdite or molybdic ochre, on the sixty-ninth lot of the fourth range of the township of Egan, Ottawa county, in the province of Quebec.

Mr. C. W. Willimott has since visited the locality in question, and his observations tend to confirm the above statement in regard to the abundance of the mineral in this locality. He collected many fine specimens of the same, some of which consist of massive aggregations of crystalline plates having a more or less perfectly hexagonal outline; and also some large more or less weathered fragments of what he thought might not improbably represent the original containing rock, which he found, here and there, scattered through the soil with the molybdenite. These rock specimens have been examined, and found, after having been carefully treated for the removal of products of decomposition, to consist of a massive pyroxene containing disseminated scales and lamellar aggregations of a brownish mica, a large amount of pyrite, and some foliated masses of molybdenite. From this it may be inferred that the present presence of this mineral, in a loose condition, in the soil, is ascribable to the weathering and ultimate complete disintegration of a highly pyritiferous pyroxenic rock through which it was formerly distributed. Mineralogical notes—*Cont.*

10.—Molybdite. This has been met with by Mr. C. W. Willimott, in considerable abundance, intermixed with the soil in which the molybdenite occurring on lot sixty-nine of the fourth range of the township of Egan, Ottawa county, province of Quebec, is found. A sample of the earth in question, collected by him, and which is of a dull yellowish colour, has been examined by Mr. Wait and found to contain, in addition to the usual constituents of soil, a very large proportion of ferric hydrate, sulphates of lime, magnesia and iron, and, approximately, 7·5 per cent of molybenum trioxide. The composition of this material varies, however, as might be expected, considerably, other samples having been found to contain, in some instances more, at other times less, of the last named constituent. Molybdite, from the township of Egan, Ottawa county, Que.

11.—Quartz, Radiated. Fine specimens of a massive radiated quartz, made up of spherulitic groups, averaging from ten to twelve millimetres in diameter, having an internal structure of radiating acicular crystals and an exterior covered with projecting pyramids, with bornite filling the interstices between the spherules, have been met with in the Triassic trap rocks on the west side of Valdes Island, near Seymour Narrows, at the north end of the Strait of Georgia, province of British Columbia. Radiated quartz, from Valdes Island, Strait of Georgia, B.C.

12.—Sulphur, Native. Some small crystals and crystalline aggregates, to which my attention was drawn by Mr. R. L. Broadbent, observable in some parts of a large fragment of iron ore from the second lot of the fifth concession of the township of North Burgess, Lanark county, province of Ontario, have been examined by Mr. Johnston and found to be native sulphur. The fragment of ore in question, consists of specular iron containing, here and there, small embedded masses of chalcopyrite. In this, the sulphur occurs as a light yellowish crystalline incrustation lining cavities previously occupied by chalcopyrite, as likewise in isolated Native sulphur from the township of North Burgess, Lanark county, Ont.

2

Mineralogical notes—*Cont.*

crystals, or groupings of these on the partially weathered chalcopyrite still remaining in them.

Topaz, from Rocky Mountains, district of Alberta, N.W.T.

13.—Topaz. Two small rolled pebbles, of what on examination by Mr. Johnston proved to be topaz, were received from Mr. George Purches, of Edmonton, who stated that they had been found in the gravel of a small river to the west of Jasper House, in the Rocky Mountains, district of Alberta, North-west Territory. Of these, one, measuring twenty by twenty by thirteen millimetres, is of a light bluish-green colour, is transparent, has a hardness of 8, and a specific gravity of 3·557; while the other, measuring twenty-five by fifteen by fifteen millimetres, has a faint orange-yellow colour, is transparent, and has a specific gravity of 3·568.

ROCKS.

The analyses of these, were all conducted by Mr. F. G. Wait.

Cyanite-granite-gneiss, from near Snake Creek, Ottawa River, Que.

1.—Cyanite-granite-gneiss. From the Ottawa River, near Snake Creek, Pontiac county, province of Quebec. This, and the five following rock specimens were collected by Mr. A. E. Barlow.

It was found to have the following composition:—

Silica	66·94
Alumina	17·84
Ferrous oxide	4·30
Manganous oxide	trace.
Lime	1·86
Magnesia	1·82
Potassa	3·36
Soda	1·85
Water, at 100° C	0·15
Water, above 100° C	1·75
	99·87

Granitite-gneiss, from Taggart Bay, Lake Keepawa, Que

2.—Granitite-gneiss. From the north end of Lake Keepawa, west shore of Taggart Bay, near entrance, Pontiac county, province of Quebec.

Its analysis afforded the following results:—

Silica	71·69
Alumina	14·84
Ferrous oxide	1·25
Manganous oxide	trace.
Lime	1·03
Magnesia	0·37
Potassa	7·09
Soda	3·13
Water, at 100° C	0·10
Water, above 100° C	0·49
	99·99

3.—Granitite-gneiss. From the north end of Lake Keepawa, south shore of McLaren Bay, Pontiac county, province of Quebec.

Rocks—*Cont.*

Granitite-gneiss, from McLaren Bay, Lake Keepawa, Que

Its composition was found to be as follows:—

Silica	69·39
Alumina	17·46
Ferrous oxide	1·38
Lime	2·14
Magnesia	0·52
Potassa	2·77
Soda	5·18
Water, at 100° C	0·06
Water, above 100° C	0·47
	99·37

4.—Granite-gneiss. From the west shore of Lake Wicksteed, township 8 E., district of Nipissing, province of Ontario.

Granite-gneiss, from Lake Wicksteed, Ont.

Its analysis afforded the following results:—

Silica	67·50
Alumina	18·23
Ferrous oxide	2·39
Lime	1·85
Magnesia	1·56
Potassa	4·25
Soda	3·79
Water, at 100° C	0·08
Water, above 100° C.	0·90
	100·55

5.—Granitite-gneiss. From the north end of Opimika Narrows, west shore of Lake Temiscaming, district of Nipissing, province of Ontario.

Granitite-gneiss, from Opimika Narrows, Lake Temiscaming, Ont.

It was found to have the following composition:—

Silica	67·74
Alumina	16·13
Ferric oxide	1·50
Ferrous oxide	1·96
Manganous oxide	trace.
Lime	4·41
Magnesia	1·36
Potassa	1·30
Soda	4·92
Water, at 100° C	0·10
Water, above 100° C	0·86
	100·28

6.—Quartz-mica-diorite-gneiss. From Otter-tail Creek, lower end of 7th portage, below North Bay and Temiscaming Road, district of Nipissing, province of Ontario.

Quartz-mica-diorite-gneiss, from Otter-tail Creek, Ont.

Rocks—*Cont.*

Its composition was found to be as follows :

Silica	44·92
Alumina	18·88
Ferric oxide	2·73
Ferrous oxide	13·76
Manganous oxide	0·26
Lime	9·07
Magnesia	5·38
Potassa	0·53
Soda	2·94
Water, at 100° C	0·20
Water, above 100° C	1·62
	100·29

LIMESTONES.

(Continued from page 17 of the last Annual Report of this Survey—vol. viii., 1895.)

Limestone, from St. Louis de Mile-end quarries, Montreal, Hochelaga county, Que.

1.—From the St. Louis de Mile-end quarries, Montreal, Hochelaga county, province of Quebec. Geological position—Trenton formation, Cambro-Silurian. Collected by Dr. H. M. Ami, 1896.

A light gray, somewhat coarse-crystalline, massive limestone. Its analysis afforded Mr. R. A. A. Johnston the following results :

(After-drying at 100° C.—Hygroscopic water = 0·14 per cent.)

Carbonate of lime		97·68
" magnesia		0 42
" iron		0·19
Alumina	0·02	1·18
Silica, soluble	0·04	
Insoluble mineral matter	1·05	
Organic matter	0·07	
		99·47

This stone has been wrought to a considerable extent, chiefly for building purposes.

Limestone, from St. Laurent de Montreal quarries, Jacques Cartier county, Que.

2.—From the St. Laurent de Montreal quarries, Jacques Cartier county, province of Quebec. Geological position—Chazy, Cambro-Silurian. Collected by Dr. H. M. Ami, 1896.

A somewhat dark-gray, fine to moderately coarse-crystalline, massive, limestone. An analysis by Mr. Johnston, showed it to have the following composition :

(After drying at 100° C.—Hygroscopic water = 0·16 per cent.

Limestones—*Cont.*

Carbonate of lime		95·03
" magnesia		2·75
" iron		0·47
Alumina	0·01	1·85
Silica, soluble	0·03	
Insoluble mineral matter	1·66	
Organic matter	0·15	
		100·10

This stone is extensively quarried for structural purposes, and is also used for the manufacture of lime.

3.—From the old quarry on Gale's farm, Hochelaga, Hochelaga county, province of Quebec. Geological position—Trenton formation, Cambro-Silurian. Collected by Dr. H. M. Ami, 1896.

Limestone, from old quarry on Gale's farm, Hochelaga, Hochelaga county, Que.

A dark gray, for the most part compact, massive limestone. Its composition was found by Mr. Johnston to be as follows:

(After drying at 100° C.—Hygroscopic water = 0·34 per cent.)

Carbonate of lime			87·11
" magnesia			2·79
" iron			0·50
Sulphate of lime			0·02
Alumina		0·01	9·26
Silica, soluble		0·14	
Insoluble matter, consisting of—			
Silica	6·73	9·11	
Alumina	1·40		
Ferric oxide	0·31		
Lime	0·11		
Potassa	none		
Soda	none		
Organic matter	0·56		
			99·68

This stone has been found to yield a good hydraulic lime.

GOLD AND SILVER ASSAYS.

These were all conducted by Mr. R. A. A. Johnston.

As explanatory of the numerous instances in which no trace of either gold or silver was found, it may be mentioned that in nearly all these cases the assay was carried out by special request.

PROVINCE OF NOVA SCOTIA.

1.—From the Boisdale Hills, south-east of the south end of Long Island, Cape Breton county. Examined for Mr. N. L. Nicholson.

Province of Nova Scotia.

An association of white sub-translucent quartz with a little serpentine, carrying very small quantities of galena, copper-

Gold and silver assays—*Cont.*

pyrites and zinc-blende. The sample, consisting of a dozen fragments, weighed two ounces and a half.

It contained neither gold nor silver.

Province of Nova Scotia—*Cont.*

2.—From two miles from Gore Court House, Hants county. Examined for Mr. W. O'Brien.

A weathered schistose rock, carrying small quantities of iron-pyrites. The sample, consisting of two fragments, weighed twelve ounces. It was found to contain :

Gold.............. ....1·925 ounce to the ton of 2,000 lbs.
Silver..................none.

PROVINCE OF NEW BRUNSWICK.

Province of New Brunswick.

3.—From Woodstock, Carleton county. From the so-called No. 1 vein.

An association of white sub-translucent quartz with a gray granular felspathic rock, carrying small quantities of iron-pyrites and galena. The sample, consisting of three fragments, weighed thirteen ounces.

It contained neither gold nor silver.

4.—Also from Woodstock, Carleton county. From the so-called No. 2 vein.

A white sub-translucent quartz, carrying galena and iron-pyrites. The sample, consisting of two fragments, weighed four ounces. It was found to contain :

Gold.. ....none.
Silver..................7·642 ounces to the ton of 2,000 lbs.

5.—From Frenchman's Creek, parish of Lancaster, St. John county. This, and the four following specimens, were collected by Prof. L. W. Bailey.

A grayish-white fine granular dolomite, traversed by seams of white sub-translucent quartz carrying small quantities of a honey-yellow zinc-blende, crystalline galena, and tetrahedrite. Weight of sample, a single fragment, one pound. The metallic sulphides, freed from all gangue, contained :

Gold............. .....none.
Silver, at the rate of ....25·083 ounces to the ton of 2,000 lbs.

6.—Average sample of material from veins at and near the supposed gold mine on Serpentine River, Victoria county.

It consisted of an association of white and gray sub-translucent quartz with gray chloritic and grayish-white quartz-mica schists, carrying very small quantities of iron-pyrites. The sample, consisting of some thirty fragments, weighed twelve pounds and a half.

Gold and silver assays—*Cont.*

Province of New Brunswick—*Cont.*

It contained neither gold nor silver.

7.—From Bailey Settlement, Charlotte county.

An association of white sub-translucent quartz with a little gray chloritic schist, in parts stained with hydrated peroxide of iron, carrying very small quantities of iron-pyrites. The sample, consisting of seven fragments, weighed four pounds nine ounces.

It contained neither gold nor silver.

8.—From the Murchie Place, between Basswood Ridge road and Getchell Settlement road, Charlotte county.

A white sub-translucent quartz, stained and coated with hydrated peroxide of iron. The sample, consisting of twelve fragments, weighed three pounds five ounces.

It contained neither gold nor silver.

9.—From the Grunner farm, between Basswood Ridge road and Getchell Settlement road, Charlotte county.

An association of white sub-translucent quartz with some crystalline dolomite and a little gray chloritic schist, in parts stained with hydrated peroxide of iron, carrying very small quantities of iron-pyrites and pyrrhotite. The sample, consisting of seven fragments, weighed eight pounds five ounces.

It contained neither gold nor silver.

10.—From near St. Andrews, Charlotte county. Examined for Mr. E. A. Charters.

A flesh-red felspathic rock, through which was disseminated small quantities of iron-pyrites. The sample, consisting of three fragments, weighed six ounces.

It contained neither gold nor silver.

PROVINCE OF QUEBEC.

11.—From the fourteenth lot of the sixth range of the township of Hatley, Stanstead county. This, and the five following specimens were collected by Mr. R. Chalmers.

Province of Quebec.

Gold and silver assays—*Cont.*

Province of Quebec—*Cont.*

An association of a white sub-translucent quartz with some gray talcose schist, carrying small quantities of iron-pyrites and pyrrhotite. The sample, consisting of four fragments, weighed seven pounds.

It contained neither gold nor silver.

12.—From the same locality as the preceding specimen.

A white sub-translucent quartz with which was associated a little gray chloritic schist, carrying very small quantities of pyrrhotite. The sample, consisting of two fragments, weighed one pound nine ounces.

It contained neither gold nor silver.

13.—From the foot of Devils Rapids, Chaudière River, Beauce county.

An association of white quartz with a dark gray schistose rock, for the most part stained with hydrated peroxide of iron. The sample, consisting of three fragments, weighed two pounds eight ounces.

It contained neither gold nor silver.

14.—From the O'Farrell vein, Devils Rapids, Chaudière River, Beauce county.

A white sub-translucent quartz, in parts coated with hydrated peroxide of iron, carrying small quantities of iron-pyrites. The sample, consisting of two fragments, weighed two pounds seven ounces. It was found to contain :

Gold	trace
Silver	none

15.—From St. Charles, Gilbert River, Beauce county.

A grayish-white quartz stained and coated with hydrated peroxide of iron. The sample, consisting of two fragments, weighed four pounds eleven ounces.

It contained neither gold nor silver.

16.—From the Short farm, near Sherbrooke, Sherbrooke county.

An association of white cryptocrystalline to compact quartz with a little green diorite, in parts coated with hydrated peroxide of iron, carrying small quantities of iron-pyrites. The sample, which was composed of numerous fragments, weighed two pounds six ounces.

It contained neither gold nor silver.

17.—From the eleventh lot of the eleventh range of the township of Sutton, Brome county. Examined for Mr. E. G. Smith.

Gold and silver assays—*Cont.*

Province of Quebec—*Cont.*

An association of white quartz-felspar rock with some grayish-green chloritic schist, carrying small quantities of iron-pyrites and pyrrhotite. The sample, consisting of two fragments, weighed six pounds fifteen ounces.

It contained neither gold nor silver.

18.—From the twenty-second lot of the first range of the township of Thetford, Megantic county. Examined for Dr. James Reed.

An association of a white sub-translucent quartz with some gray chloritic schist, carrying small quantities of iron-pyrites. The sample, which was composed of six fragments, weighed one pound four ounces.

It contained neither gold nor silver.

NORTH-EAST TERRITORY.

North-east Territory.

19.—From a vein twenty miles above Fort Chimo, south bank of Koksoak River. This and the five following specimens were collected by Mr. A. P. Low.

A weathered rock carrying large quantities of iron-pyrites. The sample, a single fragment, weighed one pound eleven ounces.

It contained neither gold nor silver.

20.—From a vein on Fisher Bay, south shore of Hudson Strait.

The sample consisted of two fragments, one of which was an association of white translucent quartz with a little dark gray garnetiferous hornblendic gneiss, carrying very small quantities of iron pyrites; the other, an association of white translucent quartz with very small quantities of gray felspar and cleavable white calcite, in parts stained and coated with hydrated peroxide of iron. Weight of sample, fourteen ounces.

It contained neither gold nor silver.

21.—From a vein at the head of Wakeham Bay, south shore of Hudson Strait.

An association of white sub-translucent quartz with a little garnetiferous hornblendic gneiss, through which was disseminated a few particles of pyrrhotite. Weight of sample, eight ounces.

It contained neither gold nor silver.

22.—From a vein on Joy Bay, south shore of Hudson Strait.

An association of bluish-white opalescent quartz with a grayish black hornblendic gneiss. Weight of sample, three ounces.

It contained neither gold nor silver.

Gold and silver assays—*Cont.*

North-east Territory—*Cont.*

23.—From another vein on Joy Bay, south shore of Hudson Strait.

The sample was composed of three fragments, consisting, respectively of—a somewhat coarse grained gray granite with a little hematite; a white translucent quartz, stained and coated with hydrated peroxide of iron; and a white cryptocrystalline quartz, also stained and coated with hydrated peroxide of iron. Weight of sample, seven ounces.

It contained neither gold nor silver.

24.—From a vein near Cape Hope's Advance, south shore of Hudson Strait.

An association of white sub-translucent quartz with a dark gray gneissoid rock, carrying small quantities of iron-pyrites. Weight of sample, four ounces.

It contained neither gold nor silver.

Province of Ontario.

Province of Ontario.

25.—From the south-west arm of Lake Tamagamingue, about two miles from the end of the bay, on the north side, district of Nipissing. Width of vein, twenty-one feet. Taken eighteen feet from the surface. Examined for Mr. P. A. Ferguson.

A grayish-white quartz, carrying somewhat large quantities of crystalline iron-pyrites. The sample, a single fragment, weighed ten pounds four ounces.

It contained neither gold nor silver.

26.—From the township of Davis, district of Nipissing.

An association of grayish-white sub-translucent quartz with some white felspar, carrying somewhat large quantities of copper-pyrites and iron-pyrites. Weight of sample, a single fragment, eight ounces. It was found to contain:

Gold.....	trace.
Silver........	0·408 of an ounce to the ton of 2,000 lbs.

27.—From the tenth lot of the sixth concession of the township of Davis, district of Nipissing. Examined for Mr. D. O'Connor.

An association of gray sub-translucent quartz, with a little gray diorite, in parts stained and coated with hydrated peroxide of iron, carrying very small quantities of iron-pyrites and pyrrhotite. Weight of sample, consisting of five fragments, one pound six ounces.

It contained neither gold nor silver.

28.—From lot three of the first concession of the township of McKim, district of Nipissing. Examined for Mr. D. O'Connor.

Gold and silver assays—*Cont.*

Province of Ontario—*Cont*

An association of quartz and actinolite, more or less coated with hydrated peroxide of iron, carrying iron-pyrites, copper-pyrites and pyrrhotite. The sample, consisting of several fragments, weighed two pounds seven ounces. Assays gave:

Gold.............. none.
Silver.... .... 0·700 of an ounce to the ton of 2,000 lbs.

29.—From a vein on lot twelve of the fourth concession of the township of Blezard, district of Nipissing. This, and the following specimen were examined for Mr. M. Allard.

The specimen, which was taken from the surface, consisted of a grayish-white quartz carrying iron-pyrites, copper-pyrites and pyrrhotite. The sample, consisting of three fragments, weighed eight ounces.

It contained neither gold nor silver.

30.—From the same vein as the preceding specimen, but taken at a depth of seven feet.

It consisted of a grayish-white quartzo-felspathic rock. The sample, consisting of six fragments, weighed one pound.

It contained neither gold nor silver.

31.—From lot one of the sixth concession of the township of Shedden, district of Algoma. Examined for Mr. R. J. Whalen.

An association of grayish-white quartz with a dark gray granitic gneiss, more or less coated with hydrated peroxide of iron. The sample, consisting of several fragments, weighed nine pounds.

It contained neither gold nor silver.

32.—From lot three of the fourth concession of the township of May, district of Algoma. Examined for Mr. George Boyes.

An association of gray sub-translucent quartz with small quantities of mica-schist, carrying some specular iron and a very little iron-pyrites. The sample, consisting of a very large number of fragments, weighed twenty-five pounds.

It contained neither gold nor silver.

33.—From lot thirty-five of the eighth concession of the township of Clarendon, Frontenac county. This, and the following specimen were examined for Mr. J. Muldoon.

Gold and silver assays—*Cont.*

A massive iron-pyrites, thickly coated with hydrated peroxide of iron. Weight of sample, one pound.

It contained neither gold nor silver.

Province of Ontario—*Cont*

34.—From the thirty-eighth lot of the tenth concession of the township of Clarendon, Frontenac county.

An association of white sub-translucent quartz with a small amount of hornblendic rock, containing a few particles of garnet, some black mica and very small quantities of iron-pyrites. The sample, which was, in parts, coated with hydrated peroxide of iron, weighed eleven ounces.

It contained neither gold nor silver.

35.—From the property of Mr. George McLean, lot twenty-six, concession eleven, of the township of Dungannon, Hastings county.

A greenish-gray calcareous pyroxenite, carrying small quantities of iron-pyrites. The sample, consisting of several fragments, weighed three pounds two ounces.

It contained neither gold nor silver.

36.—From lot thirty-five, East Hastings road, township of Dungannon, Hastings county.

A weathered gneissoid rock, through which was disseminated small quantities of iron-pyrites. Weight of sample, ten ounces.

It contained neither gold nor silver.

37.—From the O'Brien shaft, east half of lot twelve, concession four, of the township of Lavant, Lanark county.

A grayish-white dolomitic limestone, through which was distributed a somewhat large quantity of iron-pyrites. It contained:

Gold	trace.
Silver	none.

38.—From the north-east half of lot twelve, concession two, of the township of South Sherbrooke, Lanark county.

A white translucent quartz, carrying small quantities of copper-pyrites, iron-pyrites and coarsely crystalline galena. The specimen, which was, in parts, coated with hydrated peroxide of iron, weighed one pound eleven ounces. It was found to contain:

Gold	3·500 ounces to the ton of 2,000 lbs.
Silver	0·408 of an ounce " "

39.—A specimen of the bismuthinite, which occurs, in the form of lead-gray lamellar masses, associated with beryl, sphene, et cætera, in a coarse granite vein in the township of Lyndoch, Renfrew county, has been submitted to assay, and with the following result: Gold and silver assays—*Cont.*

It contained neither gold nor silver.

Province of Ontario—*Cont.*

40.—From the township of Westmeath, Renfrew county.

An association of gray sub-translucent quartz, black pyroxene, fine crystalline gray dolomite, and a little black mica—here and there coated with a little blue carbonate of copper, carrying some iron-pyrites and a little copper-pyrites. The sample, some twenty fragments, weighed twenty-three pounds.

It contained neither gold nor silver.

41.—From the township of Grimsthorpe, Hastings county.

A white, for the most part cryptocrystalline, quartz, carrying small quantities of mispickel. Weight of sample, consisting of three fragments, twenty pounds. It was found to contain:

Gold	trace.
Silver	none.

42.—From near the village of Wabigoon, district of Rainy River. Examined for Mr. George Aske.

A white sub-translucent quartz, carrying somewhat large quantities of pyrrhotite. The sample, consisting of two fragments, weighed thirteen ounces.

It contained neither gold nor silver.

43.—From the vicinity of Heron Bay, district of Thunder Bay. Examined for Mr. J. B. Dumoulin.

A white translucent quartz, carrying very small quantities of iron-pyrites and pyrrhotite. The sample, consisting of four fragments, weighed three pounds.

It contained neither gold nor silver.

NORTH-WEST TERRITORY.

North-west Territory.

44.—From Muskuskow River, below Elbow Lake, district of Keewatin. This, and the two following specimens were collected by Mr. J. B. Tyrrell.

A grayish-white quartz, for the most part stained with hydrated peroxide of iron, carrying small quantities of iron-pyrites.

It contained neither gold nor silver.

45.—From Nelson River, Cross Lake, district of Keewatin.

A weathered quartzose rock. Weight of sample, four ounces.

It contained neither gold nor silver.

Gold and silver assays—*Cont.*

North-west Territory—*Cont.*

46.—From Nelson River, above Pipestone Lake, district of Keewatin.

A dark gray quartzite, containing, here and there, a few particles of iron-pyrites. Weight of sample, a single fragment, fourteen ounces.

It contained neither gold nor silver.

47.—Ash from a burnt-out seam of lignite on the left bank of the North Saskatchewan River, at Edmonton, district of Alberta. Collected by Dr. G. M. Dawson. Weight of sample, one pound.

It contained neither gold nor silver.

48.—From near the west end of Castle Mountain, about two miles from Baker Creek, District of Alberta. Examined for Major Walker.

A somewhat coarsely crystalline galena in a gangue composed of an association of grayish-white felspathic rock with white calcite. The sample, consisting of several fragments, weighed one pound five ounces. It was found to contain:

Gold........................trace.
Silver..................1·167 ounce to the ton of 2,000 lbs.

49.—From the claim of T. Grierson on Sheep Creek, district of Alberta. Received from Mr. Wm. Pearce.

The material consisted of a mixture of a gray, slightly calcareous sandstone—in some instances stained with hydrated peroxide of iron, with a gray quartz-conglomerate. Weight of sample, two pounds two ounces.

It contained neither gold nor silver.

50.—From near the head of Smoky River, district of Alberta. Examined for Mr. George Purches.

A quartz-conglomerate, in parts coated with hydrated peroxide of iron. The sample, consisting of two fragments, weighed eleven ounces.

It contained neither gold nor silver.

51.—From No. 8 claim, Eldorado Creek, Klondike River, about three-quarters of a mile up the creek, Yukon district. This, and the two following specimens were collected by Mr. William Ogilvie.

An association of white cryptocrystalline quartz with some grayish-green mica-schist. The sample, a single fragment, weighed nine ounces.

It contained neither gold nor silver.

52.—From lower end of cañon on Forty-mile River, Yukon district

An association of white translucent quartz with small quantities of gray mica-schist, in parts thickly coated with hydrated peroxide of iron. The sample, two fragments, weighed one pound two ounces. Gold and silver assays—*Cont.*

It contained neither gold nor silver. North-west Territory—*Cont.*

53.—From the Cone Hill gold claim, Yukon district.

An association of a dark grayish-green serpentine limestone with a white quartzo-felspathic rock, in parts stained and coated with hydrated peroxide of iron and green carbonate of copper.

It contained neither gold nor silver.

Province of British Columbia.

Of the following—

Specimens Nos.	54-60	are from the	West Kootenay district.
"	61-80	"	Interior plateau region.
"	81-87	"	Coast ranges and coast region.

54.—From the Ruth claim, one and a quarter mile, by road, from Sandon, West Kootenay district. Province of British Columbia.

A coarsely crystalline galena, in parts coated with hydrated peroxide of iron. Weight of sample, one pound one ounce. Assays gave:

Gold....... .... none.
Silver.......... .. 194·687 ounces to the ton of 2,000 lbs.

55.—From the Black Fox mine, near Nelson, West Kootenay district.

A coarse crystalline galena to which was attached radiating groups of white transparent quartz crystals. The galena, freed from associated quartz, was found to contain:

Gold............... none.
Silver.............. 80·937 ounces to the ton of 2,000 lbs.

56.—From the Cable claim, head of Woodberry Creek, Kootenay Lake, West Kootenay district. Examined for Mr. H. A. Cameron.

A gray quartzo-felspathic rock, through which was disseminated numerous fine particles of iron-pyrites. The sample, two fragments, weighed one pound. It contained:

Gold........... ... trace.
Silver .. .. 6·008 ounces to the ton of 2,000 lbs.

57.—From the Sunset claim, near Lardeau, West Kootenay district.

An association of white translucent quartz with a little green chromiferous mica-schist, in parts thickly coated with hydrated

Gold and silver assays—*Cont.*

peroxide of iron, carrying somewhat large quantities of coarsely crystalline galena. The sample, consisting of five fragments, weighed one pound ten ounces. Assays showed it to contain :

Province of British Columbia—*Cont.*

Gold................none
Silver................86·333 ounces to the ton of 2,000 lbs.

58.—From Cariboo Creek, South Fork of Kaslo Creek, West Kootenay district. Examined by Mr. A. Goodanough.

A coarsely crystalline galena, with which was associated small quantities of calcite and cerussite. Assays gave:

Gold................none
Silver................14·583 ounces to the ton of 2,000 lbs.

59.—From Laforme Creek, Columbia River, twenty miles north of Revelstoke, West Kootenay district. Examined for Mr. W. E. McLauchlin.

An association of pyrrhotite and mispickel, through which was disseminated a little quartzose gangue. The sample, a single fragment, weighed one pound. It was found to contain:

Gold..............0·467 of an ounce to the ton of 2,000 lbs.
Silver.............0·408 " "

60.—From Six-mile Creek, ten miles below Slocan Lake—West Kootenay district. Examined for Mr. S. L. Goldburg.

An association of white quartz with a white felspar and gray pyroxene, carrying small quantities of pyrrhotite and a few scales of graphite. Weight of sample, one pound one ounce.

It contained neither gold nor silver.

61.—From a ledge on Roper Mountain, one mile south of Kamloops Lake, and two miles and a half from Cherry Creek siding on the line of the Canadian Pacific Railway—Interior plateau region. Examined for Mr. John Morrill.

Copper-pyrites with a very small amount of a calcareous gangue. Weight of sample, seven ounces. It contained :

Gold................none
Silver................4·258 ounces to the ton of 2,000 lbs.

62.—From three miles south-west of Grande Prairie—Interior plateau region. This, and the two following specimens were collected by Mr. J. McEvoy.

A weathered felspathic rock, here and there coated with green carbonate of copper, carrying large quanties of copper-pyrites. The sample, a single fragment, weighed one pound. Assays gave :

Gold and silver assays—*Cont.*

Gold................trace
Silver...............6·533 ounces to the ton of 2,000 lbs.

Province of British Columbia—*Cont.*

63.—From Salmon River, fifteen miles south of Grande Prairie, Interior plateau region.

A gray quartzo-felspathic rock, through which was distributed numerous particles of pyrrhotite. The sample, a single fragment, weighed one pound four ounces.

It contained neither gold nor silver.

64.—From nine miles west of Chaperon Lake, Interior plateau region.

A white cryptocrystalline quartz, through which was distributed a few particles of iron-pyrites and copper-pyrites. The sample, consisting of three fragments, weighed two pounds four ounces.

It contained neither gold nor silver.

65.—From the Iron Mask claim, situated about half a mile south of the south-eastern corner of Roper's wire fence on the Savona wagon road, and about half way between Dufferin and Sugar Loaf Hills, Interior plateau region. This, and the six following specimens were examined for Mr. Wentworth F. Wood.

The material, which was taken at a depth of forty feet below the surface, consisted of an association of copper-pyrites, iron-pyrites and magnetite. The sample, two fragments, weighed one pound four ounces. It was found to contain :

Gold............. trace.
Silver.............. 0·483 of an ounce to the ton of 2,000 lbs.

66.—From the Charlotte claim, situated south-east of Coal Hill and about one mile west of James Mellon's house, Interior plateau region.

A white quartz, in parts coated with hydrated peroxide of iron, carrying iron-pyrites and copper-pyrites. The sample, a single fragment, weighed one pound two ounces. Assays showed it to contain :

Gold...... ... . trace.
Silver.................. 1·575 ounce to the ton of 2,000 lbs.

67.—From the Lucky Strike claim, situated half way between Dufferin and Sugar Loaf Hills, Interior plateau region.

Gold and silver assays—*Cont.*

Province of British Columbia—*Cont.*

The material, which was taken from near the surface, consisted of a weathered copper-pyrites. The sample, a single fragment, weighed one pound ten ounces. It contained :

Gold.............. trace.
Silver............. 0·233 of an ounce to the ton of 2,000 lbs.

68.—From the Copper King claim, situated some three hundred yards north of William Roper's house, Interior plateau region.

The material, which was taken at a depth of eighteen feet below the surface, consisted of copper-pyrites in a gangue of gray quartzo-felspathic rock. The sample, a single fragment, weighed four pounds ten ounces. It was found to contain :

Gold .... trace.
Silver................. 3·792 ounces to the ton of 2,000 lbs.

69.—From the Laurier claim, situated on the north side of the Savona wagon road, about half way between James Guerin's and J. L. Hughes's ranches, Interior plateau region.

The sample, a surface specimen, consisted of an association of a gray quartzo-felspathic rock with some white crystalline calcite, in parts coated with green carbonate of copper, carrying somewhat large quantities of copper-glance. Weight of sample, eight ounces. Assays gave ;

Gold.............. none.
Silver........... 0·933 of an ounce to the ton of 2,000 lbs.

70.—From the Python claim, situated on the second bench from the top of Coal Hill, north-west of the peak, Interior plateau region.

A weathered quartzo-felspathic rock, coated with hydrated peroxide of iron and green carbonate of copper, carrying somewhat large quantities of iron-pyrites and copper-pyrites. Weight of sample, a single fragment, two pounds. It contained :

Gold.............. trace.
Silver.............. 0·117 of an ounce to the ton of 2,000 lbs.

71.—From the Iron Cap claim, situated two hundred feet west of the wagon road running from Savona road to Hull's ranch, and about half a mile from the junction of the two roads, Interior plateau region.

A white quartz, in parts coated with hydrated peroxide of iron, carrying copper-pyrites and iron-pyrites. The sample, a single fragment, weighed one pound thirteen ounces. Assays showed it to contain :

Gold and silver assays—*Cont.*

Gold.... .... trace.
Silver................ 1·108 ounce to the ton of 2,000 lbs.

Province of British Columbia—*Cont.*

72.—From a boring at the Excelsior claim, Cayoosh Creek, Interior plateau region.

A somewhat finely crushed rock matter, consisting of an association of gray quartz and grayish-black chloritic schist. Weight of sample, two ounces.

It contained neither gold nor silver.

73.—From a ledge on Dog Creek, Fraser River, Interior plateau region.

A white sub-translucent quartz, in parts coated with hydrated peroxide of iron and blue and green carbonates of copper, carrying small quantities of copper-pyrites. Weight of sample, two fragments, ten ounces.

It contained neither gold nor silver.

74.—From a ledge on Upper Deadman's Creek, Thompson River, Interior plateau region.

A dark gray to white felspathic rock, through which was distributed a few particles of iron-pyrites. The sample, consisting of three fragments, weighed nine ounces.

It contained neither gold nor silver.

75.—This, and the three following specimens are from the Avoca claim, on the west side of Bonaparte River, two miles and a half above Hat Creek, Interior plateau region.

A white quartz, carrying small quantities of iron-pyrites, copper-pyrites and a dark grayish-black tennantite. The sample, consisting of two fragments, weighed two pounds nine ounces. It contained:

Gold................ trace.
Silver.............. 29·458 ounces to the ton of 2,000 lbs.

76.—A dark grayish-black, massive, tennantite, together with some iron-pyrites and galena and a little quartz. The sample, a single fragment, weighed six pounds twelve ounces. Assays gave:

Gold................ none.
Silver.............. 57·925 ounces to the ton of 2,000 lbs.

77.—Another sample of this tennantite—free from all foreign admixture—was found to contain:

Gold................ none.
Silver.............. 69·562 ounces to the ton of 2,000 lbs.

Gold and silver assays—*Cont.*

Province of British Columbia—*Cont.*

The copper was, in this instance, also estimated; it amounted to 41·51 per cent.

78.—Consisted of kaolinite carrying iron-pyrites. The sample, consisting of two fragments, weighed two pounds one ounce.

It contained neither gold nor silver.

79.—From the Maggie claim, west side of Bonaparte River, about two miles and a half above Hat Creek, Interior plateau region. This, and the following specimen were examined for Mr. J. B. Bryson.

A white, honeycombed quartz, in parts coated with hydrated peroxide of iron. The sample, consisting of several fragments, weighed four ounces. It was found to contain:

Gold..............trace.
Silver..............0·525 of an ounce to the ton of 2,000 lbs.

80.—Also from the Maggie claim.

An association of gypsum and quartz, coated with hydrated peroxide of iron and green carbonate of copper. The sample, which consisted of numerous fragments, weighed five ounces.

It contained neither gold nor silver.

81.—From the Golden Sceptre claim, on Birkenhead River, a tributary of the Mosquito, Coast ranges and Coast region. Examined for Mr. G. Griffith.

A weathered quartz rock, carrying copper-pyrites. Weight of sample, an ounce and a half. Assays gave:

Gold ....none.
Silver..................2·187 ounces to the ton of 2,000 lbs.

82.—Also from the Golden Sceptre claim.

A white crystalline quartz, for the most part thickly coated with hydrated peroxide of iron and green carbonate of copper, carrying iron-pyrites and copper-pyrites. The sample, consisting of seven fragments, weighed one pound two ounces. It contained:

Gold ....trace.
Silver.....................3·208 ounces to the ton of 2,000 lbs.

83.—A specimen of the so-called "red blanket" from the Bimetallic claim—same locality as the two preceding specimens. Examined for Mr. G. Griffith.

A massive iron-ochre. Weight of sample, one ounce and a half.

It contained neither gold nor silver.

84.—From the west side of Harrison Lake, Coast ranges and Coast region.

Gold and silver assays—*Cont.*

A light gray quartzo-felspathic rock, in parts coated with hydrated peroxide of iron, carrying small quantities of iron-pyrites. The sample, consisting of four fragments, weighed one pound four ounces.

Province of British Columbia—*Cont.*

It contained neither gold nor silver.

85.—From lot eight hundred and twelve, group one, on the north arm of Burrard Inlet, twelve miles from the city of New Westminster and thirteen miles from the city of Vancouver, Coast ranges and Coast region. Examined for Mr. E. H. Rainey.

The material, fifteen samples, consisted of: (1) iron-pyrites and pyrrhotite in a weathered felspathic rock; (2) an association of magnetite with some iron-pyrites and a little copper-pyrites; (3) iron-pyrites and magnetite in a gangue composed of felspar and a little actinolite; (4) a grayish-white quartzo-felspathic rock, carrying iron-pyrites; (5) iron-pyrites in a gangue composed of felspar and a little dolomite; (6) a grayish-white felspathic rock, carrying iron-pyrites; (7) an association of a white sub-translucent quartz with a little yellowish-green epidote; (8) iron-pyrites and magnetite in a grayish-green hornblendic rock; (9) a white quartzo-felspathic rock carrying small quantities of iron-pyrites; (10) a gray quartzo-felspathic rock through which was disseminated small quantities of iron-pyrites; (11) a white, sub-translucent quartz carrying small quantities of copper-pyrites and galena; (12) an association of fine granular pyroxene and white quartz, carrying small quantities of copper-pyrites and iron-pyrites; (13) iron-pyrites in a gangue composed of a gray quartzo-felspathic rock; (14) iron-pyrites in a gangue of white opaque quartz; (15) an association of magnetite and iron-pyrites. The whole was reduced to fine powder, and of this a fair average sample submitted to assay.

It contained neither gold nor silver.

86.—From near Deserted Bay, Jarvis Inlet, Coast ranges and Coast region. Examined for Mr. J. C. Keith.

A massive pyrrhotite. Weight of sample, three ounces. It was found to contain:

Gold.............	0·117 of an ounce o the ton of 2,000 lbs.
Silver.............	0·117 " " "

87.—From Gabriola Island, Strait of Georgia, Coast ranges and Coast region.

Gold and silver assays—*Cont.*

Province of British Columbia—*Cont.*

An association of a grayish-green serpentine rock with some white quartz and calcite, carrying galena and small quantities of iron-pyrites and copper-pyrites. The sample, consisting of five fragments, weighed six ounces. Assays showed it to contain :

Gold	0·350 of an ounce to the ton of 2,000 lbs.
Silver	2·800 ounces " "

NICKEL AND COBALT.

Estimation of, in certain ores from the undermentioned localities in the provinces of Ontario and British Columbia—Continued from p. 29 R of the last Annual Report of this Survey, vol. viii., 1895.

Pyrrhotite and pyrite, from Dalhousie, Lanark county, Ont.

1.—From the east half of the eighteenth lot of the third concession of the township of Dalhousie, Lanark county, province of Ontario. Examined for Mr. T. B. Caldwell.

An association of white translucent quartz, with a little grayish-white hornblende, carrying large quantities of iron-pyrites and pyrrhotite. An analysis by Mr. Wait showed it to contain :

Nickel	0·165 per cent.
Cobalt	trace.

The gangue constituted 29·35 per cent, by weight, of the whole. The metalliferous portion of the ore contained, therefore, 0·23 per cent of nickel.

Pyrrhotite and pyrite, from Quartz Creek, West Kootenay district, B. C.

2.—From Quartz Creek, a tributary of Salmon River, about twenty miles south of Nelson, West Kootenay district, province of British Columbia. Examined for Mr. W. H. Dixon.

An association of pyrrhotite and iron-pyrites, with small quantities of intermixed calcite and felspar. The pyrrhotite, free from all foreign admixture, was found by Mr. Wait to contain :

Nickel	trace.

Pyrrhotite, chalcopyrite, and gersdorffite, from Kootenay Mountain, West Kootenay district, B. C.

3.—From the Kootenay-Columbia property, Kootenay Mountain, a mile and a quarter north-east of the town of Rossland, West Kootenay district, province of British Columbia.

An intimate association of pyrrhotite and chalcopyrite, through which was disseminated a little gersdorffite, in a somewhat calcareous gangue. Weight of sample, six pounds ten ounces. Determinations by Mr. Wait gave :

Nickel	0·65 per cent.
Cobalt	trace.

The gangue constituted 29·03 per cent, by weight, of the whole. The metalliferous portion of the ore contained, therefore, 0·92 per cent of nickel.

Nickel and cobalt—*Cont.*

4.—From the Queen Victoria claim, on the north side of the Kootenay River, and eight miles west of Nelson, West Kootenay district, province of British Columbia.

Pyrrhotite, chalcopyrite, and pyrite, from the Queen Victoria claim, Kootenay River, West Kootenay district, B. C.

It consisted of iron-pyrites and copper-pyrites, together with some pyrrhotite, in a gangue composed of an association of andradite with some quartz and a few scales of mica. Weight of sample, two pounds ten ounces. It was examined by Mr. Wait, and found to contain:

Nickel	0·43 per cent.
Cobalt	trace.

The gangue constituted 37·15 per cent, by weight, of the whole. The metalliferous portion of the ore contained, therefore, 0·68 per cent nickel.

5.—From the Evening Star mine, on the east slope of Monte Cristo Mountain, one mile north of the town of Rossland, West Kootenay district, province of British Columbia.

Arsenopyrite, and chalcopyrite, from Monte Cristo Mountain, West Kootenay district, B. C.

It consisted of arsenical-pyrites and copper-pyrites, together with some pyrrhotite, in a gangue composed of black hornblende and a little calcite. An analysis by Mr. Wait gave:

Nickel	0·25 per cent.
Cobalt	0·59 "

The gangue constituted 62·73 per cent, by weight, of the whole. The metalliferous portion of the ore contained, therefore, 0·67 per cent nickel, and 1·58 per cent cobalt.

A description and analysis of the cobaltiferous variety of arsenopyrite—danaite, which occurs accompanying ordinary mispickel, pyrrhotite, and pyrite, et cætera, at the above mentioned mine, will be found on p. 13 R, of the last Annual Report of this Survey, vol. viii., 1895.

NATURAL WATERS.

The analyses of these, were all conducted by Mr. F. G. Wait.

1.—Water of the Bow River, district of Alberta, North-west Territory. Taken—2nd September, 1896—at low water, mid-stream, and mid-depth, underneath Langevin bridge, at Calgary. Approximate low water discharge 2,784 cubic feet per second. This, and the

Water of the Bow River, district of Alberta, N. W. T.

Natural waters—*Cont.*

four following waters were collected by Mr. J. S. Dennis, D.T.S., chief inspector of surveys.

Water of the Bow River, district of Alberta, N.W.T.—*Cont.*

It contained a trifling amount of brownish, flocculent organic matter in suspension—this was removed by filtration. The filtered water was colourless, odourless, and devoid of any marked taste. Reaction, neutral; when evaporated to a small volume, however, it becomes very faintly alkaline. Its specific gravity, at 15·5° C., was found to be 1000·26. Boiling produced a slight precipitate, consisting of carbonates of lime and magnesia.

One thousand parts, by weight, of the filtered water, at 15·5° C., were found to contain:

Potassa	trace
Soda	0·004
Lime	0·045
Magnesia	0·015
Ferrous oxide	trace
Sulphuric acid	0·016
Carbonic acid	0·131
Chlorine	0·001
Silica	0·002
Organic matter	trace
	0·214

The foregoing acids and bases may reasonably be assumed to be present in the water in the following state of combination:

(The carbonates being calculated as mono-carbonates, and all the salts estimated as anhydrous.)

Chloride of sodium	0·002
Sulphate of soda	0·007
" potassa	trace
" lime	0·020
Carbonate of lime	0·066
" magnesia	0·031
" iron	trace
Silica	0·002
Organic matter	trace
	0·128
Carbonic acid, half-combined	0·045
" free	0·041
	0·214

Total dissolved solid matter, by direct experiment, dried at 180° C., 0·115.

An imperial gallon of the water, at 15·5° C., would contain:

(The carbonates being calculated as anhydrous bi-carbonates, and the salts without their water of crystallization.)

Natural waters—*Cont.*

Water of the Bow River, district of Alberta, N.W.T.--*Cont.*

	Grains.
Chloride of sodium	0·140
Sulphate of soda	0·490
" potassa	trace.
" lime	1·400
Bi-carbonate of lime	6·652
" magnesia	3·291
" iron	trace.
Silica	0·140
Organic matter	trace.
	12·113
Carbonic acid, free	2·871
	14·984

2.—Water of the Elbow River, district of Alberta, North-west Territory. Taken—2nd September, 1896—at low water, mid-stream, and mid-depth, underneath Mission bridge, at Calgary. Approximate low water discharge, 210 cubic feet per second.

Water of the Elbow River, district of Alberta, N.W.T.--*Cont.*

It was clear, bright, colourless, odourless, and devoid of any marked taste. Reaction, neutral; when evaporated to a small volume, however, it reacted very faintly alkaline. Its specific gravity, at 15·5° C., was found to be 1000·36. Boiling produced a small precipitate, consisting of carbonates of lime and magnesia, with a trace of ferric hydrate.

One thousand parts, by weight, of the water, at 15·5° C., were found to contain:

Potassa	0·001
Soda	0·008
Lime	0·074
Magnesia	0·024
Ferrous oxide	trace.
Sulphuric acid	0·034
Carbonic acid	0·151
Chlorine	0·001
Silica	0·004
Organic matter	trace.
	0·297

The foregoing acids and bases may reasonably be assumed to be present in the water in the following state of combination:

(The carbonates being calculated as mono-carbonates, and all the salts estimated as anhydrous.)

Natural waters—*Cont.*

Water of the Elbow River, district of Alberta, N.W.T.-*Cont.*

Chloride of sodium	0·002
Sulphate of soda	0·016
" potassa	0·002
" lime	0·041
Carbonate of lime	0·102
" magnesia	0·050
" iron	trace.
Silica	0·004
Organic matter	trace.
	0·217
Carbonic acid, half-combined	0·071
" free	0·009
	0·297

Total dissolved solid matter, by direct experiment, dried at 180° C., 0·212.

An imperial gallon of the water, at 15·5° C., would contain:

(The carbonates being calculated as anhydrous bi-carbonates, and the salts without their water of crystallisation.)

	Grains.
Chloride of sodium	0·140
Sulphate of soda	1·120
" potassa	0·140
" lime	2·871
Bi-carbonate of lime	10·294
" magnesia	5·322
" iron	trace.
Silica	0·280
Organic matter	trace.
	20·167
Carbonic acid, free	0·630
	20·797

Water of the Highwood River, district of Alberta, N.W.T.

3.—Water of the Highwood River, district of Alberta, North-west Territory. Taken—5th September, 1896—at low water, mid-stream, and mid-depth, underneath traffic bridge at High River. Approximate low water discharge, 667 cubic feet per second.

It was perfectly clear and bright, colourless, odourless, and devoid of any marked taste. Reaction, neutral; when evaporated to a small volume, however, it becomes very faintly alkaline. Its specific gravity, at 15·5° C., was found to be 1000·29. Boiling produced a slight precipitate, consisting of carbonates of lime and magnesia.

One thousand parts, by weight, of the water, at 15·5° C., were found to contain:

Natural waters—*Cont.*

Water of the Highwood River, district of Alberta, N.W.T.—*Cont.*

Potassa	trace.
Soda	0·008
Lime	0·063
Magnesia	0·019
Ferrous oxide	trace.
Sulphuric acid	0·020
Carbonic acid	0·128
Chlorine	0·001
Silica	0·008
Organic matter	trace.
	0·247

The foregoing acids and bases may reasonably be assumed to be present in the water in the following state of combination:

(The carbonates being calculated as mono-carbonates, and all the salts estimated as anhydrous.)

Chloride of sodium	0·002
Sulphate of soda	0·016
" potassa	trace.
" lime	0·019
Carbonate of lime	0·098
" magnesia	0·040
" iron	trace.
Silica	0·008
Organic matter	trace.
	0·183
Carbonic acid, half-combined	0·064
" free	.....
	0·247

Total dissolved solid matter, by direct experiment, dried at 180° C., 0·178.

An imperial gallon of the water, at 15·5° C., would contain:

(The carbonates being calculated as anhydrous bi-carbonates, and the salts without their water of crystallization.)

	Grains.
Chloride of sodium	0·140
Sulphate of soda	1·120
" potassa	trace.
" lime	1·331
Bi-carbonate of lime	9·873
" magnesia	4·271
" iron	trace.
Silica	0·560
Organic matter	trace.
	17·295
Carbonic acid, free	.....
	17·295

Natural waters—*Cont.*

Water of Fish Creek, district of Alberta, N.W.T.

4.—Water of Fish Creek, district of Alberta, North-west Territory. Taken—26th August, 1896—at low water, mid-stream and mid-depth, underneath bridge on McLeod trail. Approximate low water discharge, 5 cubic feet per second.

It contained a trifling amount of brownish, flocculent organic matter in suspension—this was removed by filtration. The filtered water—which was perfectly clear and bright, was colourless, odourless, and devoid of any marked taste. Reaction, neutral; when evaporated to a small volume, however, daintly alkaline. Its specific gravity, at 15·5° C., was found to be 1000·38. Boiling produced a slight precipitate, consisting of carbonates of lime and magnesia.

One thousand parts, by weight, of the filtered water, at 15·5° C., were found to contain:

Potassa	0·004
Soda	0·022
Lime	0·063
Magnesia	0·030
Ferrous oxide	trace.
Sulphuric acid	0·011
Carbonic acid	0·189
Chlorine	0·001
Silica	0·013
Organic matter	trace.
	0·333

The foregoing acids and bases may reasonably be assumed to be present in the water in the following state of combination:

(The carbonates being calculated as mono-carbonates, and all the salts estimated as anhydrous.)

Chloride of sodium	0·002
Sulphate of soda	0·014
" potassa	0·007
Carbonate of soda	0·027
" lime	0·112
" magnesia	0·063
" iron	trace.
Silica	0·013
Organic matter	trace.
	0·238
Carbonic acid, half-combined	0·093
" free	0·002
	0·333

Total dissolved solid matter, by direct experiment, dried at 180° C., 0·232.

An imperial gallon of the water, at 15·5° C., would contain:

Natural waters—*Cont.*

(The carbonates being calculated as anhydrous bi-carbonates, and the salts without their water of crystallization.)

Water of Fish Creek, district of Alberta, N.W.T.—*Cont.*

	Grains.
Chloride of sodium	0·140
Sulphate of soda	0·980
" potassa	0·490
Bi-carbonate of soda	2·661
" lime.	11·274
" magnesia.	6·723
" iron	trace.
Silica	0·910
Organic matter	trace.
	23·178
Carbonic acid, free	0·140
	23·318

Water of the Sheep River, district of Alberta, N.W.T.

5.—Water of the Sheep River, district of Alberta, North-west Territory. Taken—6th September, 1896—at low water, mid-stream, and mid-depth, underneath Calgary and Edmonton railway bridge, near Dewdney. Approximate low water discharge, 257 cubic feet per second.

It contained a trifling amount of white, flocculent organic matter in suspension—this was removed by filtration. The filtered water was perfectly clear and bright, colourless, odourless, and devoid of any marked taste. Reaction, neutral, but when evaporated to a small volume, decidedly alkaline. Its specific gravity, at 15·5° C., was found to be 1000·33. Boiling produced a slight precipitate, consisting of carbonates of lime and magnesia.

One thousand parts, by weight, of the filtered water, at 15·5° C., were found to contain:

Potassa	0·001
Soda	0·011
Lime	0·069
Magnesia	0·022
Ferrous oxide	trace.
Sulphuric acid	0·030
Carbonic acid	0·140
Chlorine	0·001
Silica	0·005
Organic matter	trace.
	·0279

The foregoing acids and bases may reasonably be assumed to be present in the water in the following state of combination:

(The carbonates being calculated as mono-carbonates and all the salts estimated as anhydrous.)

Natural waters—*Cont.*

Water of the Sheep River, district of Alberta, N.W.T.—*Cont.*

Chloride of sodium	0·002
Sulphate of soda	0·023
" potassa	0·002
" lime	0·027
Carbonate of lime	0·104
" magnesia	0·046
" iron	trace.
Silica	0·005
Organic matter	trace.
	0·209
Carbonic acid, half-combined	0·070
" free	.....
	0·279

Total dissolved solid matter, by direct experiment, dried at 180° C., 0·200.

An imperial gallon of the water, at 15·5° C., would contain:

(The carbonates being calculated as anhydrous bi-carbonates, and the salts without their water of crystallization.)

	Grains.
Chloride of sodium	0·140
Sulphate of soda	1·610
" potassa	0·140
" lime	1·891
Bi-carbonate of lime	10·503
" magnesia	4·902
" iron	trace.
Silica	0·350
Organic matter	trace.
	19·536
Carbonic acid, free	.....
	19·536

The foregoing five river waters were, it may be mentioned, collected with a due observance of all the necessary precautions. The containers consisted of stoppered glass bottles of the kind technically known as "Winchester Quarts."

Water from a boring at Baddeck Bay, Victoria county, N.S.

6.—Water from a boring at Crescent Grove, Baddeck Bay, Victoria county, province of Nova Scotia. Examined for Mr. A. W. McCurdy.

The sample received for examination contained a trifling amount of brownish flocculent matter in suspension; this was removed by filtration. The filtered water was bright, colourless, odourless, and devoid of any marked taste. Reaction, neutral; when evaporated to a small volume, however, decidedly alkaline. Its specific gravity, at 15·5° C., was found to be 1000·96. The total dissolved saline matter, dried at 180° C., amounted to 1·029 parts per 1,000—equivalent to 72·1 grains per imperial gallon.

Natural waters—*Cont.*

A qualitative analysis indicated the presence of:

Water from a boring at Baddeck Bay, Victoria county, N.S. —*Cont.*

Soda	somewhat large quantity.
Lime	very small quantity.
Magnesia	very small quantity.
Sulphuric acid	small quantity.
Carbonic acid	small quantity.
Chlorine	rather small quantity.
Silica	trace.
Organic matter	none.

Boiling produced a slight precipitate, consisting of carbonates of lime and magnesia.

7.—Water from a well near Cantley post-office, lot nine, range thirteen, of the township of Hull, Ottawa county, province of Quebec. Examined for Mr. Robert Brown.

Water from a well in Cantley, Ottawa county, Q.

The sample received for examination was slightly turbid, and contained a small quantity of white flocculent organic matter in suspension. This was removed by filtration. The filtered water had a faint yellowish colour; was odourless, and had a somewhat flat taste. Reaction, neutral; when reduced to a small volume, however, faintly alkaline. It contained 0·90 parts of dissolved saline matter, dried at 180° C., in 1,000 parts, by weight, of the water—equivalent to 63 grains per imperial gallon.

A qualitative analysis showed it to contain:

Soda	rather small quantity.
Lime	small quantity.
Magnesia	very small quantity.
Alumina	trace.
Ferrous oxide	trace.
Sulphuric acid	small quantity.
Carbonic acid	very small quantity.
Chlorine	rather small quantity.
Silica	trace.
Organic matter	faint trace.

Boiling produced a slight precipitate, consisting of carbonate of lime with some carbonate of magnesia and a very little sulphate of lime.

8.—Water from a spring on the north-east half of the thirteenth lot of the sixth range of the township of Litchfield, Pontiac county, province of Quebec. Examined for Mr. William Kelly.

Water from a spring in Litchfield, Pontiac county, Q.

The sample received for examination contained a small quantity of brownish, flocculent organic matter in suspension; this was

Natural waters—*Cont.*

Water from a spring in Litchfield, Pontiac county, Q.—*Cont.*

removed by filtration. The filtered water was bright, colourless, odourless, and devoid of any marked taste. Reaction, neutral—both before and after concentration. Its specific gravity, at 15·5° C., was found to be 1000·17. The total dissolved saline matter, dried at 180° C., amounted to 0·18 parts per 1000—equivalent to 12·6 grains per imperial gallon.

It was found to contain:

Soda	very small quantity.
Lime	small quantity.
Magnesia	small quantity.
Sulphuric acid	very small quantity.
Carbonic acid	rather small quantity.
Chlorine	very small quantity.
Silica	trace.
Organic matter	none.

Boiling produced a small precipitate, consisting of carbonates of lime and magnesia with traces of sulphate of lime.

Water from a spring in Litchfield, Pontiac county, Q.

9.—Water from another spring on the north-east half of the thirteenth lot of the sixth range of the township of Litchfield, Pontiac county, province of Quebec. Examined for Mr. William Kelly.

The sample supplied for examination contained a small quantity of brownish, flocculent organic matter in suspension, which was removed by filtration. The filtered water had a faint brownish-yellow colour, was devoid of odour, and any marked taste. Reaction, neutral—when evaporated to a small volume, however, alkaline. Its specific gravity, at 15·5° C., was found to be 1000·41. The total dissolved saline matter, dried at 180° C., amounted to 0·374 parts per 1000—equivalent to 26·18 grains per imperial gallon.

It contained:

Potassa	trace.
Soda	rather small quantity.
Lime	small quantity.
Magnesia	small quantity.
Sulphuric acid	small quantity.
Carbonic acid	somewhat large quantity.
Chlorine	small quantity.
Silica	trace.
Organic matter	trace.

Boiling produced a rather small precipitate, consisting of carbonates of lime and magnesia.

Water from a spring on Mount Baldur, West Kootenay district, B.C.

10.—Water from a spring on Mount Baldur, between Fosthall and Pingston Creeks, west side of upper Arrow Lake, West Kootenay district, province of British Columbia. This, and the following water, were examined for Mr. W. D. McGee.

Natural waters—*Cont.*

The sample sent for examination, contained a small quantity of brownish-yellow flocculent matter in suspension. This was removed by filtration. It consisted almost exclusively of hydrated peroxide of iron. The filtered water was clear, bright, colourless, odourless, and devoid of any marked taste. Reaction, faintly acid. The total dissolved saline matter, dried at 180° C., amounted to 0·196 parts per 1000—equivalent to 13·72 grains per imperial gallon.

Water from a spring on Mount Baldur, West Kootenay district, B.C.—*Cont.*

A qualitative analysis showed it to contain :

Soda	trace.
Lime	small quantity.
Magnesia	very small quantity.
Ferrous oxide	very small quantity.
Sulphuric acid	somewhat large quantity.
Chlorine	trace.
Silica	trace.

Boiling produced a very slight precipitate, consisting of hydrated peroxide of iron with a trace of sulphate of lime.

11.—Water from another spring—some eight hundred feet distant from that from which the preceding water was taken—on Mount Baldur, between Fosthall and Pingston Creeks, west side of upper Arrow Lake, West Kootenay district, province of British Columbia.

Water from a spring on Mount Baldur, West Kootenay district, B.C.

The sample received for examination, contained a trifling amount of white, flocculent organic matter in suspension—this was removed by filtration. The filtered water was found to be clear and bright, of a faint brownish-yellow colour, devoid of odour, and any marked taste. Reaction, neutral—when evaporated to a small volume, however, faintly alkaline. The total dissolved saline matter, dried at 180° C., amounted to 0·074 parts per 1000—equivalent to 5·18 grains per imperial gallon.

It was found to contain :

Soda	trace.
Lime	very small quantity.
Magnesia	strong traces.
Ferrous oxide	trace.
Sulphuric acid	very small quantity.
Carbonic acid	very small quantity.
Chlorine	trace.
Silica	trace.
Organic matter	trace.

Boiling produced but a trifling precipitate, consisting of carbonate of lime.

Natural waters—*Cont.*

12.—Water from a spring on Mayne Island off the south-east coast of Vancouver Island, province of British Columbia.

Water from a spring on Mayne Island, B.C.

The sample sent for examination, contained a very trifling amount of white, flocculent organic matter in suspension. This was removed by filtration. The filtered water was colourless; had a faint odour of sulphuretted hydrogen, and a somewhat flat taste. It reacted neutral; when evaporated to a small volume, however, distinctly alkaline. The total dissolved saline matter, dried at 180° C., amounted to 0·42 parts per 1000—equivalent to 29·4 grains per imperial gallon.

A qualitative analysis gave:

Potassa	very small quantity.
Soda	small quantity.
Lime	very small quantity.
Magnesia	trace.
Sulphuric acid	very small quantity.
Carbonic acid	very small quantity.
Chlorine	small quantity.
Silica	trace.
Organic matter	trace.

Boiling produced but a very slight precipitate.

Water from a spring on Cañon Creek, Alaska.

13.—Water from one of several springs on Cañon Creek, a tributary of Forty-mile River, about three miles west of the International Boundary, in Alaska; but springs of a similar water occur, according to Mr. William Ogilvie, in a south-easterly direction from this, on Glacier Creek, an affluent of Sixty-mile River, a short distance east of the International Boundary, in the Yukon district, North-west Territory.

The sample examined—which was collected by Mr. Ogilvie—was, apart from a trifling amount of white flocculent organic matter, clear and colourless. On removal of the stopper of the container, there was a brisk evolution of carbonic acid, the water became turbid, and deposited earthy carbonates. Reaction, acid; when evaporated to a small volume, however, alkaline. Its specific gravity, at 15·5° C., was found to be 1005·10. The total dissolved saline matter, dried at 180° C., amounted to 3·795 parts per 1,000—equivalent to 266·98 grains per imperial gallon.

A qualitative analysis showed it to contain;

Natural waters—*Cont.*

Water from a spring on Cañon Creek, Alaska—*Cont.*

Potassa	trace.
Soda	small quantity.
Lithia	faint trace.
Strontia	faint trace.
Lime	large quantity.
Magnesia	large quantity.
Ferrous oxide	trace.
Sulphuric acid	somewhat large quantity.
Carbonic acid	very large quantity.
Chlorine	very small quantity.
Silica	very small quantity.
Organic matter	trace.

Boiling produced a copious precipitate, consisting of carbonates of lime and magnesia.

This water recalls to mind that of Dougherty's so-called "Carbonic acid spring"—previously described as occurring in mountains between Clinton and Carguile's, but which is now known as the "Soda" spring, and would be more accurately described as being situate on the west side of the wagon road, about ten miles south of Clinton, in Lillooet district—the results of the examination of which are given in one of my previous reports. (Rep. Geol. Surv. Can., new series, vol. 2, p. 13 T, 1886).

MISCELLANEOUS EXAMINATIONS.

Actinolite, from Lanark county, O.; and Brome county, Q.

1.—Actinolite. A greenish-gray, fine-columnar, compact, massive actinolite, from Keisey's lot, township of Dalhousie, Lanark county, province of Ontario; and a light greenish-gray, fine-fibrous, massive variety of this mineral from the township of Potton, Brome county, province of Quebec, have been examined by Mr. Johnston and found to contain—the former, 3·02; and the latter, 4·71 per cent of ferrous oxide.

Clay from Riding Mountain, Man.

2.—Clay. A sample of clay from Riding Mountain, province of Manitoba, received from Messrs. Munson and Allan, has been examined by Mr. Wait, and found to be impregnated with sulphates of magnesia, lime, alumina and iron—principally the first named. These, amounting in all to from three to four per cent of the whole, were readily removable by treatment of the material with water. The residue subsequently treated with hot dilute hydrochloric acid, yielded to this reagent rather large amounts of iron, alumina and magnesia, and a small quantity of lime. The clay proved to be highly plastic at all stages, namely, in its natural state, after treatment with water, as likewise after treatment with dilute acid. In its natural state, it burns light reddish-

Miscellaneous examinations —*Cont.*

brown and is readily fusible; after treatment with water, it still burns pale reddish-brown and is somewhat readily fusible; after treatment with acid it burns perfectly white and is somewhat difficultly fusible. This material would appear to have resulted from the weathering of a highly pyritiferous shale.

Clay from junction of Coldwater and Nicola Rivers, B.C.

3.—Clay. This clay occurs in connection with the coal seams at the junction of the Coldwater with the Nicola river, Yale district, province of British Columbia. It is a bluish-gray—in the air-dried condition, dull yellow to brownish-yellow weathering, non-calcareous, plastic clay, which when burnt assumes a very pleasing light red, gray, or pale russet colour. It is somewhat readily fusible at an elevated temperature.

Clay from Marshall's Town, N.S.

4.—Clay. From what is said to be an extensive deposit situate about a mile south-east of Marshall's Town church, Digby county, province of Nova Scotia. A light gray—in the air-dried condition, non-calcareous, plastic, difficultly fusible clay, which when burnt has a yellowish-white tinge. It would appear to be well suited for the manufacture of ordinary building brick, stove linings, and would make a fairly refractory fire-brick.

Graphitic shale from French Vale, Cape Breton county, N.S.

5.—Graphitic shale. From near Guthro' Lake, French Vale, Cape Breton county, province of Nova Scotia. The results of a complete analysis of a sample of the material from this locality, together with full particulars in regard to the nature of the graphite contained in it, are given in the Report of Progress of this Survey for 1879-80, p. 1 H. The present specimen was received from the Rev. M. A. Macpherson, who stated that the deposit is now in course of development, and seems to turn out very well. It was found by Mr. Wait to contain 45·43 per cent of graphitic carbon.

Graphitic shale, from Thorns Book, Kings county, N.B.

6.—Graphitic shale. From the east side of Thorns brook, parish of Havelock, Kings county, province of New Brunswick. Collected by Mr. H. P. H. Brumell, who describes the deposit—Report of Progress of this Survey for 1890-91, p. 71 SS—in the following words:—"It is about twenty feet wide, striking north-east, and is in altered slates which are very much jointed and broken up. The graphite is nowwhere very solid where exposed, but can readily be dug with pick and shovel. It is said the deposit can be traced for over a mile on the strike of the vein." This material was found by Mr. Wait to contain not more than 7·51 per cent of graphitic carbon.

7.—Hematite. A fossiliferous red hematite from the mouth of Mabou Harbour, Inverness county, province of Nova Scotia, received from Mr. M. McFadyen, has been examined by Mr. Wait and found to contain ferric oxide 61·10=42·77 metallic iron; manganous oxide 0·14; phosphoric acid equivalent to at least 0·4 phosphorous, and insoluble residue 30·77 per cent.

Miscellaneous examinations —*Cont.* Hematite from Mabou Harbour, N.S.

8.—Peat. A sample of peat received from Mr. Gideon Bower, of Vancouver, province of British Columbia, examined by Mr. Wait, was found to contain 49·05 per cent water, and to leave on incineration 15·23 per cent of a light brownish-yellow coloured ash.

Peat from Vancouver, B.C.

9.—Tremolite. The percentage of ferrous iron in tremolite from the undermentioned localities in the province of Ontario, has been estimated by Mr. Johnston, and found to be as follows:—(*a*) A light faint greenish-gray tremolite from the west half of the twenty-sixth lot of the twelfth concession of the township of Bathurst, Lanark county, 0·92 per cent ferrous oxide: (*b*) a dark gray, radiating fibrous tremolite, from the township of Kennebec, Frontenac county, 1·13 per cent ferrous oxide: (*c*) a very pale greenish-gray, fine fibrous tremolite from the thirty-seventh lot of the seventh concession of the township of Clarendon, also in Frontenac county, 0·96 per cent ferrous oxide; (*d*) a grayish-white translucent tremolite, with a vitreous lustre, from the twenty-third lot of the fourth concession of the township of Ross, Renfrew county, 0·17 per cent ferrous oxide: (*e*) a light greenish-gray fibrous tremolite, found on the twenty-second and twenty-third lots of the fourth concession of the township of Blythfield, also in Renfrew county, 2·25 per cent ferrous oxide: (*f*) a massive faintly greenish-grayish-white, radiating fibrous tremolite from the thirteenth lot of the third concession of the township of Bagot, in the last mentioned county, 0·91 per cent, ferrous oxide.

ERRATA.

P. 108 s, PETROLEUM article :—line 5, *for* 25 per cent *read* 4 per cent.
Table 1. Petroleum. Paraffine wax, 1896. Value: *for* \$466,978 *read* \$76,249 and total below: *for* \$2,267,642 *read* \$1,876,913.

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

1896

ELFRIC DREW INGALL, M.E.,

Associate of the Royal School of Mines, England, Mining Engineer to the Geological Survey of Canada.

ASSISTANTS

A. A. COLE, M.A., B.A. Sc. J. McLEISH, B.A.

OTTAWA

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

1897

No 625

To Dr. G. M. Dawson, C.M.G., F.R.S.,

Director Geological Survey of Canada.

Sir,—Herewith permit me to hand you the detailed statistical re port of the mineral industry of Canada for 1896. The preliminary summary statement for that year was completed on the 13th February, 1897, and issued in pamphlet form, as usual, soon after.

The report for 1895, contained only the figures relating to the different mineral industries, as it was found impossible, as therein explained, to find time for the preparation of a more complete statement with the then lessened staff of the section.

In the present report, many of the tables of figures have been revised in the light of more complete information which has of late become available, and the vacancies left by the resignation of Messrs. Brumell, and Brophy having now been filled by Messrs. Cole and McLeish, a beginning has been made in the direction of adding the explanatory matter necessary for an intelligent annual review of the various mineral industries of the country. It is felt, however, that this cannot be accomplished completely and thoroughly until the arrears of office work have been overcome and the officers of the section can become more personally familiar with many of the localities with which they have to deal.

It is gratifying to be able to state that already the strengthening the staff of the section has borne fruit, and our report will not only be fuller, but will be ready earlier than last year, thus fulfilling the promise then made.

Besides the annual report above alluded to, the work of the section has included, as in past years, the preparation of numerous memoranda in reply to inquirers on various points relating to Canada's mineral resources and industries and general technical matters.

I desire to make special acknowledgment of the efficient and careful work done by Mr. A. A. Cole, as well as by Mr. J. McLeish, since his accession to the staff in July.

Although too numerous to mention, thanks are due also to those who individually have, 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.

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.—TARIFF.

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.

The rates of duty given in the tables of imports throughout this Report, are those of the tariff ruling during the fiscal year 1895-6. This was replaced during the Parliamentary Session of 1896-7 by the present tariff, which came into force 23rd of April, 1897, and which may be obtained, at 15c. per copy, by application to the Queen's Printer, Ottawa.

VALUES ADOPTED.

The values of the metallic minerals produced, as per returns to this Department, are calculated on the basis of their metallic contents at the average market price of the metal for the current year. Spot values have been adopted for the figures of production of the non-metallic minerals.

GENERAL NOTES.

As in the past, care is taken to avoid interference with private interests in the manner of publishing results, and all returns of production of individual mines are treated as confidential unless otherwise arranged with those interested. The confidence of the mining community thus gained, has resulted in an increasingly general response to our circulars, although to complete our data personal application is still necessary in a small number of instances, and a yet more prompt response on the part of all applied to, will help still further towards an earlier publication of the material.

In view of criticisms of these statistics which have been made recently, and from time to time in the past, it may be well to take this opportunity to explain the working methods adopted, in order to prevent the misunderstandings which underlie such criticisms and suggestions, and to correct the impression thereby conveyed to the public that the reports are unreliable.

The figures given throughout the reports are based, as far as possible, upon returns obtained direct from the various operators, and the totals have for some years been checked by comparison with railway shipments, exports, and all other available sources of information. It can be therefore fairly claimed, that they are as accurate as it is possible to make such figures.

After investigation of the subject we have, however, found that in the nature of things, export and railway figures can only be taken as approximately correct in most instances. In the case of the export figures, entries are made as a rule by those having no technical knowledge of mineral substances, and in the case of the railways, but few of the shipments are actually weighed, so that car-load lots, for instance, may differ considerably from the theoretical load of the car.

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.

NOTE.

Natural Gas.—Attention having lately been drawn to the question of the production of natural gas in Canada, it may be mentioned that the figures given in this Report represent the estimated value of the gas where produced, as in the case of all other non-metallic minerals.

INTRODUCTION.

In examining the attached table of the Mineral Production of Canada for the past eleven years, the following important features relating to Canada's mineral development will be noticed.

In 1886, the total mineral production of the country, as per direct returns, supplemented by close estimates where complete returns could not be obtained, was valued at a little over ten million dollars. In 1896, the value of Canada's mineral production had increased 125 per cent or to over twenty-two and a half million dollars. Taking the data given for the United States in the volume of the "Mineral Industry," issued by the Engineering and Mining Journal of New York, we find that in a similar period the increase there has been only about 40 per cent. The mineral production of the United States, however, is of course vastly greater than that of Canada, the latter amounting in 1896 to but 3½ per cent of the former. The relative per capita production of minerals for the two countries is as follows, viz., for Canada about $4.50 and for the United States about $8. The rapid growth noted above is, however, a most encouraging feature, and the present outlook for mineral discovery and development in Canada would seem to promise a rapid rate of increase for many years to come. The main part of this increase must of course be in those minerals which permit of being exported and sold in foreign markets, as the home market is necessarily limited and grows slowly in a country with so small a population, and in which the population is scattered over so large an extent of territory. This also influences in an important way the question of distribution, enhancing considerably the cost of carriage from producer to consumer, and even rendering many of our deposits of the lower priced minerals unworkable at a profit at present. Great improvements have been made in this respect of late years, and others are contemplated in the near future which will bring some of the most promising mineral districts within economically reachable distance of extensive markets and help considerably towards the expected general growth of the industry.

It is interesting to note the proportions contributed by the various minerals towards the grand total, and their arrangement according to importance, as in the following table, brings out some instructive points.

MINERAL PRODUCTION OF CANADA.

MINERAL PRODUCTION OF CANADA, 1896.

Proportionate Value of different Mineral Products.

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	31·94				
Gold	12·30				
Silver	....	9·50			
Bricks (estimated)	....	7·10			
Nickel	....	5·25			
Petroleum	....	5·11			
Copper	....	....	4·52		
Building stone (estimated)	....	....	4·43		
Lead	....	....	3·20		
Lime (estimated)	....	....	2·88		
Asbestus	....	....	1·90		
Salt	....	....	1·50		
Natural gas	....	....	1·22		
Gypsum	....	....	....	0·76	
Iron	....	....	....	0·65	
Sundry under 1 p.c.	....	....	....	7·74	
Totals	44·24	26·96	19·65	9·15	100·00

From the above it will be seen that, in the year under consideration, coal is to be credited with almost a third, while gold comes second at about 12 per cent. In the five to ten per cent class come silver, bricks, nickel and petroleum; whilst in the one to five per cent class we find copper, building stone, lead, lime, asbestus, salt and natural gas, in the order named. Gypsum and iron contribute less than one per cent. Over 90 per cent of the total is thus accounted for under the above fifteen headings out of a total number of fifty-four minerals mentioned.

Taking the different classes of minerals, we find that the metallic group contributed 35·63 per cent; the miscellaneous non-metallic 44·12 per cent; the structural materials 19·14 per cent, with an allowance of 1·11 per cent for estimated value of mineral products unreturned.

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, as can be seen by comparison of 1896 with earlier years in the main table. In order to facilitate this use of the table, the features of increase and decrease have been brought out the use of differing type as explained in the foot notes.

MINERAL PRODUCTION OF CANADA.

EXPORTS.

EXPORTS.

MINERALS AND MINERAL PRODUCTS MINED OR MANUFACTURED IN CANADA DURING CALENDAR YEAR 1896.

Products.	Value.	Products.	Value.
Asbestus, first class	$ 107,527	Mica	$ 47,756
" second class	320,842	Mineral pigments	5,459
" third class	139,598	Nickel	658,213
Bricks	5,678	Oil, crude	101
Cement	1,328	" refined	999
Chromite	31,411	Phosphate	2,995
Clay, manufactures of	752	Platinum	225
Coal	2,388,735	Plumbago, crude	9,126
Coke	151	" manufactures of	354
Copper	281,070	Pyrites	33,837
Felspar	2,583	Salt	899
Gold	1,318,545	Sand and gravel	80,110
Grindstones	19,139	Silver	2,271,959
Gypsum, crude	186,589	Slate	8,913
" ground	21,267	Stone, unwrought	32,897
Iron and steel	284,295	" wrought	4,934
Iron ore	1,911	Other articles	15,273
Lead	462,095		
Lime	70,820	Total	8,822,360
Manganese ore	3,975		

EXPORTS

OF PRODUCTS OF THE MINE, WITH DESTINATIONS, DURING THE FISCAL YEAR 1895–1896.

Destination.	Value.	Destination.	Value.
United States (and Alaska)	$7,437,814	China	$ 13,051
Newfoundland	183,080	France	12,115
Great Britain	175,512	Hayti	5,640
Germany	128,652	Central American States	5,600
Hawaiian Islands	25,909	Spanish West Indies	3,865
British Guiana	20,085	Hong Kong	2,143
" West Indies	16,315	Argentine Republic	750
Belgium	15,375		
St. Pierre	13,744	Total	$8,059,650

IMPORTS.

IMPORTS.

MINERALS AND MINERAL PRODUCTS, FOR FISCAL YEAR 1895-1896.

Products.	Value.	Products.	Value.
Alum and aluminous cake	$ 28,375	Iron and steel—mfrs. of—machinery, hardware, &c	$ 5,943,912
Aluminium	7,537	Lead—pig, bars, bl'ks, old scrap, &c.	193,331
Antimony	9,557	" manufactures of	42,778
Arsenic	27,523	Lime	7,331
Asbestus and mfrs. of	23,900	Lithographic stone	4,964
Asphaltum	33,875	Manganese, oxide of	4,075
Bismuth	188	Marble—blocks, slabs, &c.	21,970
Borax	35,255	" mfrs. of	68,095
Bricks	33,321	Mercury	32,343
" bath	1,655	Metallic alloys — brass, bronze, german silver, pewter, &c.	505,076
" and tiles, fire	129,024	Mineral and bituminous substances, N.E.S	28,754
Buhrstones	2,049	Mineral and metallic pigments	426,651
Building stone	54,130	Mineral waters	55,864
Cement	12,620	Nickel	4,787
" Portland	242,409	Ores of metals, N.E.S.	24,038
Chalk	6,467	Paraffine wax	10,042
Clay, china	33,836	" candles	4,072
" fire	19,729	Petroleum and products of.	735,913
" pipe	955	Platinum	6,185
" all other, N.E.S.	8,464	Precious stones	380,279
Coal, anthracite	5,667,096	Pumice	3,721
" bituminous	3,299,025	Salt	363,438
" dust, &c.	53,742	Saltpetre	55,628
" tar and pitch	31,209	Sand and gravel	24,604
Coke	203,826	Slate	24,176
Copper, pigs, precipitate, scrap, &c.	9,226	Stone and granite, N.E.S.	51,499
" ingots and mfrs. of	285,220	Spelter	40,548
Copperas	3,178	Sulphate of copper	57,380
Cryolite	2,699	Sulphur	63,973
Earthenware	575,493	Sulphuric acid	1,430
Emery	27,740	Tiles, sewer pipes, &c.	19,296
Felspar, quartz, flint, &c.	8,750	Tin—pigs, bars, &c.	213,710
Fertilizers	45,334	" mfrs. of	1,023,974
Fuller's earth	1,834	Whiting	27,322
Graphite, crude	2,865	Zinc—pigs, bars, dust, &c.	81,488
" mfrs. of	37,931	" mfrs. of	6,290
Grindstones	26,561	Total	25,581,771
Gypsum, crude	848		
" plaster of Paris, &c.	2,198		
Iron and steel—Pig, scrap, blooms, &c.	675,811		
" ferro-silicon, ferro-manganese, &c.	12,811		
" Rolled—bars, plates, &c. including chrome steel.	3,339,568		

ABRASIVE MATERIALS.

ABRASIVE MATERIALS.

Grindstones.

The production under this heading includes grindstones, wood-pulp, stones, spindlestones, polishing grit, whetstones, buhrstones, &c., and for the year was as follows :—

New Brunswick.......	2,263	tons, valued at	$18,810
Nova Scotia..........	1,450	" "	14,500
Total..............	3,713		$33,310

TABLE 1.

ABRASIVE MATERIALS.

ANNUAL PRODUCTION OF GRINDSTONES.

Calendar Year.	Tons.	Value.
1886..........	4,000	$46,545
1887..........	5,292	64,008
1888..........	5,764	51,129
1889..........	3,404	30,863
1890..........	4,884	42,340
1891..........	4,479	42,587
1892..........	5,283	51,187
1893..........	4,600	38,379
1894..........	3,757	32,717
1895..........	3,475	31,932
1896..........	3,713	33,310

As in former years, the quarries which have supplied this product are situated in the provinces of New Brunswick and Nova Scotia, those of the former province being situated chiefly in Westmoreland, Northumberland and Gloucester counties, and in the latter in Pictou and Cumberland counties.

Grindstones.—Mr. Hugh Fletcher writes as follows about the Atlantic Stone Company's quarries at Lower Cove, Cumberland, which he visited during the autumn of 1896 :—" The product sold is all manufactured ; *grindstones* for all kinds of edge tools (including scythes, &c., from 84 inches in diameter by 14 inches thick, to 6 inches in diameter and 1½ to 3 inches thick, supplied in dimensions as ordered, not manufactured haphazard ; *whetstones* (for field use for scythes, &c.) These are from the gray sandstones of the quarry at Lower Cove, the fine-grained waving stone being best adapted for scythes, the coarser varieties for other purposes."

" A red 'oil-stone,' with gray and greenish fine stripes and spots, is also here made from a quarry near Mill Cove, about five miles higher

ABRASIVE MATERIALS.

up the bay, also on the property of the Atlantic Stone Company. The stone used is taken from tide-water."

Grindstones.

" The quarries of gray stone are near the reefs on the shore, also a short distance inland. The thick fine layers are exposed in a face thirty feet high, and twenty feet of good stone is to be quarried below. A horse-winch is used to raise from this upper quarry blocks ten tons in weight, and a stone-winch on the ground is capable of lifting sixteen tons. The large blocks are sawn into the required thickness."

Pulpstones.—There have been several inquiries at this office about stones for grinding wood-pulp. Mr. C. E. Fish, of Newcastle, N.B., writes in this connection that wherever his product has been tried it is very well liked. He states that the Canada Paper Company, of Montreal, are using these stones at three of their mills, and find them entirely satisfactory.

Mr. Fish says further: " We are furnishing two stones free to any of the mills that will give them a trial, and we have in every case succeeded in getting a share of their order and in overcoming their preference for foreign stones."

Messrs. Read & Clark, of Sackville, N.B., also made some sample stones for grinding wood-pulp, and reports, so far, say they are proving very good for that purpose.

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

TABLE 3.

ABRASIVE MATERIALS.

EXPORTS OF GRINDSTONES.

ABRASIVE MATERIALS.

Grindstones.

Provinces.	Calendar Year.			
	1893.	1894.	1895.	1896.
Quebec	$ 625	$ 1	....	....
Nova Scotia	11,317	10,048	$ 8,723	$ 12,145
New Brunswick	9,730	2,530	8,000	6,994
Totals	$ 21,672	$ 12,579	$ 16,723	$ 19,139

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.......... .. Duty, $1.75 per ton.	1,862	26,561

* Not mounted and not less than 12 inches in diameter.

ABRASIVE MATERIALS.

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—Duty free	2,049

* Buhrstones in blocks, rough or unmanufactured, not bound up or prepared for binding into mill-stones.

Pumice-stone.

As no pumice-stone stone is produced in Canada, the figures of imports given below constitute all the information on the subject.

TABLE 6.

ABRASIVE MATERIALS.

IMPORTS OF 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—Duty free	3,721

* Pumice and pumice stone, ground or unground.

ABRASIVE MATERIALS.

Corundum.

Corundum is known to occur in Canada, but so far the deposits have not been worked, and there is therefore nothing to report in the way of production of either that mineral or of the granular form known as emery.

The recent discoveries of corundum in Hastings and Renfrew counties in eastern Ontario are located along a belt of country varying from one and a half to three miles in width, extending from the German Settlement, south of the village of Rockingham, in the township of Brudenell, for about sixteen miles W.S.W. into the township of Carlow. The mineral occurs as a very important and at times abundant constituent in pegmatite, cutting biotite-granite-gneiss; in a very felspathic granite or syenite gneiss and in a light-gray or whitish albite-gneiss and nepheline-syenite. It is also sparingly present in small crystals disseminated through the more felspathic bands of the ordinary biotite-gneiss but seems to be rarely if ever present in the dark-coloured basic portions interbanded with these rocks. Over certain limited areas the mineral is more concentrated, in many instances constituting from 30 to 60 per cent of the rock mass. Some of the deposits at present known, especially those in the north-western part of Raglan are easy of access.*

Emery

Table 7 below, giving the imports of emery, illustrates the home market for this class of abrasive materials :—

TABLE 7.
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

a. Emery, in bulk, crushed or ground.
b. Emery wheels and manufactures of emery.
† Duty free.
* Duty, 25 per cent.

*Further particulars regarding the discovery, &c., of this mineral will be found in the Summary Report of the Director of the Geological Survey for 1896, pp. 116–118A, and in the forthcoming Geological Report of Mr. A. E. Barlow on the district.

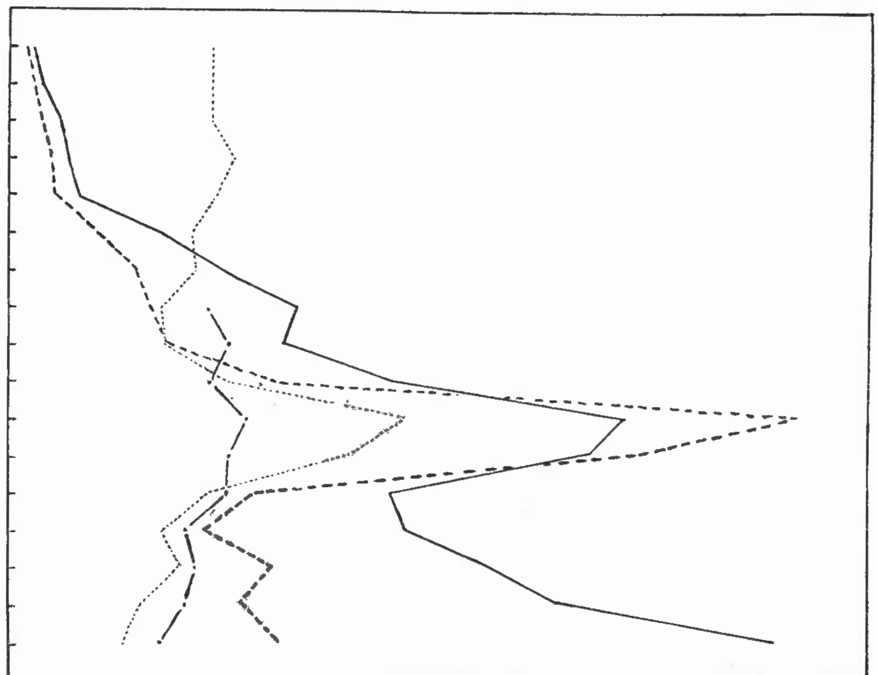
ASBESTUS.
Production.

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.

Asbestus.

Production.

The production of asbestus in Canada during 1896, amounted to 12,250 tons, valued at $429,856, as compared with 8,756 tons, valued at $368,175, for the previous year, an increase of 3,494 tons, or about 40 per cent. The total value of the production increased $61,681, or only about 17 per cent, indicating a much lower average value. This is due to the much larger proportion of the lower grades in the sales and shipments for the year.

The development of this industry is well illustrated in the accompanying graphic table, where the production from 1880 to 1896 is shown by the heavy solid line, the heavy broken line showing the total value of the same and the light broken line the average value of the shipments for each year as deduced from the last two. The most interesting feature thus brought out is the great rise in production and value in 1890. In a description of the industry, given by Mr. Klein, printed in the report for 1890, he attributes the high prices, to which this great increase in both production and value was due, to the operation of speculators who bought up and held all the stocks of the mineral, and to the eagerness of the manufacturers to buy owing to their belief in the limited capacity of the mines. In the following three years, 1890 to 1893 the inevitable reaction brought values down to about what they had been in the earlier history of the industry. An examination of the average value curve shows a decrease of about 60 per cent between 1890 and 1896. This is to be accounted for partly by the drop in prices and partly by the increase in the proportion of the lower grades of mineral in the shipments made, as compared with previous years.

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 1st class	1,834	$107,527
1896 2nd "	5,428	320,842
1896 3rd "	4,580	139,598
Total, 1896	11,842	$567,967

ASBESTUS.

It had been intended to show the relative proportions of the three grades, as given in the export figures (see Table of Exports of Asbestus in this and previous reports), but on taking out the percentages and average values for the different grades, the results in the latter case showed that the division into 'firsts' and 'seconds' has been merely nominal during the past five years. It was found that the average price of the asbestus entered for export as 'firsts' was often much lower than that entered as 'seconds' and sometimes about the same. This arises from the fact that the practice of the producers with regard to grading has varied very much, so that the best grade from one mine has often been only equivalent in length of fibre to that ranked as 'seconds' by another operator. The grade of the 'thirds,' however, has probably been more uniform than that of the firsts and 'seconds.' A comparison of the two curves in the graphic table representing the average value per ton of the production, and that of the exported asbestus, as per customs returns, shows a great discrepancy in the years from 1888 to 1891 inclusive; while for the years 1892 to 1896 inclusive, the value curves mentioned are seen to conform very fairly, although the average value of the exported mineral is considerably higher than the value of the produce as per direct returns. This is about as it should be, as the exports, especially to Europe, would be of the higher grades. For the rest, the figures in Table 1 must be taken for what they are worth. The customs officers can only take the entries of the shippers as the basis of their compilation, and these are undoubtedly very often lacking in accuracy, for various reasons.

Imports.

Table 2 gives all the figures there are available regarding imports of asbestus and needs no further explanation.

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—Duty 25 p.c.	23,900

* Asbestus, in any form other than crude, and all manufactures of.

ASBESTUS. Discovery and development.

In the autumn a visit was made to the asbestus mining districts of Black Lake, Thetford and Danville, of which Mr. Ingall speaks as follows (see Annual Report of the Geological Survey for 1896, vol. ix., p. 120A):—

"The eastern trip was undertaken by myself, and a short visit was made to the asbestus mining centres of Black Lake, Thetford and Danville. In this industry the low prices ruling for the past few years have caused all but the larger producers to suspend operations, and have resulted, in the case of those still operating, in a much larger use of machinery and the extraction of much fibre that used to be considered too short to be worth treatment. The processes in use consist, in a general way, of some method that, while crushing the rock, frees the fibre without breaking it; followed generally by the passage of the crushed material over travelling picking tables, where the longest fibre is selected out, and then over shaking screens having a slight slope. The effect of these screens is to sort out the remaining shorter fibre into lengths, and also by reason of a funnel with strong up-draught, overhanging the lower end of the screen, to lift the fibre away from the rock particles, the latter then passing off over the ends of the screens. At Danville this latter material is being stored outside the mill in dump, as it is now coming into use to replace ordinary sand and hair in wall plastering. It is claimed that this 'Asbestic,' as it is called, takes a better finish than ordinary plaster, does not crumble under the action of fire, and that it will not crack or crumble when nails are driven into it."

At this mine very considerable developments have been made in the last few years, and a very large and well appointed mill is in operation for the crushing of the mineral and the separating of the fibre from it. This has a capacity of 400 to 500 tons per day, and is driven by a 600 h. p. engine. The rock is first crushed in large Blake rock breakers, and then passes to revolving screens having a jolting as well as a rotary motion. The sorting out of the lumps of long fibred material to go into the first and second grade, is done by hand as the material passes a row of pickers seated on either side of a travelling picking table. The rest of the material is more finely crushed and passes over the series of flat shaking screens above described. The "asbestic" which passes away out of the mill, consists of the rock material crushed to the consistency of sand intermixed with a proportion of very short asbestus fibre. Its value is about $5 per ton, f.o.b., at Danville, and it is hoped that an extensive market can be worked up for this material, which should in that case become an important factor in the

ASBESTUS. Discovery and development.

future prosperity of this industry. This company employs some 300 men.

Besides the above-described mills, visits were made to those at Thetford, where assistance was kindly given by Mr. George R. Smith, manager for the Bell's Asbestus Company, and by Mr. R. J. Bennet, manager for Messrs. King Bros. Both these mines have fully equipped mills in operation, as have also the Johnson Asbestus Co. At Black Lake, the mill of the American Asbestus Co., under the management of Mr. L. A. Klein, and that of the Glasgow and Montreal Co., under the direction of Mr. J. S. Costigan, were in operation. The latter company, however, was not working its pits, the mines having been idle for about four years, and operations only recommenced in October. At this time the plant was increased by the addition of a 100 h. p. Corliss engine, cyclone pulveriser, fans, screens, etc., for extracting the asbestus fibre from the mineral. A rotary dryer is also in process of construction for drying the lower grades of material.

Although no shipments of asbestus were made by the Brompton Lake Asbestus Co. during the year, development work was in progress.

The above comprise the chief operators in this industry, but some of the mines which used to work in the days of higher prices, although now idle, have contributed to the production from old stock.

Outside the original asbestus district in the Eastern Townships of Quebec, the only work prosecuted was that by the Non-Magnetic Asbestus Co. at Point au Chene, Argenteuil county, and by the Armitage Co. of Newark, New Jersey, U.S.A., in Lowe township, Ottawa county, both points situated in the province of Quebec. At the first-mentioned place a mill has been erected for the separation of the asbestus from the rock, and the company, besides treating their own product, have put through, from other mines in the Eastern Townships as well as the Ottawa Valley, some 600 tons or more of mineral which has been fibreized and cleaned for the European and American markets. The conditions at these two last mentioned mines are different from those found in the Eastern Townships, the asbestus in the former occurring in connection with the serpentinous limestones of the Laurentian system, whilst in the latter it occurs in a range of intrusive serpentine rocks of much later age.

In Ontario nothing was done at the actinolite deposits in Elzevir township, Hastings county, but it is hoped that financial arrangements can be made to start in the near future. A few tons of actinolite were, however, shipped at Tweed on the Canadian Pacific Railway from the Bridgewater actinolite deposits. It has been suggested that the actinolite of this vicinity be quarried and sawn for making fire-brick for furnace linings, stoves, etc., the débris being ground and utilized for paper filling, boiler coatings, etc., and such uses as are found for fibrous talc and the lower grades of chrysotile. ASBESTUS. Discovery and development.

CHROMITE.

CHROMITE.

The mineral chromite, also known as chromic iron or chrome iron ore, has a composition represented by the formula $FeCr_2O_4$. If pure it would be compose of 68 per cent of chromium sesquioxide (Cr_2O_3) and 32 per cent of iron protoxide (FeO). Analyses of the commercial chrome ore usually show considerable quantities of magnesia, alumina and silica, derived in most cases from the serpentine in which ore occurs. (See analyses given below). The value of the ore depends on the percentage of chromic oxide contained. In order to make it readily marketable, the ore should contain at least 50 per cent of chromic oxide. In the use of chromite for the production of chromium salts, the cost of treating low- and high-grade ores is the same, but there is a decided difference in the quantity of the finished product, so that unless the smaller initial cost of the low-grade ore will counterbalance the value of this difference of the finished product, its use is unprofitable. These factors therefore fix the price of low-grade ore, and circumstances such as labour and cost of shipment, will determine whether it can be worked at a profit or not.

The principal producers of the world's supply of chromite are Russia and Turkey. Turkey produces about 40,000 tons of chromite annually, or about one-half the total production of the world. New Caledonia is also an important producer, having exported in 1896, 17,887 metric tons, valued at 967,942 francs. Chromite is produced in the United States, in California, but the ores are for the most part low-grade, and the production small, being for 1896, only 786 long tons valued at $6.667.

Canadian chromite comes from the Eastern Townships in the province of Quebec, the points of shipment being Black Lake, D'Israeli and Broughton on the Quebec Central Railway.

The Canadian production of chromite for 1896 shows a decided decline, both in quantity and value, when compared with the previous year. The prices received ranged from $8.00 to $18.00 per ton, depending on the percentage of chromic oxide contained in the ore. More low-grade ore than usual was shipped this year, thus lowering the average price of the shipments to $11.53 per short ton.

CHROMITE. Production.

Table 1 gives the production of chromite from the year 1886. Test shipments were made in 1886 and 1887, but it was not until 1894 that the industry was firmly established.

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
....	....	....	....
1894	1,000	20 00	20,000
1895	3,177	13 00	41,300
1896	*2,342	11 53	27,004

* Railway shipments.

Analyses.

The following analyses will indicate what may be expected in the composition of a chrome ore :—

ANALYSES OF CHROME ORES.

Number.	Cr_2O_3.	FeO.	Al_2O_3.	SiO_2.	MgO.	CaO.	Total.
	%	%	%	%	%	%	%
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	50·65	13·93	12·70	3·35	15·04	....	95·67
9	55·04	11·57	10·81	3·80	16·10	1·13	98·45
10	51·80	24·72	13·90	2·05	7·81	0·41	100 69
11	55·54	14·50	15·43	1·30	12·85	0·80	100·42
12	42·40	12·28	20·23	5·69	16·52	1·40	98·52
13	42·45	14·83	16·75	6·48	16·42	1·21	98·14

No. 1, Tp. Bolton, Que. G. S. C. Report, 1863, p. 504.
" 2, Lake Memphremagog. G. S. C. Report, 1863, p. 504.
" 3, Tp. Coleraine, Megantic Co., Que. Coleraine Mining Co. G. S. C. Report, 1894, p. 67 R.
" 4, 17. IV. Thetford, Megantic Co., Que. G. S. C. Report, 1887-88 pt. II, 56 T.
" 5, 6 and 7, Canadian Mining Manual, 1896, p. 342.
" 8, Canada
" 9 and 10, Turkish (Asia)
" 11, New Caledonia
" 12 and 13 California

} "Mineral Industry," 1895, p. 101. Scientific Pub. Co., New York.

The principal producers of chromic iron in Canada for 1896 were the following :— CHROMITE. Producers.

Name.	Shipping Station, Quebec Central Railway.	Address.
Anglo-Canadian Asbestus Co.	Black Lake.	314 Board Trade, Montreal, Que.
Blondeau & Roberge.	"	Black Lake, Que.
L. J. Frechette.	"	St. Ferdinand "
W. H. Lamblay.	"	Inverness "
Victoria Mining Co. (P. P. Hall).	"	Quebec "
J. O. Brousseau.	D'Israeli.	D'Israeli "
Leonard & Morin.	"	" "
James Reed, M.D.	Broughton.	Reedsdale "

COAL.

COAL.

The total production of coal for the Dominion is shown in graphic Table A. From the figures there given, it will be seen that the increase over last year amounted to 267,372 tons and $487,309, or 7·69 and 7·23 per cent respectively. The increase since 1886 has been $3,486,622, equal to about 93 per cent, and 1,629,063 tons, equal to about 77 per cent.

COAL. Annual Production.

COAL.

ANNUAL PRODUCTION.

Table A.

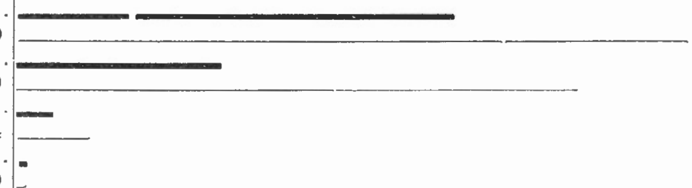
Calend'r Year.	Tons.	Value.
		$
1886	2,116,653	3,739,840
1887	2,429,330	4,388,206
1888	2,602,552	4,674,140
1889	2,658,303	4,894,287
1890	3,084,682	5,676,247
1891	3,577,749	7,019,425
1892	3,287,745	6,363,757
1893	3,783,499	7,359,080
1894	3,847,070	7,429,468
1895	3,478,344	6,739,153
1896	3,745,716	7,226,462

The relative proportions contributed by the different provinces to the grand total are graphically exhibited in Table B, and the below given figures in Table I show the increase or decrease for the different provinces in 1896 as compared with 1895 :—

COAL.
Production by provinces.

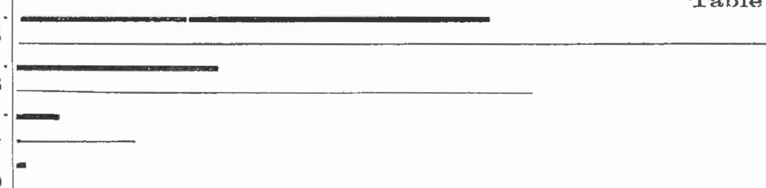
COAL.
CALENDAR YEAR, 1895.
PRODUCTION BY PROVINCES.
Table B.

Province	Tons, 2,000 lbs.	Value.
		$
N. S.	2,225,145	3,476,790
B. C.	1,058,045	2,834,049
N. W. T.	185,654	414,064
N. B.	9,500	14,250



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.
Production by provinces.

TABLE 1.

COAL.

PRODUCTION. COMPARISON OF 1895 AND 1896.

Province.	Increase or Decrease.			
	Tons.	Per cent.	Value.	Per cent.
Nova Scotia	283,434	12·74	442,865	12·74
New Brunswick.	2,000	21·05	3,000	21·05
North-west Territories.......	40,214	21·66	192,827	46·57
British Columbia.	54,276	5·13	145,383	5·13
Dominion.....	267,372	7·69	487,309	7·23

NOTE.—The figures underlined in this table represent increases, the others decreases.

The export trade for the Dominion is illustrated by graphic Table C. From this it will be seen that the increase in the amount of coal exported from 1886 to 1896 is about 112 per cent, whilst the difference between the first year given, viz., 1873 and 1886, represents an increase of about 163 per cent.

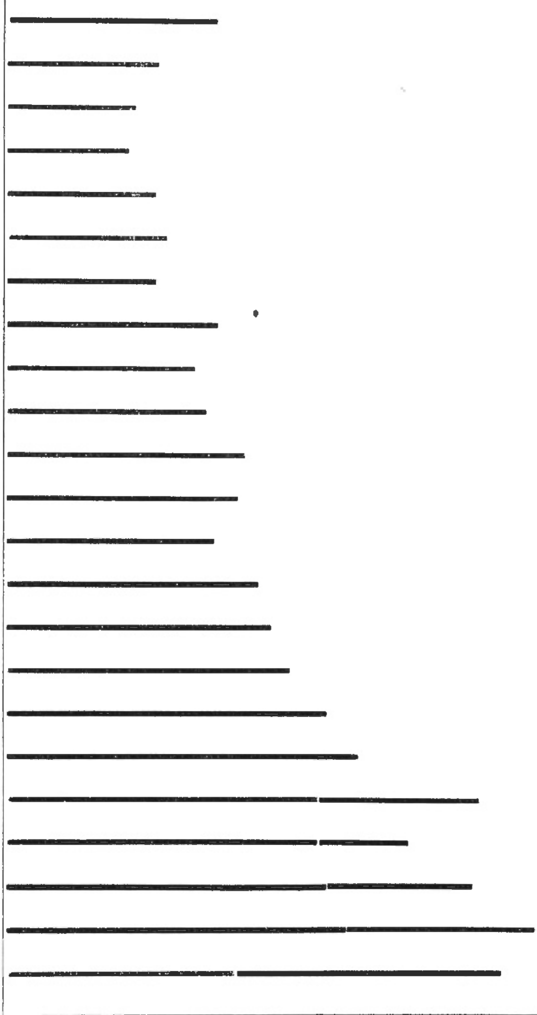
Graphic Table D is given as supplementing Table C, although it has hardly any bearing upon the mineral industry.

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



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

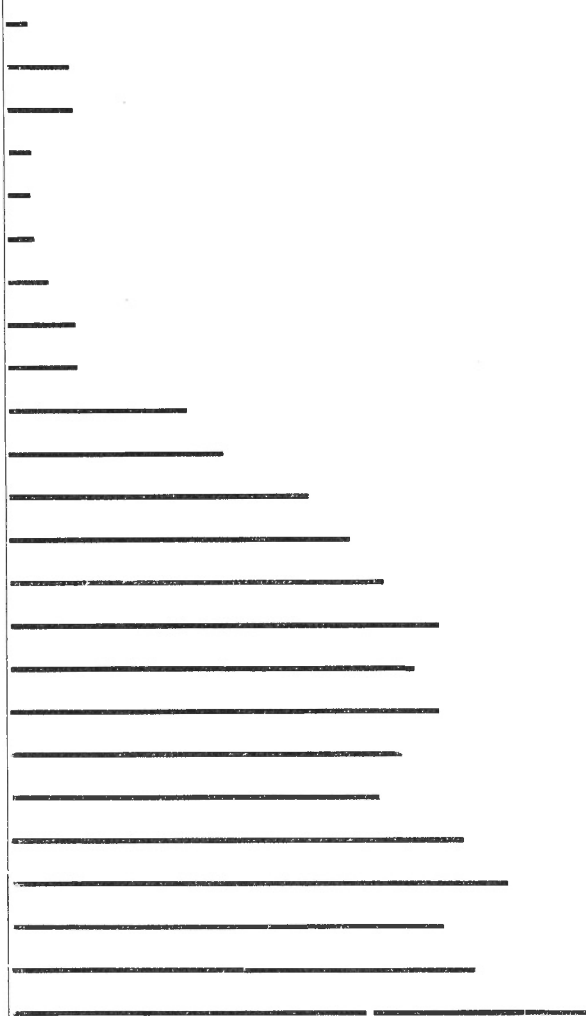


Table 2 below gives the export by provinces and explains itself, except that it should be borne in mind that the entries made under the heading of any given province do not necessarily or always represent coal produced in that province, for some coal is undoubtedly shipped to other provinces and exported thence, thus appearing under the head of the exporting rather than the producing province.

COAL. Exports by provinces.

Table 3 of exports not the produce of Canada is given as supplementing the previous one.

TABLE 2.

COAL.

EXPORTS. THE PRODUCE OF CANADA.

Provinces.	Calendar Year					
	1894.		1895.		1896.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
Ontario	104	$ 115	....	....	....	....
Quebec	7,600	22,995	148	$ 382	....	....
Nova Scotia ...	310,277	633,398	241,091	534,479	380,149	$ 787,270
New Brunswick	919	2,948	4,445	13,343	1,075	3,364
P. E. Island...	1,221	2,850	150	450	....	....
N. W. Ter.....	13,134	24,293	37,118	77,015	45,638	90,349
Brit. Columbia.	770,439	2,855,216	728,283	2,692,562	679,799	2,507,752
Total.......	1,103,694	$3,541,815	1,011,235	$3,318,231	1,106,661	$3,388,735

TABLE 3.

COAL.

EXPORTS. NOT THE PRODUCE OF CANADA.

Provinces.	Calendar Year.					
	1894.		1895.		1896.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
Ontario.........	83,599	$ 184,314	93,027	$ 191,783	112,539	$ 222,484
Quebec	5,338	11,378	2,956	6,139	28	160
Nova Scotia....	631	1,374	472	1,791	546	2,064
New Brunswick	218	577	380	1,019	3,661	9,432
Manitoba	....	....	1	13	....	....
Total........	89,786	$ 197,643	96,836	$ 200,745	116,774	$ 234,140

Table 4 gives the exports of coal from Nova Scotia and British Columbia from 1874 to 1896. An examination of the figures will show that the export trade for the former province, while varying considerably from year to year, has yet remained fairly uniform on an average. On the other hand, the exports from British Columbia have, with the exception of occasional years, maintained a steady and con-

COAL. Exports. British Columbia and Nova Scotia.

siderable increase. Thus the tonnage in 1896 was over thirteen times that of 1874.

TABLE 4.

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

*See foot note table 16.

The imports of the various grades of coal are to be found in the Tables Nos. 5, 6 and 7 below. From the figures in Table 5 it will be seen that since 1880 the imports of bituminous coal have increased 335 per cent. From 1886 there was a continual increase in the amount up to 1892, since which year the figures show a certain amount of rise and fall. The per capita consumption of imported bituminous coal has risen from a little over $\frac{1}{10}$th of a ton to nearly $\frac{3}{10}$ths in 1896.

GEOLOGICAL SURVEY OF CANADA.

SECTION OF MINERAL STATISTICS AND MINES.

Mineral Production of Canada, Calendar Years 1886 to 1896.

PRODUCTS.		1886. Quantity.	1886. Value.	1887. Quantity.	1887. Value.	1888. Quantity.	1888. Value.	1889. Quantity.	1889. Value.	1890. Quantity.	1890. Value.	1891. Quantity.	1891. 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	59,884	1,237,804	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	349,330	341,645	395,377	371,654	383,318	358,785	400,687	419,118	414,523	409,549
Total value, Metallic		...	*2,118,608	...	2,118,120	...	2,588,948	...	3,251,299	...	3,614,488	...	5,421,659
NON-METALLIC.													
Arsenic (white)	Tons.	120	(a) 5,460	30	(a) 1,200	†30	(a) †1,200	...	(a) ...	25	(a) 1,500	20	(a) 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	"	*4,000	*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	Brls.	...	(b)	*69,843	*81,909	50,668	35,593	90,474	69,790	102,216	92,405	93,473	108,561
" Portland	"												
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	...	2,118,120	...	2,588,948	...	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	...	11,365,705	...	12,479,550	...	14,013,913	...	16,763,353	...	18,976,616

PRODUCTS.	1892. Quantity.	1892. Value.	1893. Quantity.	1893. Value.	1894. Quantity.	1894. Value.	1895. Quantity.	1895. Value.	1896. Quantity.	1896. 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
Gold.	43,908	907,601	47,247	976,603	54,605	1,128,688	92,485	1,911,676	134,498	2,780,086
Iron ore.	103,248	263,866	125,602	299,368	109,991	226,611	102,797	238,070	91,906	191,557
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
Mercury.	...	...	...	...	...	...	5,431	2,343	4,437	1,940
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
Platinum.	...	3,500	...	1,800	...	950	...	3,800	...	750
Silver.	310,651	272,130	422,158	330,128	847,697	534,049	1,775,683	1,159,166	3,205,343	2,149,503
(Total value, Metallic)	...	3,698,697	...	4,630,495	...	4,688,551	...	6,153,469	...	8,055,945
Arsenic.	...	(a) ...	...	(a) ...	7	(a) 420	...	(a) ...	...	(a) ...
Asbestus.	6,082	390,462	6,331	310,156	7,630	420,825	8,756	368,175	12,250	429,856
Chromite.					1,000	20,000	3,177	41,300	2,342	27,004
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
Coke.	56,135	160,249	61,078	161,790	58,044	148,551	53,356	143,047	49,619	110,257
Felspar.	175	525	575	4,525	...	...	...	(k) 2,545	972	(k) 2,583
Fire clay.	1,991	4,467	540	700	539	2,167	1,329	3,492	842	1,805
Graphite.	167	3,763	...	...	69	223	220	6,150	139	9,455
Grindstones.	5,283	51,187	4,600	38,379	3,757	32,717	3,475	31,932	3,713	33,310
Gypsum.	241,048	241,127	192,568	196,150	223,631	202,031	226,178	202,608	207,032	178,061
Limestone.	22,967	21,492	27,797	27,519	35,101	34,347	34,579	32,916	37,462	36,140
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
Mica.	...	104,745	...	75,719	...	45,581	...	65,000	...	60,000
Baryta.	315	1,260	...	...	1,081	2,830	...	...	145	715
Ochres.	390	5,800	1,070	17,710	611	8,690	1,339	14,600	2,362	16,045
Mineral waters.	640,380	75,348	725,096	108,347	767,460	110,040	739,382	126,048	706,372	111,736
Molybdenite.	...	...	...	...	...	...	...	...	...	...
Moulding sand.	345	1,380	4,370	9,086	6,214	12,428	6,765	13,530	5,739	11,478
Natural gas.	...	150,000	...	376,233	...	313,754	...	423,032	...	276,301
Petroleum.	779,753	984,438	798,406	874,255	829,104	835,322	726,138	1,086,738	726,822	1,155,647
Phosphate.	11,932	157,424	8,198	70,942	6,861	41,166	1,822	9,565	570	3,420
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
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
Soapstone.	1,374	6,240	717	1,920	916	1,640	475	2,138	410	1,230
Bricks.	202,147	1,251,934	290,000	1,800,000	...	†1,800,000	308,836	1,670,000	...	1,600,000
Building stone.	...	609,827	...	1,100,000	...	1,200,000	...	1,095,000	...	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
" Portland.	29,221	52,751	31,924	63,848					78,385	141,151
Flagstones.	13,700	1,869	40,500	3,487	152,700	5,298	80,005	6,687	...	6,710
Granite.	24,302	89,326	22,521	94,393	16,392	109,936	19,238	84,838	18,717	106,709
Lime.	2,260,640	411,270	6,750,000	900,000	...	†900,000	5,225,000	700,000	...	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
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
Sewer pipe.	...	367,660	...	350,000	...	250,325	...	257,045	...	153,875
Slate.	5,180	69,070	7,112	90,825	...	75,550	...	58,900	...	53,370
Terra-cotta.	...	97,239	...	55,704	...	65,600	...	195,123	...	83,855
Tiles.	15,689	190,857	100,000	200,000	...	†200,000	19,200	210,000	...	225,000
Tripolite.	...	...	...	...	...	...	...	...	664	9,960
Whiting.	...	...	...	...	500	750	...	...	...	...
(Total structural materials and clay products)	...	3,603,455	...	5,133,946	...	5,004,408	...	4,726,368	...	4,327,542
(All other non-metallic)	...	9,076,265	...	10,020,641	...	9,990,898	...	9,585,482	...	9,976,338
(Total value, non-metallic)	...	12,679,720	...	15,154,587	...	14,995,306	...	14,311,850	...	14,303,880
(" metallic)	...	3,698,697	...	4,630,495	...	4,688,551	...	6,153,469	...	8,055,945
(Estimated value of products unspecified or not reported (m))	...	†250,000	...	†250,000	...	†250,000	...	†250,000	...	†250,000
(Grand total)	...	16,628,417	...	20,035,082	...	19,933,857	...	20,715,319	...	22,609,825

(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.

TABLE 5.
COAL.
IMPORTS OF BITUMINOUS COAL.

COAL.
Imports.

Fiscal Year.	Tons.	Value.
1880	457,049	$1,220,761
1881	587,024	1,741,568
1882	636,374	1,992,081
1883	911,629	2,996,198
1884	1,118,615	3,613,470
1885	1,011,875	3,197,539
1886	930,949	2,591,554
1887	1,149,792	3,126,225
1888	1,231,234	3,451,661
1889	1,248,540	3,255,171
1890	1,409,282	3,528,959
1891	1,598,855	4,060,896
1892	1,615,220	4,099,221
1893	1,603,154	3,967,764
1894	1,359,509	3,315,094
1895	1,444,928	3,321,387
1896........Duty, 60c. per ton.	1,538,489	3,299,025

A study of the figures in Table 6 brings to light the following interesting facts. Since 1880 there has been a steady increase in the importations of anthracite coal, with the exception of the years 1888 and 1895, in the former of which there was a very exceptional increase† and in the latter a slight falling off. The ratio of importation of anthracite coal per capita of the population of the country increased from about $\frac{12}{100}$ths of a ton in 1880 to a little over $\frac{30}{100}$ths of a ton in 1896.

TABLE 6.
COAL.
IMPORTS OF ANTHRACITE COAL.

Fiscal Year.	Tons.	Value.
1880	516,729	$1,509,960
1881	572,092	2,325,937
1882	638,273	2,666,356
1883	754,891	3,344,936
1884	868,000	3,831,283
1885	910,324	3,909,844
1886	995,425	4,028,050
1887	1,100,165	4,423,062
1888	2,138,627	5,291,875
1889	1,291,705	5,199,481
1890	1,201,335	4,595,727
1891	1,399,067	5,224,452
1892	1,479,106	5,640,346
1893	1,500,550	6,355,285
1894	1,530,522	6,354,040
1895	1,404,342	5,350,627
*1896........Duty free.	1,574,355	5,667,096

* Coal, anthracite, and anthracite coal dust. †There is some reason to believe this is due to typographical error in the Trade and Navigation Report.

COAL. Imports.

There is a yearly importation of small coal, classified by the Customs Department as "coal dust," as shown in Table 7, and in this also there has been a general increase since 1881.

TABLE 7.

COAL.

IMPORTS OF COAL DUST.

Fiscal Year.	Tons.	Value.
1880..	3,565	$ 8,877
1881..	337	666
1882..	471	900
1883..	8,154	10,082
1884..	12,782	14,600
1885..	20,185	20,412
1886..	36,230	36,996
1887..	31,401	33,178
1888..	28,808	34,730
1889..	39,980	47,139
1890..	53,104	29,818
1891..	60,127	36,130
1892..	82,091	39,840
1893..	109,585	44,474
1894..	117,573	49,510
1895..	181,318	52,221
1896.. Duty 20 p.c.	210,386	53,742

Taking the data given in the above tables and assuming that the figures of imports for the fiscal year as given in Tables 5, 6 and 7 above represent closely enough the importation of coal during the calendar year we have the consumption of the country for 1896 as follows:—

Home consumption.

	Tons.	
Production, Table A	3,745,716	
Exports of coal the produce of Canada, Table C.	1,106,661	
Home consumption of Canadian coal		2,639,055
Imports of bituminous, anthracite and coal dust, Tables 5, 6 and 7	3,323,230	
Exports of coal not the produce of Canada	116,774	
		3,206,456
Total consumption of coal in Canada, home and imported		5,845,511

Table 8, following, calculated on the same basis, gives the figures for the past ten years :—

COAL. Home consumption.

TABLE 8.

CONSUMPTION OF COAL IN CANADA.

Calendar Year.	Tons.
1886	3,480,111
1887	4,040,625
1888	5,328,278
1889	4,483,919
1890	4,941,383
1891	5,586,712
1892	5,546,441
1893	5,933,649
1894	5,661,194
1895	5,400,861
1896	5,845,511

From the eleven years covered by the figures given above, it will be seen that the consumption of coal in Canada has increased about 67 per cent. Calculating from estimates of the population furnished by the Census Department for the years 1886 and 1896 it will be found that the per capita consumption for the two years dealt with is as follows :—

TABLE 9.

PER CAPITA CONSUMPTION OF COAL IN CANADA.

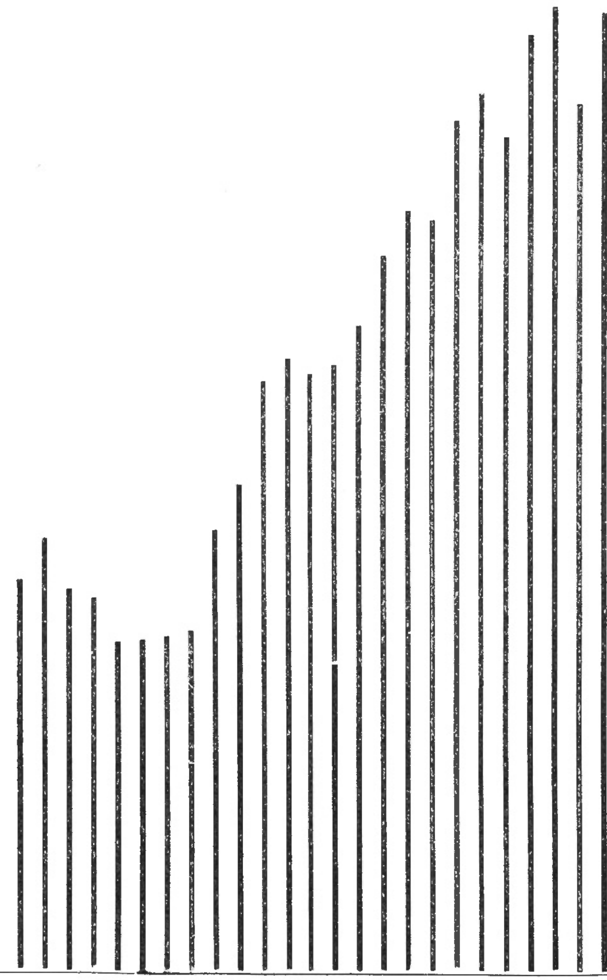
—	1886.	1896.	Increase over 1886, per cent.
	Tons.	Tons.	
Home product	0·347	0·514	48·1
Imported	0·411	0·626	52·3
Total	0·758	1·140	50·4

NOVA SCOTIA.

The growth of the coal mining industry of this province is well illustrated in Graphic Table E, below. Comparing 1896 with 1872, the first year given, we find an increase in the production of this province of 1,564,773 tons or almost 150 per cent.

COAL. Nova Scotia.

COAL.
NOVA SCOTIA.
ANNUAL PRODUCTION.
Table E.



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	866,220
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

Table 10 gives the detail of the production for past years as well as the total values for each, which it will be seen is based on an average value taken at $1.75 per ton. This table represents a thorough revision of the subject and comparison with the original data in the provincial reports.

COAL.
Nova Scotia.

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

* 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.

COAL. Nova Scotia.

Table 11 following, illustrating the production by districts, is self explanatory. In Table 12 the year's production is given for the different collieries which are again grouped under the heading of the districts where they are located :—

TABLE 11.

COAL.

NOVA SCOTIA :—COAL TRADE BY COUNTIES.

Calendar Year, 1896.	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..	148,397	130,881	94,029	92,930	122,340	67,786	1,198	470
2nd " ..	129,156	113,548	107,391	116,622	455,735	405,488	6,574	5,442
3rd " ..	107,920	94,289	118,133	97,363	643,553	631,101	8,016	7,941
4th " ..	132,678	113,597	106,015	67,975	382,016	342,833	4,743	4,181
Totals, 1896.	518,151	452,315	425,568	374,890	1,603,644	1,447,208	20,531	18,034
" 1895	542,202	470,520	455,956	405,203	1,229,146	1,123,689	12,423	8,857

TABLE 12.

COAL.

NOVA SCOTIA :—OUTPUT BY COLLIERIES DURING THE CALENDAR YEAR 1895.

Colliery.	Tons 2000 lbs.	Colliery.	Tons 2000 lbs.
Cumberland Co.		*Cape Breton Co.*	
Chignecto........	202	Sydney..........	312,069
Joggins.........	57,741	Dom. Coal Co.—	
Minudie..........	2,971	Old Bridgeport.	1,291,127
Scotia...........	1,196	Caledonia......	
Cape Breton......	19,518	Glace Bay......	
Springhill........	455,942	Gowrie	
		International...	
Pictou County.		Reserve.......	
		Victoria........	
Acadia...........	223,219	Hub...........	
Intercolonial.....	202,349	Dominion No. 1	
		Greener..........	448
Inverness County.			
		Total.........	2,567,796
Broad Cove	529		
Mabou...........	485		

Nova Scotia coal, as one would suppose, finds its chief market in the eastern provinces of Canada and the adjacent colony of Newfoundland, from five to ten per cent only going to the United States and about one-half per cent to the West Indies. The exact figures for 1895 and 1896 are given in Table 13 below :— Coal. Nova Scotia.

TABLE 13.

COAL.

NOVA SCOTIA :—DISTRIBUTION OF COAL SOLD.

Market.	Calendar Years.	
	1895.	1896.
	Tons 2000 lbs.	Tons 2000 lbs.
Nova Scotia, transported by land	388,625	378,500
" " sea	307,196	359,231
Total, Nova Scotia	695,821	737,731
New Brunswick	248,198	284,144
Prince Edward Island	73,706	69,547
Quebec	818,675	882,672
Newfoundland	86,919	104,048
West Indies	9,070	11,324
United States	75,881	202,981
Other countries	Nil.	Nil.
Total	2,008,270	2,292,447

NEW BRUNSWICK. New Brunswick.

The production of coal in New Brunswick shows a falling off of from 20 to 25 per cent in 1896 as compared with 1895. From a study of the figures in Table 14 following it will be seen that the industry is small, and while varying somewhat from year to year, has remained on the average in practically the same condition for the past ten years.

TABLE 14.

COAL.

NEW BRUNSWICK :—PRODUCTION.

Calendar Year.	Tons.	Value.
1887	10,040	$ 23,607
1888	5,730	11,050
1889	5,673	11,733
1890	7,110	13,850
1891	5,422	11,030
1892	6,768	9,375
1893	6,200	9,837
1894	6,469	10,264
1895	9,500	14,250
1896	7,500	11,250

Coal. Manitoba and North-west Territories.

Manitoba and North-west Territories.

The statistics of the coal mining industry of Manitoba and the North-west Territories are given in Table 15 following. They show an increase in the production of 1896 of about 22 per cent over 1895 and of about 205 per cent over 1887.

Table 15.

Coal.

North-west Territories :—Production.

Calendar Year.	Tons.	Value.
1887	74,152	$ 157,577
1888	115,124	183,354
1889	97,364	179,640
1890	128,953	198,498
1891	174,131	437,243
1892	184,370	469,930
1893	238,395	598,745
1894	199,991	488,980
1895	185,654	414,064
1896	225,868	606,891

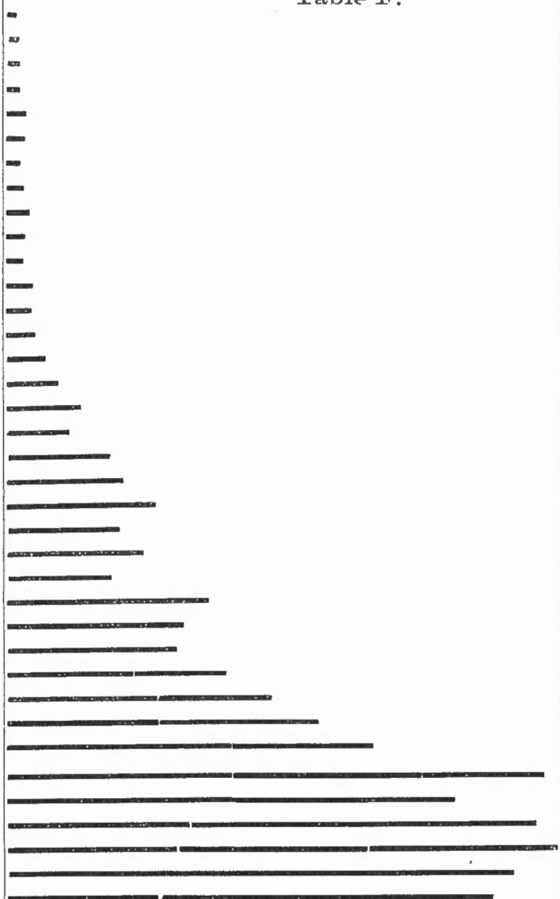
British Columbia.

A glance at Table F will show the fluctuations in the growth of the coal mining industry of this province for the past 60 years. It will be evident that on the average there has been a steady and considerable growth since the beginning, although in the last five years there is shown a falling off of about five per cent as compared with 1891. Comparing 1896 with 1876 there is shown an increase of about 540 per cent in the period of 20 years.

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 (1871–1873)
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



*Two months only.

Table 16, following, gives the details of the output, production, &c., for the same period of 60 years compiled from data contained in the "Mineral Wealth of British Columbia," by Dr. G. M. Dawson,* and in the reports of the Minister of Mines of the province. It represents a

*Part R. Ann. Rept., Geological Surv., Canada, 1887.

COAL British Columbia.

revision of the figures according to the latest data available. Similar details for each colliery for the past two years will be found in Table 17.

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, 2,240lbs.	Value.
						$	$
1836–52..	10,000				11,200	4 00	40,000
1852–59..	25,398				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	From 1836 to 1873 inclusive the output is taken as production.			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	2,980,254
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

*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 4, the only explanation being that the data in the two cases are from different sources, and there is no possibility of finding out the cause of the difference.

**Two months only.

TABLE 17.

COAL.

COAL British Columbia.

BRITISH COLUMBIA :—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

PRODUCTION, SALES, &c., FOR CALENDAR YEAR 1895.

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	378,782	113,287	262,440	4,039	7,094	1,087
Wellington	377,334	57,214	330,263	25,692	15,549	1,024
Union.........	296,296	40,450	254,390	13,477	14,933	813
Total	1,052,412	210,951	847,093	43,208	37,576	2,924

From the figures given in Table 16 it will be seen that the proportion of the production to be credited to home consumption is very small varying since 1874 by calculation between 20 and 30 per cent. This is of course as might be expected in view of the comparatively small population of the province and the prohibitive distance of the eastern home markets. With the advent, however, of increased activity in metal mining, accompanied by the use of steam power in mining and milling, the future should see a much larger home consumption, a condition which will be assisted by the contemplated construction of railway communication between the present mining centres in Kootenay and the coast.

About 60 per cent of the coal exported by the mines of the province went to the Californian market, the remainder being sold in the States of Oregon and Washington, and in Alaska, Petropaulovski and the Hawaiian Islands. The following figures give the consumption of coal

COAL. British Columbia.

in the Californian market for the year ending 31st December, 1896, and the sources from which it is supplied. From these it is evident that British Columbia coal occupies a prominent place, supplying as it does about 36 per cent of the total.

	Tons of 2,000 lbs.
British Columbia	618,074
Australia	306,707
English and Welsh	175,132
Scotch	9,359
Eastern (Cumberland and Anthracite)	20,056
Seattle, Franklin and Green River	144,387
Carbon Hill and South Prairie	285,928
Mount Diablo and Coos Bay	123,465
Japan	2,516
Total for the year 1896	1,685,624
" " 1895	1,653,520

Coke.

COKE.

The production of coke in 1896 shows a decrease of 3,737 tons, or nearly 7 per cent, whilst the decrease in value amounts to $32,790, or nearly 23 per cent. The figures for the current and past years are set forth in Table 1, below, from a study of which the progress of this industry can be seen. There is found to have been a steady increase in the production from 1886 to 1893, since which each subsequent year has shown a falling off. Future years should, however, show an increase in view of the possible demand for use in smelting the ores of the rapidly developing British Columbia mining districts.

Another reason for expecting an increased activity in coke production in the future lies in the recent organization of the People's Light and Heat Company of Halifax, N.S., which proposes to operate a coking plant at that place with a capacity of 15,000 to 20,000 tons, using Otto-Hoffmann ovens with some modifications, and besides other by-products, utilizing the gas for heating and lighting purposes in the city, working in conjunction with the electric light and street car service.

A similar effort will also be made in St. John, N.B.

TABLE 1.
COKE.
ANNUAL PRODUCTION.

COAL.
Coke.
Production.

Calendar Year.	Tons.	Value.
1886	35,396	$101,940
1887	40,428	135,951
1888	45,373	134,181
1889	54,539	155,043
1890	56,450	166,298
1891	57,084	175,592
1892	56,135	160,249
1893	61,078	161,790
1894	58,044	148,551
1895	53,356	143,047
1896	49,619	110,257

Table 2, below, taken in conjunction with Table 1, illustrates the demand for oven coke in Canada. It will be seen that there was a continuous increase in the use of foreign coke until 1893, after which year the importations were smaller until 1896, which witnessed not only a large actual increase, but also a reversal of the relative proportions of the home product and imported, the latter being for the first time greater than the former. This has been due to the greatly increased importations into Ontario, probably for use at the Hamilton smelter, and into British Columbia for use in smelting the sulphuretted ores of West Kootenay. The imports for the fiscal year 1896 into the former province shows an increase of about 30 per cent, and those of the latter are about ten times what they were in 1895.

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 .... Duty free	61,612	203,826

COAL.
Coke.

The customs figures for exports of coke during the calendar year show 57 tons, valued at $151. As, however, 52 tons of this are credited to Ontario and three tons to New Brunswick, where no oven coke is produced, it is evidently all gas coke, except perhaps the two remaining tons credited to British Columbia.

There is nothing particular to note about this industry apart from the continuance of the Nova Scotia operations, except the recent inauguration of coke manufacture by the Union Colliery Company of British Columbia. This company have now a plant of 100 ovens, having a double front, 50 on each side. The gas generated in the process is used for raising steam. According to the statement of the Inspector of Mines in the report of the Minister of Mines for the province, the coke made is of good quality, with about 8·5 per cent of fixed ash, and the company is finding a ready market for its product in the California market, and has good reason to believe it can successfully compete with coke from the United States in the rapidly growing home market.

The "screenings" obtained from the Luhrig coal washer recently installed by the company supply the material used in making the coke.

COPPER.

COPPER.

In Table 1 below will be found the figures for 1896 and previous years illustrative of the copper production of the country. This statement shows the fluctuation in production, both in amount, value and percentage. In this way the variations are clearly brought out, as well as their connection with the activity of the industry and fluctuation in the prices. It will be seen that at times decreases in the quantity produced have been more than made up by increases in the price. In comparison with 1895, the production for 1896 showed increases of 603,850 lbs. or 6·87 per cent in the quantity, and $76,246 or 8·06 per cent in the value, there having been a slight increase in the average market price.

TABLE 1.

COPPER.

ANNUAL PRODUCTION.*

COPPER.
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, 85	6·87	1,021,960	76,246	8·06	10·88

* 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.

Table 2 gives the figures of exports of copper in copper-bearing material from 1885 to 1896. These figures, however, are given for what they are worth, as they do not agree with the direct returns of production, especially for later years. In regard to the quantities stated as pounds of copper contained in ore, matte, &c., it is supposed that the entries are made in that way by the exporters, but there are evidently many errors, as the figures do not compare at all with those of production, although all the production is exported. Then as to the valuation, the basis adopted is quite different from that followed by this office. For these reasons, no comparison between the two sets of figures is possible.

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	1,625,389	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

The consumption of foreign copper and of manufactures of this metal in Canada is illustrated by the figures of imports given in Tables 3 and 4. The data taken from the reports of the Customs Department have been divided so as to separate highly manufactured goods from the metal in those cruder forms such as would be produced from smelting works operated in Canada. COPPER.

Taking into consideration, then, the home markets for metallurgical products, as shown in Table 3, we find that from 1880 to 1893 there was a decided growth, since which year the importations have averaged much lower. In the ten-year period—1887 to 1896—the range has been between $2,500 and $16,000, not a large sum. The imports of manufactures of copper in Table 4 are seen to total about $285,000 for last year. In the same period of years the lowest amount recorded was $123,060, in 1880, and the highest $563,-522, in 1891.

TABLE 3.

COPPER.

IMPORTS OF PIGS, OLD, SCRAP, ETC.

Imports.

Fiscal Year.	Pounds.	Value.
1880.	31,900	$ 2,130
1881.	9,800	1,157
1882.	20,200	1,984
1883.	124,500	20,273
1884.	40,200	3,180
1885.	28,600	2,016
1886.	82,000	6,969
1887.	40,100	2,507
1888.	32,300	2,322
1889.	32,300	3,288
1890.	112,200	11,521
1891.	107,800	10,452
1892.	343,600	14,894
1893.	168,300	16,331
1894.	101,200	7,397
1895.	72,062	6,770
1896 Copper, old and scrap.... Duty free.	38,100	3,406
1896 Copper in pigs.... do	48,600	5,784
1896 Precipitate of copper, crude.... do	205	36
Total, 1896....	86,905	$ 9,226

COPPER.
Imports.

TABLE 4.

COPPER.

IMPORTS OF MANUFACTURES.

Fiscal Year.				Value.
1880				$123,061
1881				159,163
1882				220,235
1883				247,141
1884				134,534
1885				181,469
1886				219,420
1887				325,365
1888				303,459
1889				402,216
1890				472,668
1891				563,522
1892				422,870
1893				458,715
1894				175,404
1895				251,615
		Duty.	Pounds.	
1896	Copper, ingots, sheets, plates and sheathing, not planished or coated	Free.	1,461,100	$168,421
1896	Copper nails, rivets and burrs	30 p. c.	....	2,132
1896	" wire	15 "	346,942	46,902
1896	" wire-cloth	20 "	....	4,540
1896	" all other manufactures of, N.E.S.	30 "	....	24,995
1896	" seamless drawn tubing	Free.	....	13,662
1896	" in bars, rods and bolts in lengths not less than six feet	"	205,100	24,282
1896	" rollers for use in calico printing	"	....	286
	Total, 1896	....	....	$285,220

Quebec.

QUEBEC.

The production of copper in this province represents, as in the past, the copper contents of the pyritous ores mined at Capelton and Eustis, near Sherbrooke, which are utilized in acid making, partly in Canada but the larger proportion in the United States.

This is an old established industry, the two mines situated one at Eustis and one at Capelton, having been operated for a long period of years. They have each a fully equipped mining plant, and as might be expected the underground developments are considerable. At Capelton they utilize part of the ore on the spot in their acid-making plant.

ONTARIO.

COPPER. Ontario.

There is nothing new to note in this province. The copper contained in the matte output of the nickel mines at Sudbury represents the whole production. These operations will be more fully described under the heading Nickel, so need not be further dealt with here.

There are, of course, other known deposits of copper bearing ores in Ontario, including the sulphuret ores at various points in the west and the native copper bearing rocks on the Canadian shores of Lake Superior, but for various reasons no profitable use has been made of any of these of late years.

BRITISH COLUMBIA.

British Columbia.

The production of this province, as elsewhere, represents the copper contained in the ores, matte, etc., produced from deposits mined primarily for other metals, so that the developments connected therewith will be more fittingly described under the heading of the Precious Metals.

An interesting feature is to be noted, however, in the fact that the province has only recently contributed to the copper production of Canada, and yet last year its output amounted to over 40 per cent of the whole. Taking the figures from the report of the Minister of Mines for the province, given below, we see that the production for 1896, compared with the first year 1894, shows an increase of 3,493,876 pounds, or, that since 1894 the production has increased nearly twelve times in quantity.

Table 5 below gives the details of the production of the province. The figures of the amounts and spot values are taken from the report of the Minister of Mines whilst the items in the last column represent the valuations of the metal on the basis elsewhere adopted in this report:—

TABLE 5.

COPPER.

PRODUCTION IN BRITISH COLUMBIA.

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

GRAPHITE.

GRAPHITE.

Production.

From the figures of production for this and past years given in Table 1, below, it will be seen that the graphite industry of Canada can hardly yet be said to be well established, both the amounts and value per ton varying greatly.

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*	69	223
1895	220	6,150
1896	139	9,455

*Exports.

The average value per ton, for the first three years given in the table, is about $8. After that a considerable rise is evident. The reason for this is to be found in the fact that in 1889 the Quebec mines began to contribute to the total, whilst previously the only production had been that of low grade mineral in New Brunswick. The Quebec product, being in general more highly prepared, brought an average price per ton varying from $60 to $80, thus raising the average value of the whole product.

In Table 2, below, will be found the quantities and values, for a number of years, of the shipments of graphite from Canada. Previous to 1896 the data entered under Ontario would represent altogether material mined in Quebec but entered for export at Ottawa.

TABLE 2.

GRAPHITE.

EXPORTS.

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	15	60	4,590	3,443	....	....
1893	....	....	12	38	....	....	....	....
1894	....	....	69	223	....	....	....	....
1895	1	8	1,087	4,825	....	....	....	....
1896 Crude	270	106	2,285	7,415	....	....	160	1,605
1896 Manufactu'd	....	....	....	3	....	351	....	....
	270	106	2,285	7,418	....	351	160	1,605

Graphite. Imports.

The imports of graphite, crude and manufactured, into Canada amounted last year to about $40,000 worth. The details of the imports are given below in Table 3 :—

TABLE 3.

GRAPHITE.

IMPORTS OF RAW AND MANUFACTURED PLUMBAGO.

Fiscal Year.	Duty.	Plumbago.	Manufactures of Plumbago. Black-lead.	Manufactures of Plumbago. 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 Plumbago, crude	10 p.c.	$2,865	....	....
1896 Black-lead	25 "	....	$18,434	....
1896 Plumbago, crucibles	Free.	....	....	$ 7,407
1896 Plumbago, manufactures of, N.E.S.	25 p.c.	....	....	12,090
Total, 1896	....	$2,865	$18,434	$19,497

During 1896 operations were carried on at the following places :—

Producers.

New Brunswick.—Marble Cove Mine, St. John, N.B., Canada Paint Co., 572 William Street, Montreal.

Quebec.—Buckingham Mine, 25 VI. Buckingham, the Buckingham Co.

North American Graphite Co., Buckingham, H. P. H. Brumell, Elgin Street. Ottawa.

Ontario.—Black Donald Mine, township of Brougham, Renfrew county, Ontario Graphite Co., Ltd., Hector McRae, Queen St., Ottawa.

GRAPHITE.
Occurrences,

The list given below gives the localities at which graphite has been reported to occur :—

	County.	Township.	Range.	Lot.
Quebec	Ottawa	Buckingham	IV.,	22, 24,
"	"	"	V.,	19, 20, 22, 23, 24, 27.
"	"	"	VI.,	22, 23, 24, 25, 26, 27, 28.
"	"	"	VII.,	4, 15, 16, 21, 22, 23, 24, 25, 26, 27, 28.
"	"	"	VIII.,	20, 21.
"	"	"	IX.,	4, 5, 17.
"	"	"	X.,	3, 4, 13, 17.
"	"	"	XI.,	4, 5.
"	"	Lochaber	VII.,	10, 24.
"	"	"	VIII.,	23, 24, 25.
"	"	"	X.,	28,
"	"	"	XI.,	23, 24, 25, 26.
"	"	"	XII.,	23.
"	"	Wakefield	I.,	7.
"	"	Hull		
"	Argenteuil	Grenville	II.,	3.
"	"	"	IV.,	13, 14.
"	"	"	V.,	10.
"	"	"	VI.,	1, 3.
"	"	"	X.,	3.
"	"	Wentworth	III.,	1, 2.
"	"	Chatham Gore	IX.,	5.
"	"	Petite Nation		
"	Pontiac	Litchfield	IX.,	25, 26.
Ontario	Frontenac	Loughboro'.	IX.,	6.
"	"	"		West side of Mud Lake.
"	"	Bedford	IX.,	18.
"	"	"		Bira Lake.
"	Lanark	South Burgess	I.,	10.
"	"	North Elmsley	VI.,	21.
"			Near Bob's Lake.	
"			Parry Sound, Georgian Bay.	
"			Robert's Bay.	
Nova Scotia	Inverness	Glendale.		
"	Cape Breton	French Vale.		
New Brunswick			Dumbarton Station, St. John.	
"			Woodstock.	
N. W. Territories			Reindeer Lake.	
"			North side of Athabasca Lake.	
"			Near Ashes Inlet, Hudson Strait.	
British Columbia			Alkow Harbour, Dean's Canal.	

QUEBEC.

Quebec.

The outlook in this industry is at present uncertain. For many years past the chief interest centred in the operations of the Walker Mining Co., in Buckingham township, Ottawa county, Quebec. These operations were much more extensive and continuous than those of the few other occasional operators, and it was hoped that through them the possibilities of putting Canada's graphite deposits to profitable use might be demonstrated. After a varied career extending over many years, during which the venture can hardly have been said to have passed out of the experimental stage, the mines were closed down in July, 1896.

GRAPHITE. Quebec.

In the summer of 1895, the North American Graphite Company opened on a deposit north of Donaldson's Lake in the same township, about three miles from the last mentioned. They erected a mill, which has been operated, with some idle intervals, during 1896.*

On the adjacent property a mill was erected some years since by Mr. Jacob Weart, of Jersey City, N.J., U.S.A. The intention was to produce graphite for use by the same company in the manufacture of self-lubricating bushings. This mill has only been operated, however, on a small scale and at intervals. It is at present owned by the Buckingham Co.

The operations above described constitute practically all that has been done to utilize the graphite deposits of the province of Quebec, with the exception of limited developments prosecuted from time to time at various points throughout the above-mentioned district.

The business interests of those responsible for the works carried on, of course, stand in the way of the acquirement of accurate details as to the results attained, but from what is publicly known it would seem as if they left the question of utilizing Canadian graphite deposits still in abeyance.

Some of the mineral produced and marketed was undoubtedly of good quality, as evidenced by the exhibits, of the companies mentioned, in the Museum of the Survey. It seems yet doubtful however if profitable results can be expected without a large and extensive plant and a capital sufficient to enable working to be carried on at a loss, perhaps for some years, until the methods of production are perfected, and the difficulties of introduction of the product into a closed market, strongly prejudiced in favour of other brands, can be overcome.

Ontario.

ONTARIO.

Besides those already mentioned in western Quebec a number of occurrences of graphite are known in the adjacent parts of eastern Ontario. Whilst a certain amount of development work was done on these in the past, of late years no attention was paid to them until the discovery of the deposit in Brougham township, Renfrew county, in 1895. The good showing at this place led to an effort being made to utilize it, and a company was formed to work it, known as the Ontario Graphite Company of Ottawa. This company has mined several hundred tons, some of which has been brought to Ottawa, where a small plant has been erected for experimental tests of the

*This company suspended operations in July of the present year (1897).

best methods of preparation for the material, which tests were still progressing at the end of the year. GRAPHITE Ontario.

This deposit is situated on lot 18, in range III., of Brougham township, and has been named the Black Donald. It was visited by Dr. Ells, of the Survey staff in 1896, who in the Summary Report of the department for that year thus describes it :—

"In the 18th lot of range III. of Brougham, at the south end of Whitefish Lake, an important deposit of graphite occurs. The containing rocks are crystalline limestone, but dykes of granite also appear in the vicinity. At the shore of the lake, the deposit has been uncovered to a distance of 150 feet or more, showing a bed of graphite eight to ten feet in thickness. The mineral appears to be, for the most part at least, amorphous, but a flakey structure is seen in certain portions. The mine is about twelve miles distant from the railway at Calabogie, and a new road has been constructed for the purpose of shipment. A small deposit of similar graphite occurs in the township of Darling, near Tatlock."

NEW BRUNSWICK. New Brunswick.

In New Brunswick work has been carried on with some intermissions near St. John, where graphite in a finely divided state is disseminated through the rock, and at a few points is found in beds of economic importance. The product is only hand-picked, and therefore none of the higher grades of mineral are produced.

NOVA SCOTIA. Nova Scotia.

Although there was no production of graphite proper in Nova Scotia, Mr. Hugh Fletcher, in the Summary Report of the Geological Survey for 1896, calls attention to the fact that graphitic shales have been worked near Christmas Island, among quartzites and dark slates underlying soft, red Carboniferous marl and conglomerate and perhaps of Cambrian age.

GYPSUM.

GYPSUM.

Gypsum is produced in Canada in Nova Scotia, New Brunswick and Ontario, and deposits of the mineral have been noted in Manitoba, the North-west Territories and British Columbia. Nova Scotia supplies nearly three-fourths of the total output.

GYPSUM.
Production.

TABLE 1.
GYPSUM.
ANNUAL PRODUCTION.

Calendar Year.		Tons.	Value.
1886		162,000	$178,742
1887		154,008	157,277
1888		175,887	179,393
1889		213,273	205,108
1890		226,509	194,033
1891		203,605	206,251
1892		241,048	241,127
1893		192,568	196,150
1894		223,631	202,031
1895		226,178	202,608
1896	Nova Scotia	136,590	111,251
	New Brunswick	67,137	59,024
	Ontario	3,305	7,786
Total, 1896		207,032	178,061

The following tables, Nos. 2, 3, 4, 5 and 6, give all the data available regarding exports and imports :—

Exports.

TABLE 2.
GYPSUM.
EXPORTS OF CRUDE GYPSUM.

Calendar Years	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

TABLE 3.

GYPSUM.

EXPORTS OF GROUND GYPSUM.

GYPSUM. Exports.

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

TABLE 4.

GYPSUM.

IMPORTS OF CRUDE GYPSUM.

Imports.

Fiscal Year.	Tons.	Value.
1880	1,854	$3,203
1881	1,731	3,442
1882	2,132	3,761
1883	1,384	3,001
1884		3,416
1885	1,353	2,354
1886	1,870	2,429
1887	1,557	2,492
1888	1,236	2,193
1889	1,360	2,472
1890	1,050	1,928
1891	376	640
1892	626	1,182
1893	496	1,014
1894		1,660
1895	603	960
1896 Duty free.	1,045	848

Gypsum.

Imports.

TABLE 5.

GYPSUM.

IMPORTS OF GROUND GYPSUM.

Fiscal Year.	Pounds.	Value.
1880	1,606,578	$ 5,948
1881	1,544,714	4,676
1882	759,460	2,576
1883	1,017,905	2,579
1884	687,432	1,936
1885	461,400	1,177
1886	224,119	675
1887	13,266	73
1888	106,068	558
1889	74,390	372
1890	434,400	2,136
1891	36,500	215
1892	310,250	2,149
1893	140,830	442
1894	23,270	198
1895	20,700	88
Duty 15 p.c.	*64,500	198

* 215 brls.

TABLE 6.

GYPSUM.

IMPORTS OF PLASTER OF PARIS.

Fiscal Year.	Pounds.	Value.
1880	667,676	$ 2,376
1881	574,006	2,864
1882	751,147	4,184
1883	1,448,650	7,867
1884	782,920	5,226
1885	689,521	4,809
1886	820,273	5,463
1887	594,146	4,342
1888	942,338	6,662
1889	1,173,996	8,513
1890	693,435	6,004
1891	1,035,605	8,412
1892	1,166,200	5,595
1893	552,130	3,143
1894	422,700	2,386
1895	259,200	1,619
1896 Duty 40c. per 300 lbs.	*297,000	2,000

* 990 brls.

GYPSUM.

NOVA SCOTIA.

Nova Scotia.

Gypsum is very largely developed in Nova Scotia. It occurs in extensive beds associated with Carboniferous limestone. It is abundant in Hants county in the vicinity of Windsor, Cheverie and Walton, and in the counties of Pictou, Colchester and Antigonish, and also throughout Cape Breton Island, notably at Mabou, Lennox Ferry and Baddeck. Large cliffs of gypsum form a very striking feature in several localities on the shores of Bras d'Or Lake. Most of the gypsum produced is exported to the United States in the raw state. The remainder is either burnt for plaster of Paris or used locally as land plaster. It is produced by open quarrying and little or no underground mining is done.

NEW BRUNSWICK.

New Brunswick.

There are abundant deposits of gypsum in New Brunswick underlying the Millstone Grit of the Carboniferous and also occurring at the top of the Lower Carboniferous formation. It is found in the counties of Albert, Westmoreland, King's and Victoria. The principal deposit worked is near Hillsborough, in Albert county, where the thickness of the bed varies from 70 to 100 feet. Part of this, however, is anhydrite.

The associated gypsum is mostly a pure white or slightly clouded alabaster. Calcination works were erected at Hillsborough in 1861, which have been working more or less constantly ever since. Workable beds occur upon the North River, a few miles from Petitcodiac Station on the Intercolonial Railway in Westmoreland county. The gypsum from this locality is highly crystalline. Large beds of gypsum also exist upon the Tobique River, in Victoria county.

ONTARIO.

Ontario.

A small amount of gypsum is mined yearly in Ontario, on the Grand River in the vicinity of Paris in Brant county, and Cayuga in Haldimand county. It is principally manufactured into "alabastine."

OTHER OCCURRENCES.

Specimens of gypsum are exhibited in the Geological Survey Museum from the following localities:—

Moose River, 38 miles above Moose Factory, district of Algoma, Ontario.

Lake St. Martin, about 10 miles west of the outlet of Little Saskatchewan River, Manitoba.

Peace Point, Peace River, N.W.T.

Salmon River, between the South Thompson and head of Okanagan Lake, B.C.

From the vicinity of Spence's Bridge, Thompson River, B.C.

IRON.

IRON.

Production.

During the year 1896 the production of iron ore in Canada shows a falling off of about 10 per cent. in the quantity and nearly 20 per cent. in the value, the output for 1895 being 102,797 tons valued at $238,070 as compared with 91,906 tons valued at $191,557 in 1896. The total output of pig iron, however, shows an increase of 14,814 tons, which is due to the opening of a blast furnace at Hamilton, Ont. The output of this furnace is much greater than the total increase for the year, so that the combined output of the older furnaces has decreased.

IRON.
Production.

IRON.

Annual Production of Ore.

Table A.

Calendar Year.	Tons.	Value.
1886	69,708	$126,982
1887	76,330	146,197
1888	78,587	152,068
1889	84,181	151,640
1890	76,511	155,380
1891	68,979	142,005
1892	103,248	263,866
1893	125,602	299,368
1894	109,991	226,611
1895	102,797	238,070
1896	91,906	191,557

IRON.
Production by Provinces.

In Table 1, following, will be found the contributions of the various provinces to the grand total. It will be seen that Nova Scotia leads with about 64 per cent, Quebec comes next with nearly 19 per cent, and Ontario with about 17 per cent.

TABLE 1.

IRON.

PRODUCTION OF ORE, BY PROVINCES, CALENDAR YEAR, 1896.

Provinces.	Tons.
Nova Scotia	58,810
Quebec	17,630
Ontario	15,270
British Columbia	196
Total	91,906

Nova Scotia.

In Nova Scotia there were two furnaces in blast during 1896. The Nova Scotia Steel Company of New Glasgow had one furnace in operation at Ferrona. About 75 per cent of the ore used was Canadian, while the remaining 25 per cent consisted of Newfoundland and Spanish ores. This is the only company that manufactures steel in Canada. The Londonderry Iron Company also had one furnace in blast, which, however, used Canadian ores entirely. In both of these furnaces the fuel employed is coke. The Canadian ores used by these two companies were supplied principally by the Torbrook Iron Company of Torbrook, Annapolis county, and the Pictou Charcoal Iron Company of Bridgeville, Pictou county. The furnace of this latter company was idle during 1896.

TABLE 2.

IRON.

NOVA SCOTIA :—ANNUAL PRODUCTION OF ORE.

Iron.

Nova Scotia

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

New Brunswick.

No iron is now mined in New Brunswick. A small stone furnace was run for a few years near Woodstock, Carleton county. The ores used were the hæmatites of the locality, mixed with bog ores from Maugerville, Sunbury county, on the St. John River. This furnace has now been out of blast for at least fifteen years.

Quebec.

In Quebec the furnace of the Canada Iron Furnace Company at Radnor Forges was in blast for eight months. The ores used are principally the bog and lake ores of the St. Maurice district, and the furnace has a daily capacity of about twenty-five tons. At Drummondville, Drummond county, Messrs. John McDougall & Company's furnace was in blast for twenty-one weeks during 1896. The bog iron deposits of this locality supply the ore for the furnace. The fuel used by this furnace as well as that at Radnor Forges is charcoal.

The Bristol Iron Company's magnetite mines at Bristol, Pontiac county, were reopened and worked, the output being shipped to the United States.

Ontario.

The opening of a blast-furnace at Hamilton, Ont., by the Hamilton Blast Furnace Company, has revived the mining of iron in that province. Mr. L. L. Brophy, who visited the furnace in the autumn of 1896, writes as follows in the Summary Report of the Survey :—"Their furnace was blown in on the 31st of December, 1895, though no pig

Ir n. Ontario.

iron was made until some weeks later. Production has, however, been going on continuously ever since. The ore used is derived both from Canada and the United States, the Canadian ore coming from the Wallbridge and other mines in Hastings, from the north shore of Lake Erie, between Port Rowan and Port Dover, and also from the district near Smith's Falls and Merrickville. The United States ore is obtained from Escanaba, Mich., and Two Harbours, Minn. The fuel used is entirely coke, which is procured from the Reynoldsville district in Pennsylvania, and costs, laid down at the works, about $3.60 per ton. The flux is a limestone obtained from Port Colborne, Ont." The amount of Canadian ore used in 1896 was about 37 per cent of the total ore charged.

Deposits of clay ironstone have been noted in many localities in Manitoba and the North-west Territories, but none of these have as yet been worked.

The Glen Iron Mine at Cherry Bluff, near Kamloops, British Columbia, was the only producing iron mine in that province during 1896. The output was used as a flux in the Tacoma smelter.

Table 3.

Iron.

Exports.

Exports of Ore.

Province.	Calendar Years.							
	1893.		1894.		1895.		1896.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.
Ontario	1,042	$ 4,083	23	$ 93	......	......	*10 33	$ 1,911
Quebec	......	......	......	13,813	......	......	......	......
Nova Scotia	2	6	......	......	......	......	......	......
Manitoba	30	86	......	......	......	......	......	......
British Columbia	1,345	3,415	878	7,388	1,571	$ 3,909	......	......
Total	2,419	$ 7,590	......	$21,294	1,571	$ 3,909	10 33	1,911

* Probably the product of the province of Quebec, shipped via Ontario.

TABLE 4.

IRON.

PIG IRON PRODUCTION: CONSUMPTION OF ORE, FUEL, &c.,

CALENDAR YEAR, 1896.

IRON.
Production.

Materials made and used.	Canadian.		Foreign.		Totals.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
		$		$		$
Pig iron made.... ....Tons	40,720	579,089	26,548	345,040	67,268	924,129
Iron ore consumed.... "	96,560	200,887	46,300	100,205	142,860	301,092
Fuel Consumed. Charcoal. Bush	756,600	32,256	....	.... .	756,600	32,256
Fuel Consumed. Coke.... Tons	48,660	106,939	33,990	109,253	82,650	216,192
Fuel Consumed. Coal..... "	1,407	2,288	.... ..	... .	1,407	2,288
Flux consumed....... "	37,462	36,140	....	....	37,462	36,140

A bounty of $2 a ton (2,000 lbs.) was paid by the Dominion Government on all pig iron made in Canada from Canadian ores. No bounty is paid on pig iron made from foreign ores.*

TABLE 5.

IRON.

EXPORTS OF IRON AND STEEL GOODS, THE PRODUCE OF CANADA,

CALENDAR YEAR, 1896.

Exports.

Province.	Scrap Iron.	Iron Stoves.	Iron Castings.	Iron, all other and hardware.	Steel and manufactures of.	Totals.
	$	$	$	$	$	$
Ontario.................	2,167	330	109,502	11,420	18,738	142,157
Quebec..............	1,519	682	42,862	50,521	4,455	100,039
Nova Scotia...............	....	2,282	1,493	14,851	12,051	30,677
New Brunswick......	144	....	....	7,460	....	7,604
Prince Edward Island. ...	....	1	....	....	....	1
Manitoba................	....	....	....	22	221	243
North-west Territories.....	159	10	8	....	1,413	1,590
British Columbia...........	1,510	....	....	309	166	1,985
Total	5,499	3,305	153,865	84,583	37,044	284,296

* By amendments to the tariff, made in April, 1897, this was altered to $3.00 per ton for pig iron produced from Canadian ores and $2.00 per ton for that produced from foreign ores.

TABLE 6.

IRON.

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, &c. (c)							
	Tons.	Value.						
		$						
1888	48,973	648,012	....	....	....	....	23,293	297,496
1889	72,115	864,752	....	....	....	....	26,794	335,090
1890	87,613	1,148,078	....	....	....	....	47,846	678,574
1891	81,317	1,085,929	....	....	....	....	43,967	652,842
1892	68,918	886,485	....	....	....	....	32,627	433,695
	Pig Iron.		Charcoal Pig Iron.		Cast Scrap Iron.			
	Tons.	Value.	Tons.	Value.	Tons.	Value.		
		$		$		$		
1893	56,849	682,209	5,944	84,358	729	9,317	45,459	574,809
1894	42,376	483,787	2,906	34,968	78	771	30,850	369,682
1895	(d) 31,637	341,259	2,780	31,171	643	4,347	23,390	244,388
1896	(d) 36,131	394,591	917	11,726	93	741	(e)13,607	157,996

(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. Duty 1896, $4 per ton.
(e) Scrap-iron and scrap-steel, old, and fit only to be re-manufactured, being part of or recovered from any vessel wrecked in waters subject to the jurisdiction of Canada. Duty—Free.

Wrought scrap-iron and scrap-steel, being waste or refuse fit only to be re-manufactured, the same having been in actual use, not to include cuttings or clippings which can be used as iron or steel without re-manufacture, and steel bloom ends and crop ends of steel rails. Duty—$4 per ton.

Iron or steel, being pieces, punchings or clippings of boiler plate or other plates, sheets or bars of iron or steel, whether the same have had the ragged or cropped ends or edges sheared off or not, and crops from iron or steel rails having both ends sawn or sheared off, the same not having been in actual use and being fit for re-rolling or re-manufacturing only. Duty—$4 per ton.

TABLE 7.

IRON. IRON.

IMPORTS OF FERRO-MANGANESE, ETC. Imports.

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 .....Duty—5 p. c.	652	12,811

*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.....Duty $5 per ton	128,535	110,757

*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.
Imports.

Tables 9*a* and 9*b* following have been compiled from data published in the Government Trade and Navigation Reports. The preceding tables, 6, 7 and 8, cover the importation of the cruder forms of iron and steel. Importations of more highly finished iron and steel goods are given below under a classification intended to show, roughly, the distinction between articles partially manufactured or the result of first processes, and those of a more highly finished character.

TABLE 9*a*.

IRON.

IMPORTS OF IRON AND STEEL GOODS.

Fiscal Year, 1896.		Duty (1896).	Quantity.	Value.
Swedish rolled iron rods, under ½ inch in diameter and not less than 1⅜c. per lb. value	Cwt.	15 p. c.	400	$ 916
Swedish rolled iron nail rods under half an inch in diameter, for manufacture of horse-shoe nails	"	15 "	21,064	31,998
Switches, frogs, crossings and intersections for railways	"	30 "	1,873	4,237
Steel rails weighing not less than 45 lbs. per lineal yard, for use in railway tracks	"	Free	1,043,511	1,034,578
Iron or steel railway bars or rails of any form, punched or not punched, N.E.S., for railways which term for the purposes of this item shall include all kinds of railways, street railways and tramways, even although the same are used for private purposes only, and even although they are not used or intended to be used in connection with the business of common carrying of goods or passengers	Tons.	30 p. c.	6,692	125,338
Railway fish-plates and tie-plates	"	$10 per ton	2,233	50,535
Rolled iron or steel angles, channels, and other sections, weighing less than 35 lbs. per lineal yard, N.E.S.	Cwt.	35 p.c. but not less than $10 per ton.	50,178	58,867
Rolled iron or steel angles, channels, and special sections, weighing not less than 35 lbs. per lineal yard	"	12½ p. c.	87,371	101,504
Rolled iron or steel beams, joists, girders, column sections, trough sections, and other building or bridge structural sections, weighing not less than 25 lbs. per lineal yard and rolled iron or steel bridge plate not less than ⅜ of an inch thick or less than 15 inches wide, and flat eye bar blanks not punched or drilled	"	12½ "	100,941	110,257
Carried forward				1,518,230

TABLE 9a—*Con.*

IRON.

IMPORTS OF IRON AND STEEL GOODS.

IRON.
Imports.

Fiscal Year, 1896.		Duty (1896).	Quantity.	Value.
Brought forward				$1,518,230
Iron or steel beams, sheets, plates, angles and knees for iron, steel or composite ships or vessels	Cwt.	Free	16,080	21,250
Locomotive and car-wheel tires of steel in the rough	"	"	13,367	32,697
Bar iron, rolled or hammered, comprising rounds, squares, shapes of rolled iron not more than four inches in diameter, and flats not thinner than No. 16 gauge, whether in coils, bundles, rods or bars, N.E.S	"	$10 per ton	66,971	120,552
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	"	$10 per ton	33,040	57,462
Iron bridges and structural iron work.	Lbs.	30 p.c. but not less than 1 c. per lb.	1,198,973	48,318
Hoop iron, not exceeding three-eighths of an inch in width and being No. 25 gauge or thinner, used for the manufacture of tubular rivets	Cwt.	Free	265	623
Iron or steel hoops, bands and strips, 8 inches and less in width, No. 18 gauge and thicker	"	$10 per ton	22,655	32,274
Iron or steel sheets, or other iron or steel of all widths, sheet iron, common or black, smoothed, polished, coated or galvanized and Canada plates, No. 17 gauge and thinner and hoop, band or strip, iron or steel, N.E.S	"	5 p. c	377,149	751,705
Plough plates, mould boards, land sides and other plates for agricultural implements, when cut to shape from rolled plates of steel but not moulded, punched, polished or otherwise manufactured, and being of a greater value than 4 cts. a lb.	"	5 "	5,090	29,572
Steel, valued at 2½ cts. per lb. and upwards, for manufacture of skates.	"	Free	2,384	10,185
Steel for saws and straw cutters, cut to shape but not further manufactured	"	"	7,655	63,265
Steel for the manufacture of hammers, augers and auger bits, when imported by the manufacturers of such articles, for use in their factories only	Cwt.	Free	2,360	4,758
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	"	"	1,358	1,630
Carried forward				$2,692,521

TABLE 9a—*Con.*

IRON.

Imports.

IRON.

IMPORTS OF IRON AND STEEL GOODS.

Fiscal Year, 1896.		Duty (1896).	Quantity.	Value.
Brought forward....		....	....	$2,692,521
Crucible sheet steel, 11 to 16 gauge, 2½ to 18 inches wide, imported by manufacturers of mower and reaper knives for manufacture of such knives in their own factories......	Cwt.	Free...........	5,182	17,136
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........................	"	"	1,357	4,040
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..............................	"	"	2,703	14,877
Steel of No. 12 gauge and thinner, but not thinner than No. 30 gauge, imported by manufacturers of buckle clasps and ice-creepers.....	"	"	287	1,332
Steel for the manufacture of files, when imported by file manufacturers for use in their factories......	"	"	2,906	10,090
Steel, chrome steel.	"	15 p.c....	941	6,218
Steel ingots, cogged ingots, blooms and slabs, or other forms less finished than steel bars, N.E.S.. .	"	$5 per ton........	28,831	31,847
Steel, bars rolled or hammered comprising rounds and squares, shapes of rolled steel not more than 4 inches in diameter, and flats not thinner than No. 16 gauge, whether in coils, bundles, rods or bars, N.E.S	"	$10 per ton	139,283	317,070
Steel plate, universal mill or rolled edge, less than thirty inches wide, and plates or sheets of iron or steel thirty inches wide and over, and one-quarter of an inch and over in thickness.....	"	12½ p.c....	137,885	155,624
Malleable iron castings and iron or steel castings, N.E.S............	"	25 "	27,304	80,653
Iron sand or globules and dry putty for polishing glass or granite......	"	Free..	3,353	3,003
Rolls of chilled iron or steel	"	35 p.c...........	1,792	5,157
Total........................		....	....	3,339,568

TABLE 9b.

IRON.

IMPORTS OF IRON AND STEEL GOODS.

Fiscal Year, 1896.		Duty (1896).	Quantity.	Value.
Wire, covered with cotton, linen, silk or other material	Lbs.	30 p. c.	494,525	$ 41,990
Wire, galvanized-iron, No. 6, 9, 12 and 14 gauge, when imported by makers of wire fencing, for use in their factories only	Cwt.	20 "	28,152	46,674
Steel wire, Bessemer soft drawn spring, of Nos. 10, 12 and 13 gauge, respectively, and homo steel spring wire of Nos. 11 and 12 gauge, respectively, when imported by manufacturers of wire mattresses, to be used in their own factories in the manufacture of such articles	"	Free	1,149	3,385
Wire of all kinds, N.E.S.	"	25 p. c.	93,742	119,683
Wire rope, of iron or steel, N.O.P.	"	25 "	4,317	31,221
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.	"	7,438	1,105
Wire rigging for ships and vessels	Cwt.	"	3,271	10,598
Wire fencing, barbed, of iron or steel	Lbs.	$\frac{3}{4}$c. per lb.	440,298	8,854
Wire fencing, buckthorn, and strip of iron or steel	"	$\frac{1}{2}$c "	4,688	90
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.	Free	1,260	2,777
Wire, crucible cast steel	Lbs.	"	412,905	26,456
Bar and round rods, galvanized	Cwt.	$27\frac{1}{2}$ p. c.	1,072	2,373
Chains, iron or steel, $\frac{5}{16}$ of an inch in diam. and over	"	5 p. c	25,223	62,102
Chains, N.E.S.	"	$27\frac{1}{2}$ p. c.	3,466	13,854
Forgings of iron and steel, of whatever shape or size, or in whatever stage of manufacture, N.E.S.	Lbs.	35 p. c. but not less than $15 per ton	719,670	37,240
Nails, spikes and sheating nails, composition	"	15 p. c.	17,907	2,177
Nails and spikes, wrought and pressed, galvanized or not, horse-shoe nails, and all wrought-iron or steel and other nails, N.E.S., and horse, mule and ox-shoes	"	30 "	655,096	20,015
Nails and spikes, cut, including railway spikes	"	$\frac{3}{4}$c. per lb.	755,168	15,932
Nails, wire	"	1c. "	268,536	9,008
Tacks, shoe, $\frac{1}{2}$ oz. to 4 oz. to the thousand	M.	1c. per M.	12,575	246
Carried forward				455,780

IRON.
Imports.

TABLE 9b—*Con.*

IRON.

IMPORTS OF IRON AND STEEL GOODS.

Fiscal Year, 1896.		Duty (1896).	Quantity.	Value.
				$
Brought forward				455,780
Cut tacks, brads or sprigs, not exceeding 16 oz. to the thousand	M.	1½c. per M.	47,330	1,980
Cut tacks, exceeding 16 oz. to the thousand	Lbs.	1½c. per lb.	21,285	1,421
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 planks, N.E.S.	"	1c. per lb. and 20 p. c.	1,086,411	38,638
Wrought-iron or steel nuts and washers, iron or steel rivets, bolts with or without threads, nut and bolt blanks, less than three-eighths of an inch in diameter	Lbs.	1c. per lb. and 25 p.c., but not less than 35 per cent.	105,204	7,685
Screws, iron and steel, commonly called "wood screws":—				
2 inches and over in length	"	3c. per lb. but not less than 35 p.c.	23,128	1,841
1 inch and less than 2 inches	"	6c. per lb. but not less than 35 p.c.	43,866	4,570
Less than 1 inch	"	8c. per lb. but not less than 35 p.c.	15,718	2,873
Tubing—				
Boiler tubes of wrought iron or steel, including corrugated tubes or flues for marine boilers	Feet.	7½ p. c.	2,072,303	127,432
Lap-welded iron or steel tubing, threaded and coupled or not, one and one-quarter to two inches inclusive in diameter, for use exclusively in artesian wells, petroleum pipe lines, and petroleum refineries	"	20 "	751,898	40,832
Tubes, not welded, not more than 1½ inches in diameter, of rolled steel	"	15 "	857,433	97,285
Tubing, wrought-iron or steel, threaded and coupled or not, over 2 inches in diameter	"	15 "	1,867,089	295,390
Other wrought-iron or steel tubes or pipes	Lbs.	$\frac{5}{10}$c. per lb. and 30 per cent.	7,632,761	174,450
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.	Free	1,724	3,869
Carried forward				1,254,046

TABLE 9b—*Con.*

IRON.

IMPORTS OF IRON AND STEEL GOODS.

IRON.
Imports.

Fiscal Year, 1896.		Duty (1896).	Quantity.	Value.
				$
Brought forward				1,254,046
Cast-iron pipes of every description	Cwt.	$10 per ton but not less than 35 p.c.	43,776	47,407
Fittings of wrought iron or steel pipe	Lbs.	35 p.c.	1,343,337	68,940
Tools and implements—				
Axes of all kinds, N.E.S.	Doz.	35 "	6,645	31,820
Saws	$	32½ "		84,543
Carpenters', coopers', cabinetmakers' and all other mechanics' tools, N.E.S.	"	35 "		220,745
Files and rasps	"	35 "		65,085
Picks, mattocks, grub hoes, adzes, hatchets and eyes or poles for same	"	35 "		6,043
Tools of all descriptions, N.E.S.	"	35 "		46,297
Track tools, wedges, crow-bars and sledges	"	30 "		3,684
Knife blades, or knife blanks, in the rough for use by electro-platers	"	10 "		1,445
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	"	27½ "		696,662
Pen knives, jack knives and pocket knives of all kinds	"	25 "		75,704
Table cutlery, N.E.S.	"	32½ "		77,079
All other cutlery, N.E.S.	"	25 "		113,831
Muskets, rifles and other fire-arms	"	20 "		117,275
Needles, sewing machine, and all other, N.O.P.	"	30 "		27,527
Needles, knitting	"	30 "		4,415
Surgical and dental instruments	"	15 "		46,846
Hardware, viz.: Builders', cabinetmakers', upholsterers', harness makers' and saddlers', including curry combs, carriage hardware, &c.	"	32½ "		291,841
Scales, balances and weighing beams.	"	30 "		21,325
Skates, of all kinds	Pairs.	10c. per pair and 30 p.c.	39,743	14,539
Stoves	$	27½ p.c.		55,390
Butts and hinges, N.E.S.	"	32½ "		10,023
Cast iron vessels, plates, stove plates and irons, sad irons, hatters' irons, tailors' irons	"	27½ "		9,033
Locks of all kinds	"	32½ "		57,351
Safes, and doors for safes and vaults.	"	30 "		4,878
Ware—stamped tinware, japanned-ware, galvanized iron ware, including signs made from these materials	"	25 "		27,622
Ware, enamelled iron or steel ware, including signs and letters enamelled on any metal and granite or agate ware	"	35 "		88,535
Carried forward				3,569,931

TABLE 9b—*Con.*

IRON.

Imports.

IRON.

IMPORTS OF IRON AND STEEL GOODS.

Fiscal Year, 1896.		Duty (1896).	Quantity.	Value.
				$
Brought forward				3,569,931
Machines and machinery, &c.:				
Windmills	No.	27½ p.c	446	19,135
Fanning mills	"	35 "	15	166
Portable machines:				
Horse-powers	"	30 "	16	1,017
Portable steam-engines	"	30 "	58	15,640
Portable saw-mills and planing mills	"	30 "	18	2,137
Threshers and separators	"	30 "	91	23,805
All other portable machines	"	30 "	1,487	53,955
Parts of above articles	$	30 "		40,220
Sewing machines, or parts of	No.	30 "	4,283	113,901
Machines, type-writing	"	27½ "	1,243	53,590
All other machinery composed wholly or in part of iron or steel, N.E.S.	$	27½ "		1,092,504
Agricultural implements, N. E. S., viz.:				
Binding attachments	No.	20 "	64	3,766
Cultivators	"	20 "	4,533	21,371
Drills, grain seed	"	20 "	1,628	40,496
Forks, pronged	"	35 "	27,315	6,408
Harrows	"	20 "	22,685	18,684
Harvesters, self-binding and without binders	"	20 "	1,201	131,080
Hoes	"	35 "	4,055	1,052
Horse rakes	"	20 "	747	13,583
Knives, hay	"	35 "	24	7
Lawn mowers	"	35 "	238	977
Mowing machines	"	20 "	2,172	72,338
Ploughs, sulky and walking	"	20 "	3,187	51,443
Rakes, N.E.S	"	35 "	5,765	983
Reapers	"	20 "	33	2,330
Scythes	Doz.	35 "	5,772	22,430
Spades and shovels and spade and shovel blanks, and iron or steel cut to shape for the same	"	50c. per doz. and 25 p.c.	6,273	24,115
Steel bowls, for cream separators	$	Free		35,508
All other agricultural tools or implements, N.E.S.	"	35 p.c.		35,135
Axles, springs and parts thereof, axle bars and axle blanks of iron or steel, N.E.S.	Lbs.	1c. per lb. and 20 p.c.	283,700	18,773
Axles, springs and parts thereof, axle bars and axle blanks of iron or steel, for railway or tram-way vehicles	Cwt.	$20 per ton but not less than 35 p.c.	9,331	19,448
Engines, locomotives and parts thereof, for railways	$	35 p.c.		80,102
Fire	No.	35 "	10	17,003
Other, and boilers, N.E.S.	$	27½ "		26,293
Fire extinguishers	"	35 "		3,595
Carried forward				5,632,921

TABLE 9b—*Con.*

IRON.

IMPORTS OF IRON AND STEEL GOODS.

IRON.
Imports.

Fiscal Year, 1896.		Duty (1896).	Quantity.	Value.
				$
Brought forward				5,632,921
Pumps, N.E.S.	"	30 "		70,711
Pumps, steam	No.	30 "	213	39,237
Mining and smelting machinery, which is at the time of its importation of a class or kind not manufactured in Canada	$	Free		193,098
Anchors	Cwt.	"	2,163	7,875
Iron or steel masts for ships, or parts of	"	"	60	70
Total				5,943,912

TABLE 10.

IRON.

IMPORTS OF PIG IRON, IRON AND STEEL GOODS, &C., CALENDAR YEAR, 1896.
RECAPITULATION OF TABLES 6, 7, 8, 9*a* AND 9*b*.

——	Tons.	Value.
		$
Pig iron and iron kentledge	36,131	394,591
" charcoal	917	11,726
Scrap iron, cast	93	741
" steel, wrought	13,607	157,996
Ferro-manganese, &c.	652	12,811
Iron in slabs, blooms, puddled bars, &c	128,535	110,757
Iron and steel goods, manufactured		3,339,568
" highly manufactured*		5,943,912
Total		9,972,102

* Machinery, &c., classed under iron and steel goods, in Customs report.

Lead.

LEAD.

Production.

The production of lead for 1896 was 24,199,977 lbs., and is greater than that of the previous year by 7,738,183 lbs., or 47 per cent. The above production was entirely from British Columbia, no lead being produced during the year either in Quebec or Ontario.

Table 1.

Lead.

Annual Production.

Calendar Year.	Pounds.	Price per Pound.	Value.
		cts.	
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

The table of exports below gives the figures as per entries made at the various ports by the shippers. They are of values only and it will be seen that they are much lower than those in Table 1, for the same periods. The reason for this is to be found in the different basis of valuation adopted. Table 1 gives, as in the rest of the Report, the full and final value of the lead in the ore, *etc.*, shipped. In Table 2, the lead contents have been valued by the various shippers at their spot value.

LEAD.
Exports.

TABLE 2.

LEAD.

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	Quebec	1,854
	Ontario	250
	British Columbia	459,991
Total, 1896		462,095

LEAD.
Imports.

TABLE 3.
LEAD.
IMPORTS OF LEAD.

Fiscal Year.	Old, Scrap and Pig.		Bars, Blocks, Sheets.		Total.	
	Cwt.	Value.	Cwt.	Value.	Cwt.	Value.
1880	....	....	....	....	30,298	$124,117
1881	16,236	$ 56,919	18,222	$70,744	34,458	127,663
1882	36,655	120,870	10,540	35,728	47,195	156,598
1883	48,780	148,759	8,591	28,785	57,371	177,544
1884	39,409	103,413	9,704	28,458	49,113	131,871
1885	36,106	87,038	9,362	24,396	45,468	111,434
1886	39,945	110,947	9,793	28,948	49,738	139,895
1887	61,160	173,477	14,153	41,746	75,313	215,223
1888	68,678	196,845	14,957	45,900	83,635	242,745
1889	74,223	213,132	14,173	43,482	88,396	256,614
1890	101,197	283,096	19,083	59,484	120,280	342,580
1891	86,382	243,033	15,646	48,220	102,028	291,253
1892	97,375	254,384	11,299	32,368	108,674	286,752
1893	94,485	215,521	12,403	32,286	106,888	247,807
1894	70,223	149,440	8,486	20,451	78,709	169,891
1895	67,261	139,290	6,739	16,315	74,000	155,605
1896	*72,433	173,162	†8,575	23,169	81,008	196,331

* Duty, 40c. per 100 lbs. † Duty, 60c. per 100 lbs.

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

		Duty.	
1896.	Lead, Tea	Free	....
	" Pipe	$\frac{4}{10}$c. per lb. and 25 p. c.	$ 1,790
	" Shot	" " " "	1,219
	" Manufactures, N.E.S.	30 p. c.	39,769
		Total	$42,778

MANGANESE.

MANGANESE.

Manganese has been found in Canada in the provinces of Nova Scotia, New Brunswick, Quebec, Ontario and in the North-west Territories. It is only, however, in Nova Scotia and New Brunswick that it has been profitably mined. The most important manganese ore is pyrolusite with which manganite is usually associated. Deposits of wad or bog manganese, an earthy hydrated oxide of manganese, also occur in many localities.

NOVA SCOTIA.

Nova Scotia.

Considerable quantities of wad or bog manganese have been found in Nova Scotia, and many brown hæmatites contain manganese, the peroxide in some running as high as 14 per cent. Pyrolusite, however, is the only ore that has as yet paid for mining. The deposits of this mineral are very irregular. It occurs in small pockets and veins penetrating granite and also in the quartzites of the Lower Cambrian. The most extensive deposits, however, are found in the marine limestone of the Lower Carboniferous.

The small amount of manganese produced in Nova Scotia during 1896 was obtained mainly from Tennycape, in Hants county. Manganese ores were discovered in this locality about the year 1862, and have been worked with more or less regularity ever since. The ore is chiefly pyrolusite with some psilomelane and manganite, and yields from 88 to 95 per cent of available oxide. It has sometimes run in value as high as $125 to the ton. The following analyses of manganese ores from the Tennycape district, are taken from the mineral resources of the United States, 1894 :—

Analyses.

——	Douglas.	Cheverie.
Moisture	1·660	2·05
Water of composition.	3·630	....
Iron peroxide	·603	2·55
Oxygen	7·035	....
Baryta	·724	1·12
Insoluble matter	1·728	2·80
Phosphoric acid	....	1·029
Manganese oxides	84·620	....
Peroxide of manganese	....	90·15
Lime	....	Trace.
Total	100·000	99·699

MANGANESE. Manganese has also been found in Nova Scotia in King's county near Cornwallis and Wolfeville, at Musquodoboit and at Ship Harbour. It is found at many localities in Hants and Colchester counties, and occurs in workable quantities at Loch Lomond and Cheticamp in Cape Breton Island. A sample of ore from the Mira Hills, near Loch Lomond in Cape Breton county, gave on analysis 81·52 per cent manganese dioxide (G. S. C. Report, 1879-80, p. 174). Another analysis of ore from the same locality gave :

Manganese dioxide....	88·98	per cent.
Ferric oxide..................	0·21	"

In a letter received from Mr. H. Fletcher he speaks of the manganese ore of Mr. E. T. Moseley's mine at Loch Lomond, C.B., as follows :—" The quality is good though it is not crystallized or fibrous like that of Tennycape. The quantity is, from its mode of occurrence, uncertain, so that its being profitably worked might depend, as at Tennycape, on the extraordinary purity of the ore. At the latter mines, I understand, the ore cannot be mined at a profit unless it can be sold for about a hundred dollars a ton and one year it brought $140. The cost of mining will depend on the quantity. There is every facility for tramming and shipping."

New Brunswick.

NEW BRUNSWICK.

Manganese is found in the southern part of New Brunswick, underlying the Carboniferous Limestone. The most important deposit known in this province was discovered in 1862, at Markhamville, near the town of Sussex, King's county. The ore, which is a very pure pyrolusite, occurs in beds and pockets, as much as 4,000 tons having been produced from one pocket. The following analyses of high-class Manganese ores from Markhamville are taken from the Mineral Resources of the United States, 1894.

Analyses.

	No. 1.	No. 2.	No. 3.
	Per cent.	Per cent.	Per cent.
Manganese peroxide......	98·70	97·25	96·62
Silica..................	·55	....	....
Iron............... ...	·75	....	....
Iron peroxide	....	·85	·78
Baryta and Silica	Trace.	·95	·85
Water......	....	Trace.	Trace.
Loss..........	....	·95	1·75
Total.....	100·00	100·00	100·00

A small amount of work has been done at Jordon Mountain near Sussex and at Quaco Head opposite St. Martins on the Bay of Fundy. Considerable quantities of ore have been obtained from Shepody Mountain in Albert county. The only locality known in New Brunswick where manganese is found outside of the Carboniferous formation is at Gowland mountain. MANGANESE.

OTHER PROVINCES.

Manganese occurs, principally as wad, along with many of the bog iron ores and ochres in the province of Quebec, and small amounts have been mined from time to time, but the deposits are of comparatively little importance. At Sutton, Brome county, manganese is found in dolomite in the form of a carbonate.

Wad has been noted in Ontario in the township of Madoc, and manganite at Bachewaning Bay, on Lake Superior.

Further details regarding manganese in Canada will be found in the Report of this Section for 1890. (Annual Report, Geol. Surv. Can., N.S., Vol. V., pp. 92 s to 101 s.)

The statistics of the production, etc., are given in Tables 1, 2 and 3 following.

From a study of Tables 1, 2, it will be evident that the industry has been very irregular, with a decided falling off, during the last six years.

There has been a general tendency, however, toward an increased home consumption, as shown by the imports given in Table 3.

TABLE 1.

MANGANESE.

ANNUAL PRODUCTION. Production.

Calendar Year.	Tons.	Value.
1886	1,789	$41,499
1887	1,245	43,658
1888	1,801	47,944
1889	1,455	32,737
1890	1,328	32,550
1891	255	6,694
1892	115	10,250
1893	213	14,578
1894	74	4,180
1895	125	8,464
1896*	123½	3,975

*Exports.

TABLE 2.

MANGANESE.
Exports.

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

(*a*) 250 tons from Cornwallis should more correctly be classed under the heading of mineral pigments.

TABLE 3.

Imports.

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 .... duty free	108,590	4,075

MERCURY.

Mercury.

Occurrences.

The only deposits of mercury ore worked in Canada are in the vicinity of Kamloops Lake, B.C. The deposit at this locality has already been described in the Report of this Section for 1892. Dr. G. M. Dawson, who visited it in 1894, gives further particulars as follows (Annual Report, Geol. Surv., Can., N.S., Vol. VII., p. 340B.):—"What may prove to be an important deposit of cinnabar has lately been found in the vicinity of Copper Creek, Kamloops Lake, and several contiguous claims have been taken up on this, on the west side of the valley of the creek, near its mouth. The claims, have, I believe, been combined in a single property, but the best looking deposit of ore occurs on the Rosebush claim, where a shaft about fifty feet deep, connecting below with a drift more than fifty feet long, had been opened. The height of this place is about 450 feet above the lake. Other small openings have been made in the same vicinity, as well as a second shaft, thirty-five feet deep, on the Yellow Jacket claim, about a quarter of a mile northward of the Rosebush.

"The cinnabar occurs in irregular, sparry veins, consisting chiefly of calcite and quartz, with some dolomite, traversing zones of a gray felspathic and dolomitic rock, which readily weathers to a yellowish colour. Both these zones and the contained veins, as a rule, run nearly magnetic north-and-south through the main rock of the hills, which is a dark greenish-black, Tertiary eruptive, containing pyroxene and olivine........but much decomposed. A considerable quantity of rich ore has been taken from the wider portions of the main vein opened on the Rosebush. Although the slopes of the hills are abrupt, they are almost everywhere covered with drift deposits, and much more work is necessary in order that the true value of the deposit may be ascertained. Exploratory trenching in an east and west direction would be the most economical method in the first instance. A little antimony sulphide (stibnite) is observable in some parts of the ore.

"Another claim, upon which very little work has been done, is the Last Chance, No. 2, situated on the east side of Copper Creek, near the junction of the Tertiary volcanic rocks with a small area of decomposed granite. Small quantities of cinnabar are found here, and some narrow seams of molybdenite also occur. In the adjacent granitic mass, minute bright red specks of cinnabar may also be detected, and

MERCURY. Occurrences.

it would appear that the extensive decomposition of the basic volcanic rocks of this region, by heated waters or steam, has led to the diffusion of a certain quantity of cinnabar through some parts of both classes of rocks, and to its concentration in some of the veins.

"Decomposition of a similar character has affected the rocks seen on the opposite side of Kamloops Lake, along the railway, to the east of the mouth of Cherry Bluff Creek. No cinnabar has been observed here, but distinct traces of cinnabar are found in seams cutting some of the rocks at Six-mile Point, also on the south shore, but further to the west.

"I have also been informed that grains of cinnabar have been observed in washing for gold on Criss Creek, to the north.

"These occurrences, taken together, indicate that search for cinnabar may be made with some prospect of success, over a considerable area, in this vicinity."

Since the above was written it was reported that cinnabar had also lately been found in rocks about four miles further up the Copper Creek valley on its west side.

The Rosebush, Yellow Jacket, Blue Bird and Lake View claims were sold in the summer of 1895 to the Cinnabar Mining Company of British Columbia.

During August, 1895, a discovery of cinnabar was made on Hardie Mountain, about three miles north of the Cinnabar Mining Company's property. Another discovery of this mineral was reported in the autumn of 1896 in the vicinity of the Nanaimo lakes.

Other localities from which specimens of cinnabar have been obtained are as follows:—Ebenezer Mine, Hector, Kicking Horse Pass, two and a half miles east of Golden; north side of Homathco River; eastern entrance of Seshart Channel, Barclay Sound, Vancouver Island; Timothy claim, west side of Read Island, north-east coast of Vancouver Island. All the above are in British Columbia.

Tables 1 and 2 following give the production and imports of mercury. From the former it is evident that but little has been done to develop our own deposits, whilst a study of the latter shows that there is a steadily growing demand in Canada. With the growth of the mining industry in the country there should continue to be an increase in the demand for use in the milling of certain classes of ores of the precious metals.

TABLE 1.

MERCURY.

PRODUCTION.

MERCURY. Production.

Calendar Year.	Flasks, (76½ lbs.)	Price per flask.	Value.
1895	71	$ 33 00	$ 2,343
1896	58	33 44	1,940

TABLE 2.

MERCURY.

IMPORTS.

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 ......Duty free	77,869	32,343

MICA.

MICA.

The three principal varieties of mica that are of economic importance are muscovite, the potash mica, phlogopite, the magnesia mica, and biotite, the magnesia-iron mica. The biotite, however, is found to be less suitable to electrical construction than muscovite and phlogopite.

The value of mica varies greatly with the colour, transparency, cleavability, toughness, and size when cut. A clear mica, roughly split and untrimmed, that will cut 2 in. by 4 in., will be worth at the mine about six cents per pound, while the same mica if cutting 5 in. by 7 in. will be worth sixty cents per pound. By trimming the edges this latter increases in value to $1 or $1.50 per pound of finished product. These were approximately the prices that ruled during 1895 in the Canadian market.

MICA.

Mica is used principally as an electrical insulator. For this purpose there is a constant demand for the best varieties, as no other material has yet been found that will satisfactorily take its place. For some electrical purposes, however, micanite is now employed. This is a sheet mica which is built up from small pieces of mica that would otherwise be discarded as refuse. It can be moulded, and can be made of any size and thickness. There are many other uses to which mica is put, such as the manufacture of stove windows, lamp chimneys, fire screens, spectacles for metal workers, and as a lubricant and ingredient of paints and fire-proof cements. For some of these purposes the inferior grades of mica can often be employed.

Mica was produced in 1896 in the following townships in Ontario :— Levant, South Canonto, Loughboro', in Frontenac county ; Burgess, in Lanark county ; Cardiff, in Haliburton county ; and in Quebec in Templeton and Hull, Ottawa county. Most of the mica from these localities was the phlogopite or amber variety. Deposits of muscovite are found on the north shore of the St. Lawrence east of the Saguenay river, but very little work appears to have been done here during the year. Muscovite was formerly mined in Ottawa county in the townships of Villeneuve and Aylwin, and it has been found in Ontario in Miller township, Frontenac county.

The only available data regarding production, etc., are to be found in Tables 1 and 2 below. It is found very difficult to get complete and accurate figures of production, and those given represent the exports plus the known consumption in the country. It is believed, however, that the exports are very much undervalued, and in fact some of those conversant with the industry claim that the value of the mica marketed from Canadian mines is nearer double what is reported below. As no actual proof of this is available it is considered better to let the figures stand.

Production.

TABLE 1.
MICA.
ANNUAL 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

TABLE 2.

MICA.

EXPORTS.

Mica.

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

MINERAL PIGMENTS.

Mineral Pigments.

Production of ochres.

Ochres.—The production of ochres during the year 1896 was 2,362 tons, valued at $16,045, which was an increase of 1,023 tons in quantity, and $1,445 in value over the production of 1895.

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

MINERAL PIGMENTS.

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
	Duty.		
1896 Ochres and ochrey earths and raw siennas	20 p. c.	350,045	$ 2,995
1896 Oxides, dry fillers, fire-proofs, umbers and burnt siennas, N.E.S.	25 "	809,449	13,959
Total, 1896		1,159,494	$16,954

Baryta.—The production of baryta in Canada of late years has been of a very intermittent character. The small production reported for 1896, viz., 145 tons was only 13 per cent of the production of 1894, while no production whatever was reported for 1895.

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

TABLE 4.

MINERAL PIGMENTS.

IMPORTS OF BARYTA.

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, 1896.

Miscellaneous Imports.

—		Duty.	Quantity.	Value.
Paint, ground or mixed in, or with either japan, varnish, lacquers, liquid dryers, collodion, oil finish or oil varnish..	Lbs.	25 p. c....	19,781	$ 3,062
Paints and colours, and rough stuff and fillers, N.E.S.	"	25 "	39,786	2,882
Paris green, dry	"	10 "	351,934	34,814
Paints and colours ground in spirits, and all spirit varnishes and lacquers	Galls.	$1.12½ per gall.	787	2,220
Putty	Lbs.	15 p. c.. .	118,925	1,878
Colours, metallic, viz.: Oxides of cobalt, tin and copper, N.E.S.	"	Free	43,860	9,311
				$ 54,167

Litharge.—Litharge or oxide of lead (Pb O) has not as yet been manufactured in Canada. The following table gives the figures for imports of this material, showing a slight falling off for the year 1896. One third of the total amount brought into the country was absorbed by the Canadian oil refineries being used in the refining of crude petroleum.

Litharge.

MINERAL PIGMENTS.

Imports of Litharge.

TABLE 6.

MINERAL PIGMENTS.

IMPORTS OF LITHARGE.

Fiscal Year.	Cwt.	Value.
1880	3,041	$14,334
1881	6,126	22,129
1882	4,900	16,651
1883	1,532	6,173
1884	5,235	18,132
1885	4,990	16,156
1886	4,928	16,003
1887	6,397	21,865
1888	7,010	23,808
1889	8,089	31,082
1890	9,473	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 ....Duty free.	10,710	32,817

MINERAL WATERS.

MINERAL WATERS.

The production of mineral waters in Canada for 1896 shows a decrease when compared with that of 1895, while the imports show an increase.

The production reported for the year was from the provinces of New Brunswick, Quebec and Ontario.

The following is a list of producers from whom production returns were received for 1896 :—

Producers.

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.
Quebec	St. Leon Mineral Springs Co.	St. Leon	St. Leon Mineral Springs Co.	Toronto.
"		Richelieu	J. H. M. Hart	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 & Sons	Eastman's Springs
"		Ancaster	R. A. Smith	Ancaster.
"	Eudo Mineral Water Co.	Eudo	L. Forrest	Toronto.
"		Winchester	W. J. Anderson, M.D.	Smith's Falls.
"		Wensley's	Mrs. E. Wensley.	Camperdown.

MINERAL WATERS.

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

Imports.

TABLE 2.

MINERAL WATERS.

IMPORTS.

Fiscal Year.		Duty.	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.	Mineral waters, natural, not in bottles	Free	$ 1,306
	Mineral and aerated waters, N.E.S.	20 p. c.	54,558
			$55,864

MISCELLANEOUS.

MISCELLANEOUS.

Production of Antimony.

Antimony.—The most important locality in which antimony has been produced in Canada was at West Gore, Rawdon, Hants county, N.S. In 1887 the industry had assumed considerable proportions, but since that time it has gradually fallen off, and there has been no production since 1891. The production since 1887 is as follows, and is the result of operations in the province of Nova Scotia :—

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

Exports of Antimony.

TABLE 2.

MISCELLANEOUS.

EXPORTS OF ANTIMONY ORES.

Calendar Year.	Tons.	Value.	Calendar Year.	Tons.	Value.
1880.........	40	$ 1,948	1886.........	665	$31,490
1881.........	34	3,308	1887.	229	9,720
1882.........	323	11,673	1888.........	352½	6,894
1883.........	165	4,200	1889.........	30	695
1884.........	483	17,875	1890.	38	1,000
1885.........	758	36,250	1891*........	3½	60

* No exports since 1891.

TABLE 3

MISCELLANEOUS.

IMPORTS OF ANTIMONY.

MISCELLANEOUS.

Imports of Antimony.

Fiscal Year.	Pounds.	Value.
1880	42,247	$ 5,903
1881	....	7,060
1882	183,597	15,044
1883	105,346	10,355
1884	445,600	15,564
1885	82,012	8,182
1886	89,787	6,951
1887	87,827	7,122
1888	120,125	12,242
1889	119,034	11,206
1890	117,066	17,439
1891	114,084	17,483
1892	180,308	17,680
1893	181,823	14,771
1894	139,571	12,249
1895	79,707	6,131
*1896 ....Duty feee	163,209	9,557

* Antimony, not ground, pulverized or otherwise manufactured, and antimony salts.

Arsenic.—There was no production of white arsenic in Canada during 1896. The following table gives the production in former years :—

TABLE 4.

MISCELLANEOUS.

ANNUAL PRODUCTION OF ARSENIC.

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	"	"

MISCEL-LANEOUS.

Imports of Arsenic.

TABLE 5.

MISCELLANEOUS.

IMPORTS OF ARSENIC.

Fiscal Year.	Pounds.	Value.
1880	18,197	$ 576
1881	31,417	1,070
1882	138,920	3,962
1883	51,953	1,812
1884	19,337	773
1885	49,080	1,566
1886	30,181	961
1887	32,436	1,116
1888	27,510	1,016
1889	69,269	2,434
1890	138,509	4,474
1891	115,248	4,027
1892	302,958	9,365
1893	447,079	12,907
1894	292,505	10,018
1895	1,115,697	31,932
1896 ....Duty Free	664,854	27,523

Felspar.—The amount of exports of felspar has been taken to represent the production for 1896, as the direct returns received were known to be incomplete.

Production of 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

* Exports.

Fireclay.—The production of fireclay for 1896 shows a very decided decrease from that of 1895. Returns were received from the provinces of Nova Scotia, New Brunswick and British Columbia. The fireclay is found in the coal measures of these provinces.

TABLE 7.

MISCELLANEOUS.

PRODUCTION OF FIRECLAY.

MISCELLANEOUS.

Production of Fireclay.

Calendar Year.	Tons.	Value.
1889........	400	$4,800
1890........	nil.	nil.
1891........	250	750
1892........	1,991	4,467
1893........	540	700
1894........	539	2,167
1895........	1,329	3,492
1896........	842	1,805

Magnesite.—Magnesite or carbonate of magnesia ($MgCO_3$) was formerly employed mainly in the production of magnesian salts, such as epsom salts (sulphate of magnesia). Laterly, however, besides being extensively used as a bleaching agent for wood pulp in the manufacture of paper, it has been found to be an excellent refractory material. For hearths of basic steel furnaces, it is superior to anything previously employed. It is also claimed that it is eminently adapted to the manufacture of a Portland cement, which is intended to withstand the corroding action of salt water.

Magnesite.

Magnesite has been mined for many years in Austria, Germany and Greece. In America its mining has been confined to California, though its occurrence has been noted in many other parts of the continent.

The principal magnesite deposits of Canada that have yet been discovered, occur in Brome county, in the townships of Bolton and Sutton of the province of Quebec, and are there associated with the dolomites of the Quebec group, in the Lower Silurian.

On lot 17, range IX., of Bolton, there is a deposit of magnesite 20 yards wide, interstratified with steatite and an impure serpentine. It resembles a crystalline limestone, weathers a rusty red, and is marked by light green stains of oxide of chromium.

On lot 24, range IX., of Bolton, magnesite was observed in argillite. A deposite a foot thick was also found on lot 12, range VII., of Sutton.

Miscellaneous.

The following analyses* of magnesite from this district show that the mineral is not pure, but is mixed with considerable quantities of carbonate of iron and insoluble matter, and whether it will become of any economic importance must remain an open question until a practical test be made.

Analyses of Magnesite.

—	No. 1.	No. 2.	No. 3.	No. 4.
Carbonate of magnesia	83·35	33·00	59·13	59·72
" iron..........	9·02	19·35	8·32	10·31
Insoluble matter...........	8·03	45·90	32·20	29·90
Alumina..................	....	0·50	....	....
	99·40	98·75	99·65	99·93

Nos. 3 and 4 were from lot 17, range IX., Bolton.

In the township of Melbourne magnesitic ophiolites, or rocks consisting of a mixture of serpentine and magnesite, occur.

Magnesite also occurs near Black Lake, Que., and near Illecillewaet B.C., but in neither of these localities has it been found in commercial quantities.

Moulding Sand.—The production of moulding sand given below for the year 1896 is entirely from the province of Ontario.

Table 8.

Miscellaneous.

Production of Moulding Sand.

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

* Geology of Canada, 1863, pp. 457, 458.

Platinum.—As in past years the production of platinum is altogether that of British Columbia. It is obtained from the gravels of the stream beds of the Similkameen division of Yale district. The following table gives the production since 1887 :— MISCELLANEOUS. Platinum.

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

TABLE 10.

MISCELLANEOUS.

IMPORTS OF PLATINUM.

Fiscal Year.	Value.
1883	$ 113
1884	576
1885	792
1886	1,154
1887	1,422
1888	13,475
1889	3,167
1890	5,215
1891	4,055
1892	1,952
1893	14,082
1894	7,151
1895	3,937
*1896 .... Duty free	6,185

*Platinum sheets and wire, and retorts, pans, condensers, tubing and pipe made of platinum, imported by manufacturers of sulphuric acid.

MISCELLANEOUS.

Quartz.

Quartz.—The quartz industry is very small and unimportant as is shown by the following table :—

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

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 ....Duty free	3,289	2,174

Soapstone.

Soapstone.—Steatite or soapstone, the massive variety of talc,is a hydrous magnesian bisilicate. It is formed by the decomposition of such minerals as pyroxene and hornblende. It is characteristic of the magnesian band of the altered rocks of the Quebec group, but is also noted in several localities in Archæan rocks.

It is used in the manufacture of fire-bricks, lubricants, slate pencils and as an adulterant for soap. As it is soft and easily worked it has been employed, when free from impurities, for mantels, hearth-stones, &c. If strongly heated it loses part of its water of composition and becomes harder, and is then capable of receiving a polish. When finely powdered it adheres with great tenacity to stone and metal and for this reason it is sometimes used as a surface coating for protection from weathering.

MISCELLANEOUS.
Soapstone.

The only place that it is worked in Canada is on an island in Rideau Lake, in Leeds county, Ontario. An impure soapstone occurs at this locality associated with Archæan crystalline limestones. It is ground up and used in the manufacture of roofing cement.

Soapstone has been found in the following localities in Canada :—

Province.	County, &c.	Township or locality.	Range or Con.	Lot.	Remarks.
Nova Scotia.	C. Breton.	Copper Mine, Eagle, Head, Gabarus Bay	......	....	
Quebec.....	Brome....	Patton	V	16, 17, 20..	On 20, workable bed 3 ft. thick.
"	"	"	VI	24........	
"	"	Sutton.............	VII	12........	In micaceous slates; assoc. with dolomite
"	"	Bolton..	II	26........	
"	"	"	IV	4, 24......	
"	"	"	VI	2, 24......	On 24, assoc. with chlorite and dolomite.
"	"	"	IX	17........	
"	Wolfe	Garthby.....	I	6........	
"	"	Wolfestone.........	II	20........	
"	Vaudreuil	Falls of the Bras; Chaudière Valley.	. .. .	....	Assoc. with dolomite in argillite.
Ontario.....	Leeds	Elizabethtown.	......	....	
"	"	Rideau Lake; islands in.	.....	....	
"	"	Clarendon	II	14........	
B. Columbia	....	At the mouth of the Salmon River, between Keefer and N. Bend Stations, C.P.Ry.	......	....	

MISCELLANEOUS.
Soapstone.

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

Tin.

Tin.—No tin has ever been produced in Canada, nor are any deposits of its ores, of economic importance, known to exist. The following table is given to illustrate to a certain extent the local market for tin and tinware.

TABLE 14.

MISCELLANEOUS.
IMPORTS OF TIN AND TINWARE.

Fiscal Year.		Duty.	Value.
1880			$ 281,880
1881			413,924
1882			790,285
1883			1,274,150
1884			1,018,493
1885			1,060,883
1886			1,117,368
1887			1,187,312
1888			1,164,273
1889			1,243,794
1890			1,289,756
1891			1,206,918
1892			1,594,205
1893			1,242,994
1894			1,310,389
1895			973,397
1896	Tin crystals	Free	$ 1,483
	Tin in blocks, pigs and bars	"	209,813
	Tin plates and sheets	"	923,279
	Tin foil	"	35,085
	Tin strip waste	"	2,414
	Tin plate in sheets, decorated	25 p.c	3,489
	Tinware and all manufactures of tin, N.E.S.	25 "	62,121
			$1,237,684

Tripolite.—Tripolite is chiefly composed of the minute siliceous shells of diatomaceæ. It occurs in deposits often many miles in area, either uncompacted or moderately hard. The earthy variety is known by the names, "infusorial earth," "diatomaceous earth," "earthy tripolite" and "fossil flour." It is a very fine-grained earth, looking often like an earthy chalk, or a clay, but harsh to the touch, and scratching glass when rubbed on it. MISCELLANEOUS. Tripolite.

The production of tripolite in Canada for 1896 was valued at $13,280. This was the production of two companies, viz., The Fossil Flour Company of Bass River, N.S., and The Victoria Tripolite Company of North Sydney. A small amount was ground and used as an abrasive in Canada, but all the rest was shipped to the United States.

Whiting.—No production of whiting was reported for 1896. Whiting.

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

* Whiting or whitening, gilders' whiting and Paris white.—Duty free.

MISCELLANEOUS.
Chalk.

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

*Chalk, prepared.—Duty 20 p.c.

Zinc.

Zinc.—No production of zinc has been reported in Canada for years, except for 1893, when a trial shipment of ore from the Lawn Mine on Calumet Island, Pontiac county, Quebec, yielded 11,763 lbs. of the metal valued at $470. The following tables give the amount and value of zinc and zinc goods imported into Canada from the year 1880 :—

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........Duty Free	20,223	80,784

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

* Spelter in blocks and pigs.—Duty free.

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....Duty, 25 p.c.	6,290

Natural Gas

NATURAL GAS.

According to direct returns received from the producers, the production of natural gas from the Ontario gas fields for 1896 was valued at $276,301, which compared with that of 1895, viz., $423,032, shows a decrease of $146,731 in value, equivalent to about 34 per cent.

Mr. L. L. Brophy, of this section, visited this district during the autumn of 1896, and writes of it as follows in the Summary Report of the Geological Survey Department for that year :—

"At Windsor, through the courtesy of Mr. S. T. Copus, Secretary-Treasurer of the Natural Gas and Oil Company of Ontario, Ltd., some interesting particulars were obtained regarding the operations of the company up to date (October 12th, 1896). This company, which succeeded to the business and plant of the Ontario Natural Gas Company some three years ago, now practically controls all the principal wells in the Essex field, and is piping large quantities of gas from its main field in the townships of Gosford and Mersea, to Walkerville, Windsor and Detroit. Two lines of pipe have been laid into Windsor, a distance of about 32 miles. Some 2,000 families in Walkerville and Windsor are now supplied with the gas while the number of connections in Detroit is in the neighbourhood of 6,000. The total number of miles of piping laid is about 130, including all branch lines and connections. The gas, which is used almost entirely for fuel purposes, is sold for twenty cents per thousand (M) cubic feet in summer and twenty-five cents in winter ; the extra price in the latter season being due to the increased cost of keeping the regulators, mains, &c., in working order during the cold weather. The total number of wells drilled by both the old and new company, up to the time of my visit, was twenty-six and of these seventeen are still active producers. The rock-pressure at the wells is given at 400 pounds to the square inch, and their estimated output is about 35,000,000,000 cubic feet per annum.

"While no very marked decrease has been noticed in the rock-pressure at the wells in the Essex field no doubt owing to the comparatively recent date at which the consumption began, other than of a local character, a very different condition of things prevails in the Welland field, where the wells have been supplying the city of Buffalo with a considerable portion of its fuel for a number of years past. The reason for this statement will become apparent on a perusal of the following information, kindly furnished by Mr. D. Coste, Manager of the Provincial Natural Gas and Oil Company, which corporation operates most of the large wells in the Welland peninsula. Their whole output is piped into Buffalo, N.Y., through two large mains running from the field to the Niagara River. The length of pipe laid, including the mains and all connections is about 120 miles. Up to the 20th October, 1896, the number of wells drilled by this company and also by the Erie Company, (whose rights were acquired in 1893) was 124, of which 65 are still producing. When the first wells were bored some years ago, the initial rock-pressure was 520 pounds to the square inch, but the supply of gas in the meantime decreased to such an extent that the average pressure of all the wells is now barely 175 pounds to the square inch. The large compressor plant erected near Sherk's Station in the fall of 1893 was in operation for some nine months, but is now seldom used except to pump out a well of which the pressure has fallen below 70 pounds to the square inch. When a well reaches this stage the pumps are put on, the hole is pumped dry and permanently closed down and plugged. This procedure is rendered necessary by reason of the fact that the pressure in the supply mains is so much higher than that in the failing well, that instead of such a well being a source of supply it really becomes a drain on the main pipe-lines and absorbs a large quantity of gas from other wells which would otherwise be available for immediate consumption. Wells which were at one time large producers are sometimes purposely fed in this way, being used as temporary storing chambers for such gas as is not required for immediate use, the reservoirs of these wells being more readily accessible when the gas is really wanted, than in those formerly having but a small producing capacity. According to the opinion expressed by several of the leading authorities on the subject, it would appear to be merely a question of a few years before the gas supply in the Welland field will be exhausted, at least for commercial purposes, though a small flow may still continue for a much longer period which will be of service for domestic uses to farmers and others with wells on their premises and requiring only a very limited daily supply. In support of this opinion, mention may be made of the Provincial Company's well, No. 63, drilled in 1893, which yielded when the gas was struck, a flow of over 10,000,000 cubic feet per day. The flow from this well has now decreased to such an extent that it does not produce 400,000 feet in the same time, although it has in the interval been several times fed from the other wells."

NATURAL GAS

The following table gives the value of the production of natural gas in Canada since the year 1892 :—

TABLE 1.

NATURAL GAS.

Production.

ANNUAL PRODUCTION.

Calendar Year.	Value.
1892	$ 150,000
1893	376,233
1894	313,754
1895	423,032
1896	276,301

NICKEL

NICKEL.

The nickel industry of Canada is still confined to the operations of the mines at Sudbury in Ontario. During the year the chief work done was that of the Canadian Copper Company, though operations were started again during the year at the Inez mine near Worthington by the Trill Mining and Manufacturing Co. Altogether the industry gave employment directly to from 150 to 200 men.

The statistics of production for 1896 and past years are given below in Table 1. A study of the figures given will illustrate the growth of the industry. In the quantity of the metal contained in the matte, etc., shipped, it will be seen that there was an increase from the inception of the industry in 1889 to 1891. The year 1892 showed a falling off as compared with the previous year, which was made up in the two succeeding years. Since 1894, however, there has been a falling away again in the production of about 30 per cent. The total final values calculated on the basis of the market value of the contained nickel are given in the last column of the table. The fluctuations in the figures there given do not of course coincide with those in the quantity column, on account of the continual falling off in the average price shown in the middle column. Thus the decrease in the total value in the last three years has been about 36 per cent as compared with about 30 per cent in the quantity for the same period. For the whole period from 1889 the difference is still greater, the increase in the quantity of the production being about 409 per cent, whilst the value shows only about 239 per cent.

In considering these values it must be borne in mind that they represent the full and final value of the metal contained in the matte, etc., as shipped, calculated at the average value per pound for the year in New York. The spot value to the operators is of course much less. For instance, the average market value given in the table is seen to be 35 cents per pound, whilst the operators reckon the spot value of the nickel in the matte at only about one quarter that standard or about nine cents. NICKEL.

There is nothing very new to note in regard to this industry since the date of previous descriptions in former reports of this section.

TABLE 1.
NICKEL.
ANNUAL PRODUCTION.

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

* Calculated from shipments made by rail.

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

* 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.

NICKEL.
Imports.

TABLE 3.

NICKEL.

IMPORTS.

Fiscal Year.		Value.
1890		$ 3,154
1891		3,889
1892		3,208
1893		2,905
1894		3,528
1895		4,267
1896 Nickel anodes	Duty 10 p.c.	4,635
1896 Nickel *	Free.	152
		$ 4,787

* Classified under the general heading of minerals in the Trade and Navigation Report.

PETROLEUM.

PETROLEUM.

Production.

The production of the Canadian oil refineries is given in the following table for the years 1895 and 1896. A comparison of the totals given below shows clearly that the industry is a progressive one. In the total values of the production of the refineries there was an increase of about 15 per cent in 1895, and of about 25 per cent in 1896 as compared with the preceding year in each case.

TABLE 1.

PETROLEUM.

PRODUCTION OF CANADIAN OIL REFINERIES.

Products.	Calendar Years. 1894. Quantity.	1894. Value.	1895. Quantity.	1895. Value.	1896. Quantity.	1896. Value.
		$		$		$
Illuminating oils. galls.	11,289,741	1,003,973	10,711,378	1,217,426	11,207,150	1,251,122
Benzine and naphtha "	645,031	54,515	642,484	63,026	719,453	70,733
Paraffine oils "	1,282,749	118,053	1,016,039	140,245	1,014,271	132,308
Gas and fuel oils "	7,323,374	197,193	6,095,355	218,692	6,788,353	261,618
Lubricating oils and tar "	1,801,174	74,309	1,698,559	75,578	1,447,455	77,109
Paraffine wax.....lbs.	1,950,172	119,091	1,840,021	82,970	1,532,670	466,978
Axle grease "	....	....	....	8,300	318,928	7,774
Totals	....	1,567,134	....	1,806,237	....	2,267,642

TABLE 2.

PETROLEUM.

CONSUMPTION OF CRUDE OIL AND CHEMICALS.

PETROLEUM.
Consumption.

Articles.	Calendar Years.			
	1893.	1894.	1895.	1896.
Crude petroleum ......galls.	27,994,805	27,884,080	24,954,855	25,881,095
Sulphuric acid... ..... lbs.	4,676,353	4,974,610	4,919,271	5,146,429
Soda .... "	420,047	430,810	390,781	438,058
Litharge.... .... "	470,666	472,139	390,573	361,603
Sulphur............... "	74,012	96,144	78,597	80,612

As in former years, the inspection returns of the Inland Revenue Department, for Canadian oils and naphtha have been taken as a basis from which to obtain the production of petroleum in Canada. The ratio of crude to refined petroleum adopted for 1896 was 100 to 42.

As shown in Table 4, following, the amount of the production for 1896 was practically the same as for 1895, but an advance in price raises the total value.

The Canadian oils inspected during the calendar year 1896, as obtained from the books of the Inland Revenue Department, are as follows:—

TABLE 3.

PETROLEUM.

CANADIAN OILS INSPECTED, CALENDAR YEAR 1896.

Inspection of oils.

Number of Packages.	Inspection Fee.	Approximate No. of Gallons per Package.	Total Gallons.
248,867	10c.	42	10,452,414
46,374	2½c.	5	231,870
			10,684,284

Petroleum.

Inspection of oils.

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

Table 6 gives the amount of petroleum inspected, both Canadian and imported, for the fiscal year. The table is compiled from the Reports of the Inland Revenue Department.

For the fiscal year 1896, the totals were obtained as follows:—

TABLE 5.

PETROLEUM.

INSPECTION OF CANADIAN AND IMPORTED OILS, FISCAL YEAR 1896.

Number of Packages.	Inspection Fee.	Approximate Number of Gallons per Package.	Total Gallons, Canadian.	Total Gallons, Imported.
	cts.			
6	25	52	....	312
246,452	10	42	10,350,984	....
129,626	10	42	....	5,444,292
*172	10	42	3,612	3,612
1	5	10	10	....
348	5	10	....	3,480
35,869	2½	5	179,345	....
71,259	2½	5	....	356,295
Total			10,533,951	5,807,991

*These 172 packages were reported as mixed Canadian and Imported oil. From information at hand it is known that the relative proportions of Canadian and imported oils in this mixture are approximately equal, and this has been assumed in above table.

TABLE 6.

PETROLEUM.

TOTAL AMOUNT OF OIL INSPECTED, CANADIAN AND IMPORTED.

PETROLEUM.

Inspection of oils.

Fiscal Year.	Canadian.	Imported.	Total.
	Galls.	Galls.	Galls.
1881	6,406,783	476,784	6,883,567
1882	5,910,747	1,351,412	7,262,159
1883	6,970,550	1,190,828	8,161,378
1884	7,656,001	1,142,575	8,798,586
1885	7,661,617	1,278,115	8,939,732
1886	8,149,472	1,327,616	9,477,088
1887	8,243,962	1,665,604	9,909,566
1888	9,545,895	1,821,342	11,367,237
1889	9,462,834	1,767,812	11,230,646
1890	10,121,210	2,020,742	12,141,952
1891	10,270,107	2,022,002	12,292,109
1892	10,238,426	2,429,445	12,667,871
1893	10,683,806	2,641,690	13,325,496
1894	10,824,270	5,633,222	16,457,492
1895	10,936,992	5,650,994	16,587,986
1896	10,533,951	5,807,991	16,341,942

In 1893 the inspection fees for imported petroleum were lowered from 25c., 10c. and 5c., to 10c., 5c. and 2½c., and this will account for the amount of oil imported during 1894 being more than double that of 1893.

Table 8 is compiled from the books of the Inland Revenue Department, and is given with the object of more complete comparison. It is similar to Table 6 with the exception that the calendar year is used in Table 8, while in Table 6 the fiscal year is employed. The number of packages of Canadian oil inspected, from which the Canadian production was obtained, was given for Table 4. The corresponding calculation for the imported oil is given herewith.

TABLE 7.

PETROLEUM.

INSPECTION OF IMPORTED OIL, CALENDAR YEAR 1896.

Number of Packages.	Inspection Fee.	Approximate No. of gallons per package.	Total Gallons.
134,351	10c.	42	5,642,742
341	5c.	10	3,410
91,976	2½c.	5	459,880
			6,106,032

PETROLEUM.

Inspection of oils.

TABLE 8.

PETROLEUM.

TOTAL AMOUNT OF OIL INSPECTED, CANADIAN AND IMPORTED.

Calendar Year.	Canadian.	Imported.	Total.
	Galls.	Galls.	Galls.
1892	10,370,707	2,601,946	12,972,653
1893	10,618,804	4,520,392	15,139,196
1894	11,027,082	5,705,787	16,732,869
1895	10,674,232	5,677,381	16,351,613
1896	10,684,284	6,106,032	16,790,316

Exports.

TABLE 9.

PETROLEUM.

EXPORTS OF CRUDE AND REFINED PETROLEUM.

Calendar Year.	Crude Oil.		Refined Oil.		Total.	
	Gallons.	Value.	Gallons.	Value.	Gallons.	Value.
1881	....	....	....	....	501	$ 99
1882	....	....	....	....	1,119	286
1883	....	....	....	....	13,283	710
1884	....	....	....	....	1,098,090	30,168
1885	....	....	....	....	337,967	10,562
1886	....	....	....	....	241,716	9,855
1887	....	....	....	....	473,559	13,831
1888	....	....	....	....	196,602	74,542
1889	....	....	....	....	235,855	10,777
1890	....	....	....	....	420,492	18,154
1891	446,770	$ 18,471	585	$104	447,355	18,575
1892	310,387	12,945	1,146	100	311,533	13,045
1893	107,719	3,696	2,196	394	109,915	4,090
1894	53,985	2,773	5,297	513	59,282	3,286
1895	22,831	1,044	10,237	2,023	33,068	3,067
1896	601	101	7,489	999	8,090	1,100

PETROLEUM.
Imports.

TABLE 10.

PETROLEUM.

IMPORTS OF PETROLEUM AND PRODUCTS OF.

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 Oils: Mineral—	Duty.		
(a) Coal and kerosene, distilled, purified or refined, naphtha and petroleum, N.E.S.	6c. per gall.	6,882,272	$596,450
(b) Products of petroleum	6 "	204,135	17,566
(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	3 "	25	2
(d) Illuminating oils composed wholly or in part of the products of petroleum, coal, shale or lignite, costing more than 30 cents per gallon	25 p. c	43,654	14,365
(e) Lubricating oils composed wholly or in part of petroleum costing less than 25 cents per gallon	6c. par gall.	875,805	107,530
		8,005,891	$ 735,913

Petroleum.
Imports.

TABLE 11.*

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

* This table is composed of items (*b*) and (*e*) of Table 10.

TABLE 12.

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

* Duty—2c. per lb.

PETROLEUM.
Imports.

TABLE 13.

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

* Duty—4c. per lb.

Prices

TABLE 14.

PETROLEUM.

AVERAGE CLOSING PRICES FOR CRUDE OIL ON PETROLEA OIL EXCHANGE.

Month.	CALENDAR YEARS.					
	1891.	1892.	1893.	1894.	1895.	1896.
	$	$	$	$	$	$
January	1.30	1.29¼	1.18¼	1.01¼	1.16	1.72
February	1.28½	1.29	1.18¾	1.01	1.19⅞	1.72
March	1.31¾	1.27¾	1 19	1.01	1.27	1.72
April	1.37	1.26	1.19	.99½	1.55¾	1.72
May	1.37½	1.25¾	1.07	.92	1.67¼	1.70
June	1.37	1.27½	1.07	.92¾	1.52	1.50
July	1.33½	1.26½	1.06	.94	1.54¼	1.50
August	1.34¾	1.26	1.05	.96	1.54	1.50
September	1.35	1.26¼	1.04½	.98	1.55½	1.50
October	1.35	1.26¾	1.04	1.06	1.59⅞	1.50
November	1.33¼	1.25	1.04	1.12¼	1.64½	1.50
December	1.31½	1.18½	1.02	1.13½	1.72⅜	1.50
The Year	1.33¾	1 26¼	1.09½	1.00¾	1.49⅔	1.59

PHOSPHATE.

PHOSPHATE (*Apatite*).

Production.

The phosphate industry, which at one time was large and flourishing, has of late years gradually decreased, until, at the present time, the production in Canada has almost ceased. This result was due primarily to the competition of the miners of phosphatic gravels of the south eastern United States which, although mostly lower in grade than the Canadian phosphates, can be worked much cheaper than the latter. Of late, also, the market has been strongly affected by the competition of the operators of the Algerian phosphate deposits and of the phosphatic slag produced by the iron smelters.

The production for 1896 was only 570 tons, a small part of which was exported. None of the mines were operated for phosphate, although a little of the mineral is occasionally produced as a by-product at the mica mines in the eastern Ontario and western Quebec districts. The production given above represents the result of clearing up of some mineral left in dumps by operators in previous years, which was bought up and cleaned at the mill at the Bassin du Lièvre, near Buckingham, Ottawa county, Quebec. It was found impossible to get returns of the small lots produced by the mica miners as above mentioned, so that the production given in Table 1 for 1896 may be a little low.

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

TABLE 2.

PHOSPHATE.

EXPORTS.

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

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.

Taking then the gold production of the whole Dominion, we find in Table 1, below, the figures illustrating this point for a period of eleven years, for which we have complete data.

As with other mineral industries of the country, a most encouraging growth is to be noted in the past three years, of about 146 per cent. By reference to tables following, giving provincial details, it will be seen that the growth above noted is due to a heavy increase in the production of all the gold-producing provinces except Quebec, which shows a large decrease.

PRECIOUS METALS.
Gold.

The gold industry of the Dominion at large has, of late years, been pursued with renewed activity. Not only have Nova Scotia and British Columbia, the main contributors in the past, made large proportional increases, but new discoveries in Ontario, and increased activities in those districts included under the heading, North-west Territories, have caused such a general swelling of the aggregate that gold contributed over 12 per cent of the value of the whole mineral production of Canada for 1896, as compared with less than 6 per cent in 1894.

Production.

TABLE 1.
PRECIOUS METALS
GOLD—ANNUAL PRODUCTION IN CANADA.

Calendar Year.	*Ounces Fine.	Value.
		$
1886	66,061	1,365,496
1887	59,884	1,237,804
1888	53,150	1,098,610
1889	62,658	1,295,159
1890	55,625	1,149,776
1891	45,022	930,614
1892	43,908	907,601
1893	47,247	976,603
1894	54,605	1,128,688
1895	92,485	1,911,676
1896	134,498	2,780,086

* Calculated from the values at the rate of $20.67 per ounce.

Table 2, following, illustrates the contributions of the different provinces to the grand total for the year. British Columbia stands credited with over 64 per cent, and Nova Scotia with over 19 per cent. The North-west Territories, including the Yukon district, come third with about 13 per cent, and Ontario fourth with about 5 per cent, whilst Quebec contributed much under 1 per cent. Comparing these figures with those for 1894, we find the proportions contributed in that year as follows: British Columbia nearly 44 per cent; Nova Scotia nearly 36 per cent; North-west Territories, &c., over 13 per cent; Ontario nearly 4 per cent, and Quebec nearly 3 per cent.

TABLE 2.

PRECIOUS METALS.

GOLD :—PRODUCTION BY PROVINCES, CALENDAR YEAR, 1896.

PRECIOUS METALS.

Gold.

Production by Provinces.

Provinces.		Ounces.*	Value.
Nova Scotia........................	*b.*	25,103	$ 518,880
Quebec..........	*a.*	145	3,000
Ontario.......	*b.*	5,563	115,000
N. W. Territories (including Yukon district)........................	*a.*	17,175	355,000
British Columbia.............	*c.*	86,512	1,788,206
Total....................		134,498	$2,780,086

* Calculated from the values at the rate of $20.67 per ounce.
a. Placer gold.
b. Gold produced in treating free milling ores.
c. As follows: Gold from placer mining... . . ..$ 544,026
do vein do 1,244,180

$1,788,206

NOVA SCOTIA.

Nova Scotia.

The gold production of this province is in contrast with that of the other provinces, in that it results entirely from the treatment of the free-milling quartz, found in veins in rocks classed as of Cambrian age. During 1896 operations were carried on at some 56 mines comprised within the boundaries of 25 subdistricts. The number of mills was 50, many of them quite small, and operated for only a short time during the year.

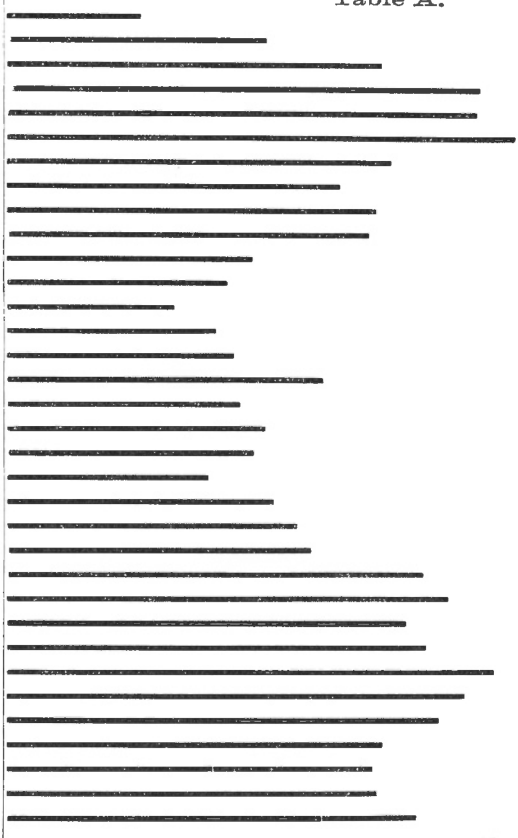
A glance at the following graphic Table A will show the growth and fluctuations of the gold mining industry of this province since 1862. It will be evident that the past three years represent a recovery from a preceding period of depression beginning in 1889 and lasting till 1893, after which the production shows a most encouraging growth. The increase of production of 1896 over 1893 amounts to about 36 per cent, most of which must be credited to 1896, which shows a gain of about 20 per cent over 1895. A glance backward over the record of past years, as exhibited in the table, shows that in the sixties the industry had attained a high degree of prosperity, the output for 1867 being well over half a million, higher even than that for 1896, and the highest for the whole period. Since those early years the mines have of course deepened and therefore have gradually left behind the more easily worked surface ores. As none of the mines are really very deep yet, this disadvantage will be found to be more than offset by the increased facilities becoming available due to the progress in the

PRECIOUS METALS.
Gold.
Nova Scotia.

general development of the country and to improvements in mechanical appliances. Doubtless also now that Canada is attracting attention as a promising field for mineral enterprise, the next few years will see an inflow of capital into the province which will result in a more vigorous development of its already known resources.

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	431,119
1896	518,880

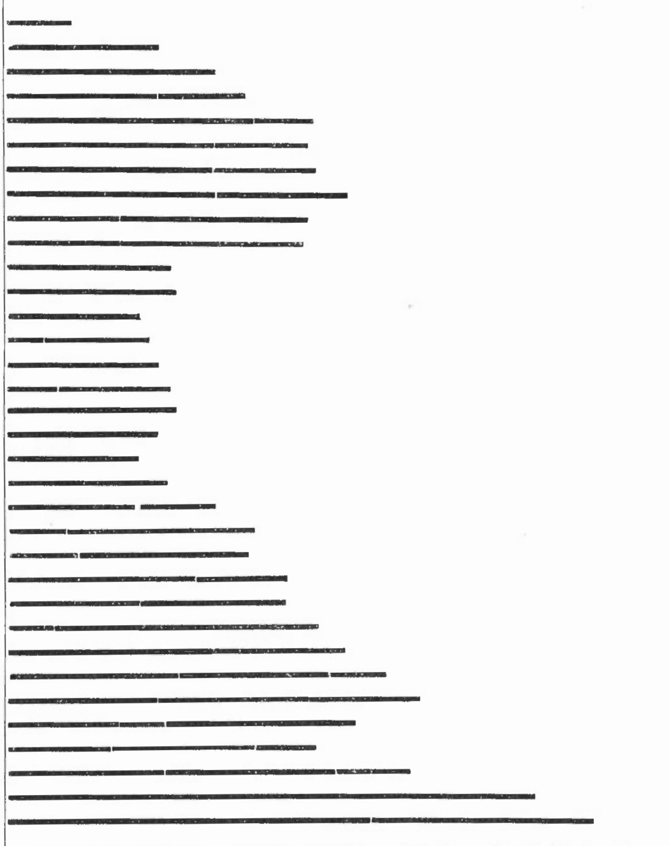


Tables B and C, following, should be studied in connection with Table A. Taking the period dealt with for the production a contrast is noticeable. The increase in the tons of ore crushed is over 112 per cent, as compared with 36 per cent for the production, which indicates a change in practice, the operators finding it worth while to handle more of their lower grade ores than they did in the initial years of the industry. This point is rendered more clear by a comparison of the amounts of ore crushed in the sixties with the figures of gold produced. The greater activity of the industry in those years, whilst quite apparent in Table B, is not nearly so well emphasized as in the production, in Table A, the selected higher grades of ore being evidently the source of the precious metal in that period.

PRECIOUS METALS. Gold. Nova Scotia.

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



In Table C, following, the points above set forth are still more apparent. It will be seen that, apart from a certain amount of

PRECIOUS METALS.
Gold.
Nova Scotia.

fluctuation year by year, there has been a steady decrease in the average yield of ore crushed and treated. The first year given, viz., 1862, shows a small number of tons of ore crushed, but a yield of gold of almost $22.00 per ton, in strong contrast with 1896, when there were over ten times the number of tons crushed but the average of the gold extracted per ton had fallen to almost one third. As before mentioned, this is not necessarily to be attributed to an impoverishment of the gold bearing veins with depth, but rather to an improvement in the practice, enabling the lower grade of ores to be treated profitably.

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	7·03
1895	7·47
1896	7·50

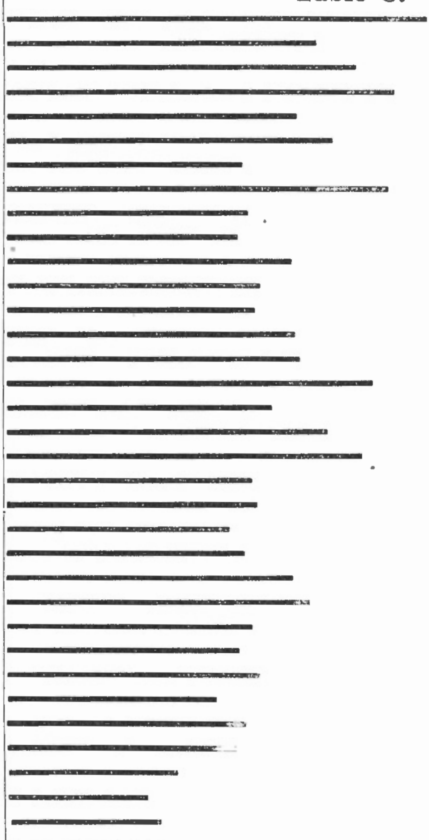


Table 3, following, gives the details of the yield of the various districts covering a period of 35 years, and well illustrates their relative importance as contributors to the grand total and the average richness of the ore treated.

PRECIOUS METALS. Gold. Nova Scotia.

TABLE 3.

PRECIOUS METALS.

GOLD—NOVA SCOTIA. PRODUCTION OF THE DIFFERENT DISTRICTS, FROM 1862 TO 1896, 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.
					$	$
Caribou and Moose R.	92,184	36,509	1	16	711,927	7·72
Montague	20,130	35,835	11	19	698,794	34·71
Oldham	44,488	48,544	9	6	946,617	21·27
Renfrew	48,456	33,909	10	2	661,235	13·64
Sherbroke	178,956	126,160	0	11	2,460,120	13·74
Stormont	95,331	43,731	1	4	852,756	8·94
Tangier & Mooseland	34,354	20,091	3	15	391,778	11·40
Uniacke	50,809	34,090	19	12	664,774	13·08
Waverly	118,595	60,064	5	20	1,171,253	9·87
Salmon River	83,988	31,906	13	19	622,181	7·40
Brookfield	15,930	12,318	14	4	240,215	15·08
Whiteburn	7,368	10,213	18	20	199,172	27·03
Lake Catcha	12,499	11,072	11	20	215,915	17·27
Rawdon	12,808	10,023	16	21	195,465	15·26
Killag	502	538	13	12	10,504	20·92
Wine Harbour	43,368	29,512	8	10	575,492	13·27
Fifteen-Mile Stream	26,976	14,633	15	5	285,358	10·57
Malaga	22,688	14,733	4	21	287,293	12·66
Gold River	570	639	13	3	12,473	21·88
Cow Bay	326	323	19	0	6,317	19·37
Ovens	27	4	19	6	97	3·59
Leipsigate	11	10	10	6	205	18·63
Liscombe Mills	7	0	15	6	15	2·12
Gays River	91	14	1	0	274	3·01
Beaver Dam	80	17	0	0	332	4·14
Lawrencetown	21	4	3	4	81	3·86
Unproclaimed	56,424	42,854	17	21	835,671	14·81
Totals	966,987	617,759	19	19	$12,046,319	$12·45

The district details for 1896 will be found tabulated in Table 4 below. In it will be found all the data necessary to compare the different districts with regard to their relative activity, richness of ore treated, etc. It will be seen that, as a rule, the operations carried on are on a small scale. Of 25 districts named, but seven crushed over 1,000 tons of ore during the year, and five of these range between 1,000 and 10,000 tons, and two go over that amount, viz., Caribou with about 13,000 and Stormont with over 27,000. The average yield

PRECIOUS METALS.
Gold.
Nova Scotia.

of gold per ton for these two districts is low, viz., 3 dwt. 19 grs., and 4 dwt. 5 grs. respectively. For those districts ranging between 1,000 and 10,000 tons of ore crushed, the average yield of gold has been higher than in the last mentioned cases, ranging from 6 dwt. 7 grs. to as high as 15 dwt. 19 grs., average of over 5,000 tons crushed in Brookfield district. For the whole of the districts worked during 1896 there appears a very wide range in the average yield per ton from the lowest at a little over 2 dwts. to the highest at over 6¼ oz. per ton, with an average for all districts, however, of 7 dwt. 9 grs.

TABLE 4.

PRECIOUS METALS.

GOLD.—NOVA SCOTIA DISTRICT DETAILS—CALENDAR YEAR 1896.

Districts.	Mines.	Mills.	Tons of Ore Crushed.	Total Yield of Gold. Oz.	Dwt.	Grs.	Average Yield of Gold Per Ton. Oz.	Dwt.	Grs.
Caribou	8	5	12,862	2,450	8	17	0	3	19
Montague	1	1	93	86	8	9	0	18	14
Oldham	2	2	223	105	17	4	0	9	12
Renfrew	1	1	326	205	10	0	0	12	14
Sherbrooke	5	5	7,177	3,287	1	9	0	9	3
Stormont	9	9	27,488	5,787	10	4	0	4	5
Tangier	2	2	565	78	15	0	0	2	18
Uniacke	5	5	4,501	3,416	13	21	0	15	4
Waverly	1	1	1,686	532	16	6	0	6	7
Brookfield	2	1	5,285	4,177	6	0	0	15	19
Lake Catcha	3	2	607	212	18	17	0	7	0
Rawdon	2	2	633	391	3	0	0	12	8
Wine Harbour	1	1	806	427	6	21	0	10	14
Fifteen-Mile Stream	1	1	5,201	2,634	4	0	0	10	3
Malaga	1	1	411	283	15	0	0	13	19
Gold River	2	2	570	639	13	3	1	2	10
Whiteburn	1	1	152	93	4	0	0	12	6
Killag	2	1	20	125	4	15	6	5	5
Cow Bay	1	1	326	323	19	0	0	19	21
Ovens	1	1	27	4	19	6	0	3	16
Leipsigate	1	1	11	10	10	6	0	19	2
Liscomb Mills	1	1	7	0	15	6	0	2	4
Gays River	1	1	91	14	1	0	0	3	2
Beaver Dam	1	1	80	17	0	0	0	4	6
Lawrencetown	1	1	21	4	3	4	0	3	22
Totals and averages.	56	50	69,169	25,311	4	4	0	7	9

Quebec.

QUEBEC.

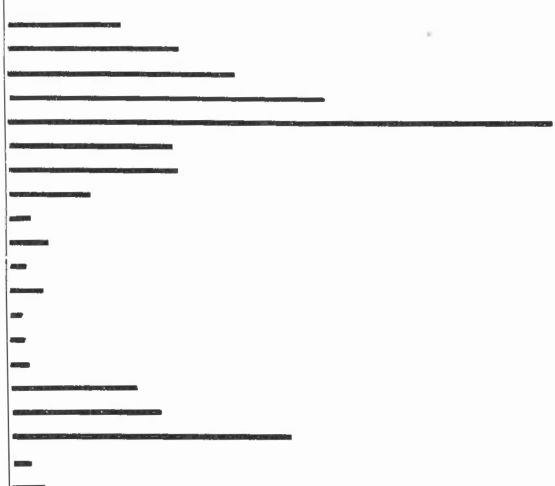
There is little to note regarding this industry at present. A glance at Graphic Table D will illustrate the great variations in the extent of the work of developing the gold deposits of this province. It will be seen that, whilst there was a period of considerable and fruitful

PRECIOUS METALS. Gold. Quebec.

activity in the first five years recorded, these were followed by a considerable falling away during the succeeding three years. From 1885 to 1891 the industry was at a very low ebb, producing but a few thousand dollars worth of gold per year, and although a most hopeful revival occurred during 1892, 1893 and 1894, depression again set in, and for the past few years but little or nothing is to be recorded in the way of production. It must be borne in mind, however, that the figures given in the table are probably below the amounts actually produced, but the progress of the industry has been so irregular and disorganized, that it was found impossible to get exact data. As illustrating the varying fortunes of the industry, however, the figures can be taken as relatively correct.

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	3,931
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



*Second half of year only.

The following statements by Mr. R. Chalmers, from the Summary Report of the Survey for 1896, refer particularly to the work done in

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mining in that year, and give also some interesting particulars in regard to the deposits:

"On entering the field, observations were first made in the different districts in which gold mining was in progress, especially where shafts, tunnels, etc., were open. Development work was found to be going on at Dudswell, Ditton, Massawippi Lake, and in Beauce county, though only to a limited extent. On the west side of Massawippi Lake, Mr. James Stark, representing an English company, was at work with twenty-two men, in the bed of a small stream on lot 14, range VI., Hatley, Stanstead county. Some gold was found in the gravels, but not sufficient quantities to pay for working. Mr. Stark's object was, however, to find it in the matrix. Broken quartz seams, with pyritous, slaty and talcose minerals, traverse the rocks mapped as pre-Cambrian there. Specimens of these were brought to the office for assay in the laboratory of the Survey. The work at this place was discontinued after a month or two.

"The stream along which the gold occurs runs entirely across pre-Cambrian rocks and falls into Massawippi Lake, and the gold seems, therefore, to be derived from these rocks. Their character is very much the same as that of the rocks in Dudswell Mountain.

"On lot 5, range XV., Magog, near the foot of Orford Mountain, mining for gold was undertaken by a Mr. Lacroix, and several men were at work in a pit in the bank of a small stream, at the time of my visit. The Cambrian slates there contain some thin quartz seams accompanied by pyritous minerals; but Mr. Lacroix could not show me any gold obtained from this opening, and later on it was closed.

"*Gold Mining at Dudswell.*—From Magog I proceeded to Dudswell, where some time was spent and repeated examinations were made during the summer as work progressed. At Harrison's, lot 1, range VI., Westbury, free gold was found in the autumn of 1895 in a thin seam of quartz in a sort of conglomerate rock.* The exposure in which it occurred was uncovered to a still greater extent, along a low ridge, during the winter, and an opening made in the conglomerate, but without any further result than as stated in the Summary Report referred to. It is evident, however, that this conglomerate exists here in much greater thickness and extent than at first supposed; but whether auriferous throughout has yet to be proved. Mr. John Armstrong, of Marlow, Beauce county, has leased this property and was

*Summary Report, Geol. Surv. Can., 1895, p. 93.

preparing to have the auriferous character of these rocks tested preparatory to working them. PRECIOUS METALS. Gold. Quebec.

"In Kingsley Brook, a considerable amount of work has been going on this season. A company has been formed to operate the mines on this stream, called The Rodrigue Mining Company, and the mining rights along the whole stream have been secured. Mr. H. C. Donnell, of Boston, U.S., is manager. Early in the season a dam was constructed near the source of Kingsley Brook, and an 80-horse-power boiler and hydraulic pump were put in, principally to work the gravels. Mr. Donnell informed me that he finds gold in paying quantities in these, but his ultimate object is to find the auriferous quartz or matrix, which he hopes to do as he sluices the gravels and uncovers the rock surface in the valley of the stream from the foot of the mountain up towards the dam. The boiler, Mr. Donnell states, is large enough to furnish power to drive a 50 or 60-stamp mill, and can be utilized for that purpose when gold is found in the rock in sufficient quantity to warrant the purchase of a mill.

"The rocks of Dudswell Mountain are, like those on the west side of Massawippi Lake, pre-Cambrian slates and schists. Kingsley Brook crosses them nearly at right angles to the strike and has dropped considerable quantities of gold into the joints and crevices. Mr. Donnell informed me he was finding gold in these to a depth of two or three feet below the surface of the rock. Latterly, he was mining the decayed or partially rotten rock to that depth along with the overlying gravels and had sunk his sluice-boxes to that level. The discovery of gold in the rock-fissures means a continuance of operations for many years longer than if the gravels alone were worked.

"In regard to the difficulties encountered in gold mining in Kingsley Brook, and probably also in the valleys of the other small streams flowing off Dudswell Mountain, the first is the scarcity of water during the midsummer months, if operations are conducted on anything like a large scale. This difficulty can only be overcome by the construction of dams and reservoirs. The second is the presence of large boulders in the gravels. These interfere, to some extent, with hydraulic work, and have to be blasted or removed by derricks before the whole of the gravels can be sluiced. No quicksands occur in the valley of these small streams as they do in Beauce county, except in the terraces at the foot of the mountain. Mining has not yet been under taken in any of these terraces.

"On a stream from one to two miles north-east of Kingsley Brook, called Rowe's Brook, lot 8, range IV., Dudswell, alluvial gold mining

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has been prosecuted this season by Messrs. Hayemal and Soteri, for some months and gold in paying quantities obtained by the ordinary process of sluicing. A clean-up which I witnessed while visiting this locality, seemed to prove this statement. The character of the deposits is very much the same as in the Kingsley Brook valley, as described in the Summary Report for 1895 (p. 91), except that the thickness is perhaps, fully greater.

"*Gold Mining in Ditton.*—In the valley of the Little Ditton River, some work has been performed during the past season by Messrs. McCritchie and McKay of Scotstown, about a quarter of mile above the bridge on the road to Chartierville. The gravels at this point were washed for some weeks by these men previous to the date of my visit and some gold was obtained. One nugget weighing an ounce was found at the bottom of the gravel, close to the bed-rock. The chief auriferous deposits here are those resting upon the rusty rotten rock, and are themselves highly oxidized, though stratified. Overlying them are alternating gravel and sand beds, which must be largely of post-glacial origin. The boulder-clay is, however, rarely seen in contact with these. They contain but little gold.

"To the south of the locality mentioned, along the little Ditton valley, gold has been washed from the gravels at several points, nearly as far up as the International boundary, *e. g.* at a point a mile north of the cross-road going west from Chartierville, also south of that road and near the source of that stream in the vicinity of Prospect Hill, where it is reported to have been found in quartz, but I could obtain no authentic information on this point. It has also been discovered in the alluviums of the main Ditton River to the south of Chartierville village. No work has been done, however, in the two last-mentioned localities.

"*Gold Mining in the Chaudière Valley.*—Along the Chaudière River and its tributaries, very little gold mining has been carried on during the past season. Work in the tunnel at St. George, referred to in the Summary Report for 1895 (p. 87), was continued until September last, when it was found that the old pre-glacial channel of Slate Creek was not likely to be reached by following the course in which the tunnel was started, and it was abandoned for the present. At the time operations were suspended, the tunnel had been run in nearly 900 feet. Great difficulties were experienced in keeping it open, owing to the presence of quicksands and to the quantities of water in the ground overhead seeking outlet and carrying these sands with it. The succession of the deposits disclosed in the tunnel is interesting from a geological point of view. In descending order it is as follows:—(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 quicksands); (4) coarse, stratified gravel with pebbles and a few boulders one or two feet in diameter—colours of gold occur in this gravel; (5) a local bed of coarse slated material with quartz bands running through it. It is apparently a decomposed slate which may have originally been thrown down as a talus at the base of a boss on the slope; (6) fine yellow sand with ochreous streaks through it, passing into rotten rock *in situ* beneath, the strata being in the same position as in the solid rock; (7) unglaciated rock.

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"The most remarkable member of the series is number 6. It is unlike any other bed met with in connection with the gold-bearing deposits of Beauce county, and is noteworthy as showing the slight erosive action of the Pleistocene ice, exposed, as this slope of the Chaudière valley must have been to the full force of the glacier which moved over this district from north-west to south-east.

"In the valley of the Rivière du Loup, Mr. L. Gendreau is endeavouring to open up a series of gravel banks on the west side, which extend from three to five miles above its mouth. These gravels are reported to contain gold in workable quantities, but I have seen no competent tests made. The following is a section of one of these banks situated about four miles above the confluence of the du Loup and Chaudière rivers. (1) Surface soil; (2) boulder clay, the upper part stratified in places; (3) a thin seam of stratified sand graduating into the following bed; (4) stratified clay (pipe-clay); (5) stratified sand and gravel, the latter usually in lenticular seams with ochreous bands, especially in the upper part. This is the deposit said to be auriferous; (6) fine, gray, stratified sand, the bottom not reached as it lies below the level of Rivière du Loup.

"Whether gold exists in paying quantities in these gravels does not appear, but Mr. A. A. Humphrey, of the Canada Gold Mining Association, formerly washed a good deal of gold out of the gravels of the du Loup valley in his No. 1 pit, just below the mouth of the Gold Stream, *i.e.*, about two miles lower down than the above section; and also in No. 2 pit near the river's mouth (see Summary Report for 1895, p. 89, where it is called No. 1 pit), though so far as known not in sufficient quantities to pay for hydraulic work.

"In the Gilbert River valley, some gold mining was carried on during the past season by the Leclerc Brothers, who are reported to have met with fair success, and to have taken out in a few weeks

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about $400 worth. Two nuggets valued at $50 and $60, I am informed. were obtained by these men. One of these nuggets was shown to me.

"On Mill Stream, near St. François, Beauce, some work has been performed by Messrs. Copal and Pomerleau, and gold has been found in parts of the valley of that stream not hitherto prospected. In the valley of Black River, a branch of Des Plantes River, joining it from the south, gold was discovered in the gravels at the confluence of the main tributary.

"The present languishing condition of the gold mining industry in Beauce county, appears to be due to causes other than the scarcity of gold in the alluviums. It would be invidious to make any remarks, however, concerning these causes. That gold still exists in a number of these valleys in paying quantities, *i.e.*, in quantities sufficient at least to warrant a skilful and economic expenditure of capital in their exploitation, is a fact which no one who has examined the district can deny. But on the other hand it must be remembered that this district can show a total of a large number of failures in gold mining, and that there are other causes for this besides want of scientific knowledge or skill and want of capital. In much of the Chaudière districts, the gold exists in a very thin and scattered condition, and the gravels containing it are capped by such thick beds of boulder-clay and quicksands that it is doubtful whether it can be profitably mined. In the deeper parts of the river valleys there are still greater difficulties to contend with. In the old 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 shafts at these levels are likely to receive a portion of the drainage waters, the expense of exploration would be great and only deposits of considerable richness would probably prove remunerative.

"The failure hitherto to find workable gold-bearing quartz, has given wrong impressions concerning the district, leading miners and mining engineers to suppose that it has been but very imperfectly explored. As a matter of fact a considerable number of geologists, mining engineers and experts have visited and examined this district, and the literature pertaining to it is somewhat voluminous. There are, of course, different local conditions existing here as regards the distribution of the gold in the alluviums from what prevail in non-glaciated countries, and these diverse conditions may not have been sufficiently taken into account. But the Chaudière district has not suffered for lack of competent and skilful exploration, or for want of capital.

"Notwithstanding the backward condition of gold mining here, this district, or at least some portions of it, offers inducements to miners and capitalists equal in some respects at least to those of some other gold regions more favourably regarded.

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"The further development of the gold mines of the Chaudière area should, it seems to me, lie in the direction of introducing machinery and plant adapted to alluvial mining under the peculiar local conditions which are found there. But first the gold-bearing gravels, in a great number of places, should be tested anew, and their gold content per cubic yard proved, with the view of ascertaining whether it is sufficient to pay for the expenditure in the direction indicated. To effect this exploration adequately, it would seem that boring machines are absolutely necessary. The great thickness of the boulder clay, which never contains gold in paying quantities, but which must be penetrated by shafts or tunnels before the auriferous deposits can be reached and worked, as well as the difficulty of locating the old river-channels in which the auriferous deposits mainly lie, have hitherto proved serious obstacles to exploration in the deep-lying beds. With boring appliances these difficulties could be overcome, at least to a much greater extent than by the methods hitherto employed, the position of the old channels could be located in less time and at much less expense, and the thickness of the auriferous beds in these ascertained before commencing actual mining operations.

"*Quartz Veins.*—In addition to the facts obtained relating to alluvial gold mines, a considerable body of data concerning quartz veins and other rocks which might be likely to yield gold was collected in the field, with a view of ascertaining, if possible, its primary source. The details regarding these will be given in my forthcoming general report; while such specimens as were brought in from the field will, meantime, be subjected to examination and assay in the laboratory of the Survey."

ONTARIO.

The revival in the gold mining industry of Ontario during the past few years will be evident from a glance at Table 5 below. For the three years following 1887 the industry was practically dead. Since the fresh start made in 1891 there has been a steady and large increase as shown. Apart, however, from several mines in the province, which can be now said to have been placed on a permanent working basis the industry as a whole is yet in the initial stage, but with a very hopeful outlook. Prospecting and development work

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has been actively prosecuted in a number of districts throughout the province and encouraging results are reported. The districts most promising have been the Lake of the Woods and Rainy River districts in the western part of the province and the Hastings and Wahnapitae districts in the east. The latter district lies north of the well known Sudbury nickel and copper mines on the main line of the Canadian Pacific Railway.

TABLE 5.

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GOLD—ONTARIO—ANNUAL PRODUCTION.

Calendar Year.	Ounces Fine.	Value.
		$
1886	....	....
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

The outlook for further discovery of veins similar to those already proved to be gold-bearing in the district already alluded to, is very hopeful. Areas of the series of rocks, classed as Huronian, and where the geological conditions are generally similar to those found in the already proved districts have been shewn by the Geological Survey to exist in many other parts of Ontario, and in many of these exploration will doubtless bring to light payable gold-bearing veins. The location of these Huronian areas is shown on the general map of Canada as well as on a number of more detailed district maps issued by the Survey. The ores of the western districts are almost altogether free-milling, the metal in that condition constituting about 80 per cent of the whole gold contents. The ores of Wahnapitae are similar.

The following description by Prof. A. P. Coleman is given of the work done at the Sultana mine on Lake of the Woods in the report of the provincial government bureau for 1896 :—

"The most justly famous mine in our whole western gold field is undoubtedly the Sultana. on an island seven miles south-east of Rat Portage, owned by Mr. John F. Caldwell, of Winnipeg. After years of hard struggle against adverse circumstances, this plucky and energetic mine owner is reaping a solid reward in the shape of a great body of rich quartz, in places forty feet wide, and already followed more than three hundred feet in depth. Nearly a thousand feet of drifting have been done and there is ore enough in sight to keep the well equipped ten-stamp mill, or one double its size, running for years. The ore bodies appear to be lenticular, the lower one of immense size, and are inclosed in the sheared and schistose edge of an area of coarse porphyritic granitoid gneiss. * * * * The ore is somewhat quartzitic looking, contains one or two per cent of iron pyrites, and is free milling to the extent of 75 or 80 per cent. A recently finished chlorination plant extracts the gold carried by the sulphides very satisfactorily. Gold mining at the Sultana has been reduced to a thoroughly business-like basis, the mill running with scarcely a halt and the weekly brick being turned out with perfect regularity. If this splendid mine had been in the hands of a stock company much would have been heard of its dividend paying powers; but its owner is too modest to boast of its success."

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Mr. Wm. McInnes, the geologist in charge of the work of the Geological Survey in this region, has described the geological conditions and other features of a number of these gold-bearing veins in the Summary Report of the Department for 1896 (pp. 34 to 43). His remarks are reproduced below :—

"While on Lake of the Woods, the Regina and Sultana mines were visited. The vein in the case of the former of these, traverses both an intrusive area of altered hornblende-granite and a Keewatin diabase, the line of contact between the two cutting the drifts in the mine and showing an overlap of the diabase by the granite.

"At the Sultana, the vein occurs in a very much crushed and sheared hornblende-granite which occurs here, as it does generally, as an intrusive mass not far from the contact between the biotite-gneiss area and an area of Keewatin rocks. The Scramble mine, which lies to the north of the railway, within six miles of Rat Portage, occurs in a band of Keewatin hornblendic schists or crushed diorites, and close to the edge of the Rossland granitic area. Some surface stripping has been done here, and a shallow shaft has been sunk on a band 25 to 35 feet in width, made up largely of quartz and heavily charged with iron-pyrites, occurring both in thin sheets along the planes of cleavage and irregularly distributed through its mass. Parts of the band were found to pan well, and an average value of over \$20 to the ton is claimed for the whole band.

"Considerable activity has been shown in developing and exploiting gold properties about Lake of the Woods generally, and attention

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is being again devoted to various properties which have lain undeveloped for years. New discoveries of gold-bearing veins have been made in various places in the district, notably about Shoal Lake, where the Mikado and other properties have been attracting attention.

"Here, as in the Seine River country, the gold has been found, in every case, of which we have any record, at no great distance from the contact between the Keewatin and intrusive granitoid rocks, which occur most frequently as narrow rims along the edge of the more extensive areas of biotite-gneiss, but which also invade the Keewatin rocks as isolated intrusive masses. I know of no case where gold-bearing veins have been found to occur in the main body of the biotite-gneiss areas which we have classed as Laurentian. On a preliminary edition of the Seine River sheet, the rocks in which the Sawbill vein occurs were so classed, but this was owing to a misinterpretation of the notes of the late Mr. W. H. Smith, and it has been corrected on the regular edition of the map.

"As surveys of Manitou Lake were already available from the work of previous seasons, it was not thought necessary to visit this lake during the summer. A number of claims have been located along the shores of the lake as well as about Little Manitou Lake. These claims lie in the Keewatin belt, which extends all along the lake in the form of a narrow band, between the large Laurentian areas to the east and west, and connecting the Keewatin area of Pipestone Lake with that of lakes Wabigoon and Minnietakie. It was known from last season's work that the Laurentian areas approach the shores of the main Manitou closely, and a trip eastward from the foot of Osborne Bay, made by Mr. Lawson last summer, proved that the gneiss area of Eagle Lake extends eastward at least to beyond Niven's 22-mile-post on the Base Line of 1893-94. The marginal area of hornblende-gneiss which so commonly surrounds the biotite-gneiss areas, was found to intervene here also between the main gneiss area and the Keewatin.

"Prospecting was extended northward during the summer into the region lying to the north of the Canadian Pacific Railway along the Minnietakie Lake Keewatin belt, which is a continuation north-easterly of the Wabigoon Lake area. Promising veins are reported in this district, and assays of specimens from there made in the laboratory of the Survey gave small quantities of gold, enough at least to confirm the occurrence of gold in the region.

"Sawbill mine (location 313X.) was visited and the rocks about Sawbill Lake examined. They were found to consist in the main of hornblende-gneisses and hornblendic granites and syenites often much crushed and sheared, in places becoming schists in structure.

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"In one of these much crushed and sheared bands the vein occurs on which the Sawbill shaft has been sunk. The shaft, which follows the vein, was down about 40 feet at the time of my visit, and work was continued actively during the summer. The vein at the surface has a width of about 4 feet. It strikes N. 9° E. astronomical (or N. 15° E. mag.)* and can be followed in a southerly direction for 300 feet, where it bends to a direction S. 24° W. for another 300 feet, gradually failing in width until it becomes very small. In a northerly direction it has been traced about 900 feet, beyond which point the surface falls away into a swamp. It was stated by those in charge at the time, that the vein could be picked up again beyond the swamp. The hade of the vein is easterly at an angle of a little over 10 degrees from the vertical. Though running 'with the formation' there seems to be no doubt about the true fissure character of the vein. The walls are well defined, the hanging-wall particularly so, often showing slickensided surfaces and a parting of crushed chloritic material between the wall and the vein-matter. On the foot-wall, there is a certain amount of mingling of the vein-matter with the inclosing rock and a number of stringers and small parallel veins, so that the vein contents do not come away so freely from this wall as from the hanging-wall. The dump showed quartz carrying iron- and copper-pyrites and a considerable amount of free gold, and the vein at the bottom of the shaft was well defined and solid.

"After a few days spent in an examination of some points about Steep Rock and Moose lakes, where the geology is somewhat complicated, Harold Lake was visited. A number of veins have been exploited here, and half a mile of tramway has been built, connecting the different openings with a five-stamp mill at the lake shore. The outlet of the lake has been deepened to allow sinking on a vein known as the shore vein, which outcrops at the base of a low cliff near the south-west corner of the lake. This vein strikes N. 29° W., with a hade to the north-east of a few degrees from the vertical; it is rich in free gold, but small and somewhat irregular. On No. 1 and No. 2 veins, which vary in width from one to two feet, were drifts about 200 and 140 feet respectively with a shallow winze on each. The mill was not working at the time of my visit. Work was continued during the summer, and Mr. Wiley informs me that a more promising vein, near the tramway, was being opened up. The veins occur near the contact

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

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of a highly crushed and altered granite with Keewatin schists and diorites.

"A week was next spent in the region about Bad Vermilion Lake, in an examination of some of the gold locations. In this vicinity, on the north shore of Shoal Lake, at Foley's (locations 174E. and 175E.), the veins occur in the so-called protogine granite area. This granite is first seen on the road leading northwards from the shore of the lake, at a point about 200 yards from the shore, and extends continuously northwards nearly to the southern shore of Bad Vermilion Lake. Two shafts have been sunk on a vein on this property to depths of a little over 200 and 100 feet respectively, with drifts aggregating over 300 feet. The vein is a true fissure, and has a width, as exposed on the surface, of from 18 inches to 3 feet. At the bottom of the deeper shaft it is stated that the vein has widened to 5 feet or more. The dump shows very rich looking quartz with iron- and copper-pyrites, galena, and a good proportion of visible free gold.

"Other good looking veins occur on the same property. One of these about 100 feet to the south-west of the first-named vein promises very well. It has a surface width of about 2½ feet, and shows free gold in good quantity. Since my visit the company have continued active work on the property, and a mill is in course of construction.

"Further to the east, on the road running northward from Mine Centre towards Hillier's and Ferguson's, the first rock exposures after leaving the Keewatin rocks, which are seen on the immediate shore, are met with about half a mile south of Hillier's, or about three miles north-west of Mine Centre, on Shoal Lake. They are greenish, highly altered granites with prominent blebs of opalescent quartz. The same granite is continuous to and beyond Ferguson's (A. L. 110). To the north, between the granite and the south shore of Bad Vermilion Lake, occurs a belt of alternating bands of gabbro and Keewatin diorite and schist. A great part of the area crossed by the road is covered with a thick coating of fine white sand, with large boulders of granite, which conceals the underlying rock, except where occasional bosses protrude.

"At Ferguson's (A.L. 110 and adjoining locations) in addition to a considerable amount of surface stripping, cross trenching, etc., two shafts have been sunk to depths of about 50 feet each. On one of these the vein is divided into two small veins of a few inches each, separated by an intervening mass of granite about 18 inches in thickness, which continues to the bottom of the present shaft though narrowing down to a few inches.

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"In the other shaft on the same vein, further west, the vein is better defined though still narrow. Among the other veins on the property is one, on which only stripping has been done, which can be traced for over 1000 feet, varying in width from 6 inches to between one and two feet. These veins carry free gold in quantity sufficient, it is claimed, to well repay working. Work was continued during the summer on this property, preparatory to the building of a mill.

"At Hillier's (the 'Lucky Coon,' 655 P.) the mill was idle and nothing was being done. The shafts, which were filled with water at the time of my visit, have been sunk on two parallel veins about 80 yards apart, one vein showing a surface width of from 3 to 6 feet and the other varying from a little over a foot to a broad, irregular vein showing about one foot of crushed country-rock, a foot and a-half to three feet of quartz, and 2 to 3 feet of mixed stringers of quartz and country-rock. These are fissure veins cutting the granite mass. This whole area of granite lying between Bad Vermilion and Shoal lakes has been very much crushed and is fissured in all directions, so that the number of veins is very great, some of them promising well. On locations A.L. 103-4-5-6, are many good veins, the principal among them striking from N. 20° W. to N.W. They vary in size up to a width of from 3 to 7 feet and generally show good walls. Many show visible free gold and others are strong in sulphides. At K. 244, on the north shore of Bad Vermilion Lake, a band of greenish-gray, quartzose, massive rock, fairly mineralized with iron- and copper-pyrites and from 50 to 100 feet in width, is inclosed in green hornblendic schists of Keewatin age with a trend parallel to the strike of the schists. This band appears to be an arm from the granitic area; it is cut in all directions by stringers and small veins of quartz from 9 inches in thickness to mere threads, running generally across the trend of the band but following also every possible direction. These stringers, where weathered on the surface, it is stated, pan well.

"On K. 231, are a number of veins, some of good size but irregular and difficult to trace on account of a swamp on one side and a sand-hill on the other. What their gold content is was not ascertained. Many other properties from which good assays are stated to have been obtained, have been taken up in the neighbourhood, some in the granite, and others both in the interbanded gabbro and diorite and in the Keewatin bands.

"There does not seem to be any good reason why gold-bearing lodes in these last-mentioned rocks should be less permanent or persistent than in the granite."

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Speaking of some of the routes traversed during the course of his season's work Mr. McInnes draws attention in the subjoined remarks, to places where prospecting might be carried on with likelihood of success.

"The route led through Upper and Lower Scotch lakes, Irish Lake, Welsh Lake, Norway Lake and a number of small lakes and streams to Upper Seine Lake and the Seine River.

"About midway on this route, the belt of Keewatin which forks from the Seine River band at Steep Rock Lake, was crossed. It has here, at its narrowest, a width of about two and a-half miles, and is made up of diorites and kindred eruptives of the Keewatin, with considerable areas of grauwacke and crushed quartz-porphyry, and of felsitic and quartzose schists, all more or less pyritous. Belts of the schist, in a number of places, show pyrites in thin sheets along the planes of cleavage, as well as scattered irregularly through the mass of the work.

"Large angular blocks of quartz with iron- and copper-pyrites, which evidently had not travelled far, were noted about the shores of two of the small lakes near the height-of-land.

"Along the southern edge of this belt, a band of hornblende-gneiss or crushed horblende-granite occurs, and forms a vein along the northern edge of the large biotite-gneiss area of Caribou Lake. This hornblende-gneiss band, where crossed on this route, has a width of a little over a mile, and is without doubt continuous with the area of the same rock about Sawbill and Moose lakes. The area just described with its extension towards the head of Sawbill Lake seems to offer a promising field for the prospector.

* * * * * *

"The regions lying immediately to the south of Eagle and Wabigoon lakes offer a field which promises well for the prospector. In both these districts are bands of Keewatin of very irregular outline, with intrusive areas of hornblende-granites and saussurite-gabbros. These two districts and that to the south of Lower Scotch Lake, have been particularly mentioned only because they are all easily accessible and do not seem to have attracted the notice of prospectors to any great extent, though the character of their rocks is such as to warrant their examination."

An interesting feature in the gold mining of the province is to be found in the work being done at the Empress mine on the north shore of Lake Superior which is situated in an area of Huronian rocks separate from those already described. Mr. McInnes thus describes this place:— PRECIOUS METALS. Gold. Ontario.

"On the way back to Ottawa, the Empress mine, situated on the north shore of Lake Superior, was visited. This is a low-grade proposition, largely free milling. It lies to the north of the Canadian Pacific Railway, near Jackfish station. At the lake-shore, the rock exposed in the cuttings on the line of railway is a medium-grained, red, hornblende-granite, and along the road leading to the mine the same rocks are seen to within a half mile or less of the mill. The veins on which work is being done occur in green, somewhat hornblendic schists striking N. 67° E. and dipping eastwards at an angle of 64°. Where work was being carried on, there is a series of closely parallel veins, striking and dipping with the cleavage of the schists. The largest of these was about six feet in width where stripped. The belt has been uncovered by cross-trenching for upwards of a mile along the strike, varying, of course, very considerably in quartz contents in that distance. The outcrop occurs on the slope of a southerly-facing hillside at a height of two hundred feet or more above the valley bottom. The ten-stamp mill now on the property, has been placed near the bottom of the hill, so that a tunnel may readily be driven which will catch the veins at a depth of about 140 feet below their outcrop, and will prove the property pretty thoroughly and permit also the economical stoping of a large amount of vein-matter. At the time of my visit no mining work of a permanent character was being done, the ore for the mill was being taken by shallow shaft and drift from wherever it could be got at most conveniently. It was the intention of the management, however, to proceed with the driving of the tunnel during the winter. The owners claim only a low grade ore, but they claim also that the unusual facilities for working economically will ensure them a reasonable margin of profit.

"Other discoveries of gold-bearing veins were reported during the summer from different points along the north shore, but none of these were seen."

NORTH-WEST TERRITORIES.

The gold production given below in Table 6 is, as in former years, that mined in the Saskatchewan River bars added to the quantity obtained from the placer washings of the tributaries of the Yukon River in Canadian territory. North-west Territories.

The nature of this work is such that but an approximate estimate can be arrived at, but the figures given are obtained by a comparison of several close estimates given by persons conversant with these

PRECIOUS METALS.
Gold.
North-west Territories.

districts, and are probably as near the truth as possible under the circumstances.

TABLE 6-

PRECIOUS METALS.

GOLD :—NORTH-WEST TERRITORIES, PRODUCTION.

Calendar Year.	*Ounces (fine).	Value.
		$
1885	24	500
1886	29	600
1887	5,907	122,100
1888	1,993	41,200
1889	9,434	195,000
1890	8,660	179,000
1891	2,201	45,500
1892	4,741	98,006
1893	8,981	185,640
1894	6,773	140,000
1895	7,257	150,002
1896	17,175	355,000

* Calculated from the value at $20.67 per oz.

BRITISH COLUMBIA.

British Columbia.

The progress of the gold mining industry of British Columbia is illustrated in Table E, following. Beginning with the first year recorded in the Table we have a production of about $700,000 ; six years later in 1863 the value of the gold produced had increase over 555 per cent to nearly four million dollars. Since the palmy days of 1863, with the exception of a few temporary recoveries, the industry has shown a steady falling off, until in 1893 the province could be credited with the production of less than $400,000 worth of gold. This unfortunate feature is due to the gradual exhaustion of the shallower and more accessible placer workings which up to a few years ago were practically the only source of the gold.

Looking at the record of the past four year period, a steady and rapid growth is apparent, the increase of 1896 over 1893 amounting to 471 per cent. This is the more encouraging as it carries great promise for the future, being due to the opening up and operating of a number of veins in the Kootenay and Yale districts of the province. Some of the increase is also to be credited to the inauguration of extensive hydraulic workings operating on the auriferous gravels of the province which, being suitable only to this method of exploitation, had heretofore received but slight attention.

Graphic Tables F and G, supplementing graphic Table E give the details of this industry for the province.

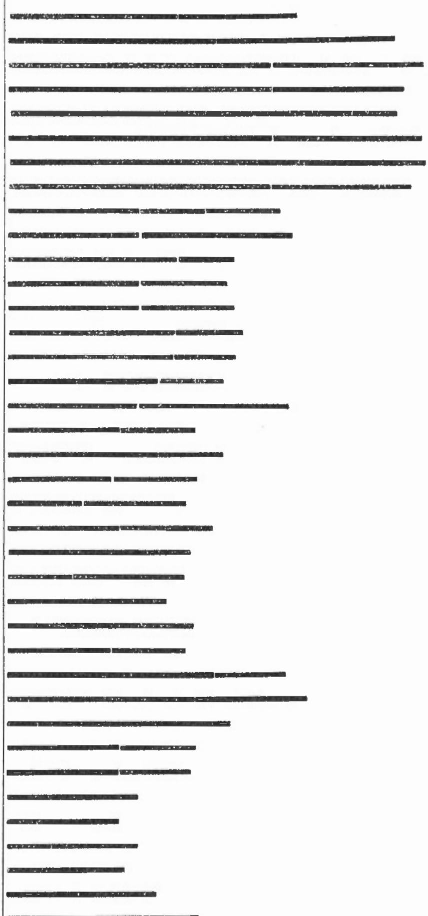
GOLD.
British Columbia.
Annual Production.
Table E.

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

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.

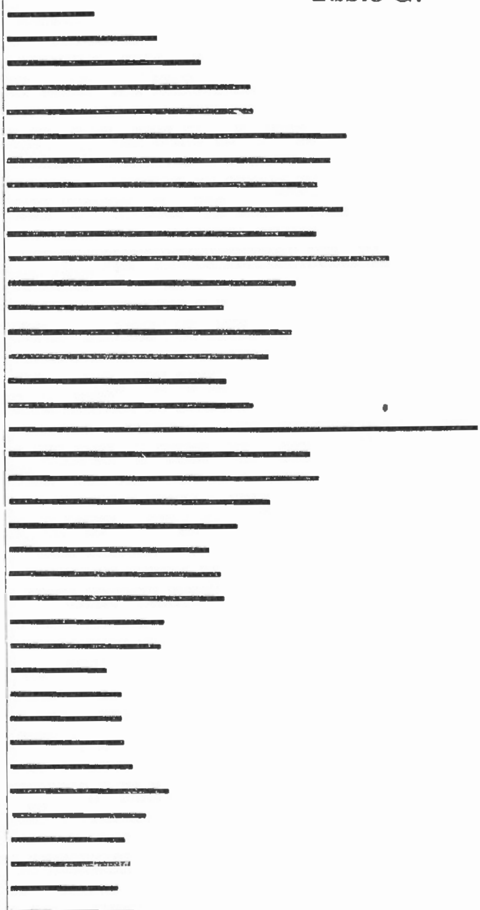
GOLD.

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



PRECIOUS METALS.
Gold.
British Columbia.

Table 7 has been compiled from data given in the Annual Report of the Minister of Mines for the province, and gives the district details for 1896. It will be seen that already the gold produced from vein mining quite overshadows that obtained from placers, the latter being but about 44 per cent. of the former.

TABLE 7.

PRECIOUS METALS.

GOLD—BRITISH COLUMBIA, PRODUCTION, BY DISTRICTS, CALENDAR YEAR, 1896.

District.	Division.	Placer.		Quartz.	
		Ounces.	Value.	Ounces.	Value.
			$		$
Cariboo..........	Barkerville........	4,145	82,900	....	....
	Lightning Creek...	2,650	53,000	....	....
	Quesnel Mouth....	2,555	51,100	....	....
	Keithley Creek....	9,853	197,050	....	....
Cassiar..........	....	1,050	21,000	....	....
Kootenay East...	....	1,054	21,076	....	.. . .
Kootenay West..	Nelson............	275	5,500	236	4,720
	Slocan	....	....	152	3,040
	Trail Creek..	....	....	55,275	1,104,500
	Other Places ...	231	4,627	35	700
Lillooet.........	....	1,683	33,665	. ...	....
Yale	Osoyoos..........	....	... .	6,561	131,220
	Similkameen	450	9,000	....	....
	Yale.............	3,255	65,108	.. ..	....
		27,201	544,026	62,259	1,244,180

The relative importance of the various districts of the province as contributors to the total gold production is shown by the figures in Table 7. Taking first the placer gold into consideration, Cariboo heads the list with about 70 per cent, Yale comes next with about 13 per cent.

Lillooet follows with about 6 per cent, Cassiar and Kootenay East contributing under 4 per cent each, and West Kootenay coming last with under 2 per cent.

PRECIOUS METALS. Gold. British Columbia.

With regard to the gold obtained in vein mining, with the exception of about 10 per cent to be credited to Yale, it all resulted from the operations of the mines in the West Kootenay division in the districts of Nelson, Trail Creek, Slocan, etc. Of this under 1 per cent came from the Nelson, Slocan and outlying districts and the remaining 99 per cent was contained in the products shipped from the Trail Creek mines, which yielded over a million dollars worth of the precious metal. This output was the result of mining and smelting the gold-bearing copper and iron sulphurets of that district. The remaining small amount represents the results of treating free milling gold ores; as at Camp McKinney, in the Osoyoos district of Yale division; at the Poorman mine, in the Nelson district, and small lots of gold ore sent out to the smelters from other parts.

The outlook for increased production from the south-eastern portion of the province is very encouraging. In the last few years numbers of discoveries have been made of payable ore-bodies and veins, and in 1896 there were about 70 mines producing in the section alluded to. The facilities of transport are now greatly advanced, and this, with the home market furnished by the local smelters, will make it possible to work many claims which a few years ago could not have been operated.

With the construction of the Crow's Nest Pass railway and other increased facilities promised in the immediate future, the outlook is decidedly encouraging for a still greater growth in 1897.

The details of the work of discovery and development in the province are fully dealt with in the report of the provincial mineralogist, Mr. W. A. Carlyle, to the Minister of Mines of the Province.

SILVER.

Silver.

Production.

The production of silver in Canada has risen in a period of ten years from 349,330 oz., valued at $341,645 in 1887, to 3,205,343 oz., valued at $2,149,503 in 1896. The increase has thus been equivalent to over 900 per cent in the quantity, but owing to the falling price of the metal, but 600 per cent increase is shown in the value. By studying the figures in the accompanying Table No. 8, it will be seen that the relative importance of the different provinces, in respect of their contributions to the total production, has altered entirely. In 1887,

PRECIOUS METALS.
Silver.

Ontario led with Quebec contributing but little less; British Columbia being credited with the remainder, amounting to but little over 3 per cent. In 1896 the relative contributions of the provinces were as follows: Ontario, nothing; Quebec, a little over 2 per cent; British Columbia, the remainder of over 97 per cent.

Production.

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	11,937	$11,675	349,330	$341,645
1888..	208,064	195,580	149,388	140,425	37,925	35,649	395,377	371,654
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	543,049
1895 .	....	....	81,753	53,369	1,693,930	1,105,797	1,775,683	1,159,166
1896..	....	....	70,000	46,942	3,135,343	2,102,561	3,205,343	2,149,503

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 ores, they contain a little silver, and the production of the province credited in the above table is altogether from this source. It will be seen that the amount produced in 1896 is but half that for 1887. This is on account of the considerable falling off in the production of ore, and is not due to any lessening of the percentage of contained silver.

Ontario.

ONTARIO.

There has been no production of silver to record for this province for the past three years. The production was over $186,000 in 1887, increasing to nearly $223,000 in 1891, after which it fell away considerably for the following two years and entirely ceased in 1894. PRECIOUS METALS. Silver.

The silver production under consideration resulted from the operation of the silver mines of Thunder Bay district on Lake Superior. In 1885 and the years immediately following, there were many new discoveries in the district of fissure veins cutting the argillites, shales and traps and the lower cherty rocks of the Animikie. This led to a revival of the silver mining of that section which had languished after the closing down of the Silver Islet mines in 1884, and for some years following the prospects were hopeful, but for various reasons all these mines ceased operations. Ontario.

BRITISH COLUMBIA. British Columbia

This province contributed but little to the total output of silver for the Dominion until the last few years. From 1887 to 1890 it increased from nearly $12,000 to over $70,000 worth, but in 1891 it fell to but little over $3,000 worth. From that date till 1896 a continuous and very considerable growth is to be noted, the quantity having increased nearly ten times and the value about seven times, the latter being less in proportion on account of the heavy fall in the market price of silver.

The above noted growth in the industry of this province is to be credited to the opening up of the argentiferous galena mines in the southern part of the Kootenay division, which began in 1892. By far the largest amount is to be credited to the Slocan district, the Ainsworth and Nelson districts contributing also.

Discovery and location of silver-bearing ore deposits had been made from time to time for many years previous to 1892, and a certain amount of work had been done, notably at the Hall mines near Nelson, but the greatest impetus was given when work began in that year in the Slocan district. The average silver contents of these ores for the whole district has been high, and so many extensive ore-bodies have been found that success has attended the opening up of the district from the start and the province has thereby become prominent as a silver producer.

Numerous veins carrying argentiferous galena are also known to exist in other districts in the southern part of the province, but with few exceptions these have been but little worked.

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

PRECIOUS METALS.

Silver.

valuation in the two tables is different. With the exception probably of the figures for 1896, the valuation in the entries for export 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.

Exports of ore.

TABLE 9.

PRECIOUS METALS.

SILVER:—EXPORTS OF ORE.

Provinces.	Calendar Years. 1890.	1891.	1892.	1893.	1894.	1895.	1896.
	$	$	$	$	$	$	$
Ontario	203,142	222,071	35,992	7,878	....	100	....
Quebec *	900	....	....	....	....	....	....
Nova Scotia	....	....	....	....	....	....	....
Manitoba	....	....	80	820	....	....	....
British Columbia .	100	3,241	20,616	204,997	359,731	994,254	2,271,959
Totals	204,142	225,312	56,688	213,695	359,731	994,354	2,271,959

*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.

PYRITES.

The ore classed under this heading is a mixture of chalcopyrite or copper-pyrites ($CuFeS_2$), with iron-pyrites (FeS_2). It is mined as an ore of sulphur.

The production of pyrites was less during 1896, than in 1895, by 483 tons and $1,439, as shown in Table 1 below. The total production for the year was 33,715 tons, of which 23,562 tons were shipped to the United States as raw ore, while the remaining 10,153 tons were used in Canada. Almost all of that retained in Canada was treated by the Nichols Chemical Company in their works at Capelton, Que. After the sulphur of the ore has been extracted as sulphuric acid, the ore is run into a matte, and in this form is shipped to the United States to be refined for its copper and silver contents. The output for 1896 contained approximately 70,000 ounces of silver and 2,400,000 pounds of copper.

PYRITES.
Production.

TABLE 1.

PYRITES.

ANNUAL 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

Imports

TABLE 2.

PYRITES.

IMPORTS.—BRIMSTONE OR 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

* Brimstone, crude, or in roll or flour, and sulphur in roll or flour. Duty free.

SALT.

SALT.

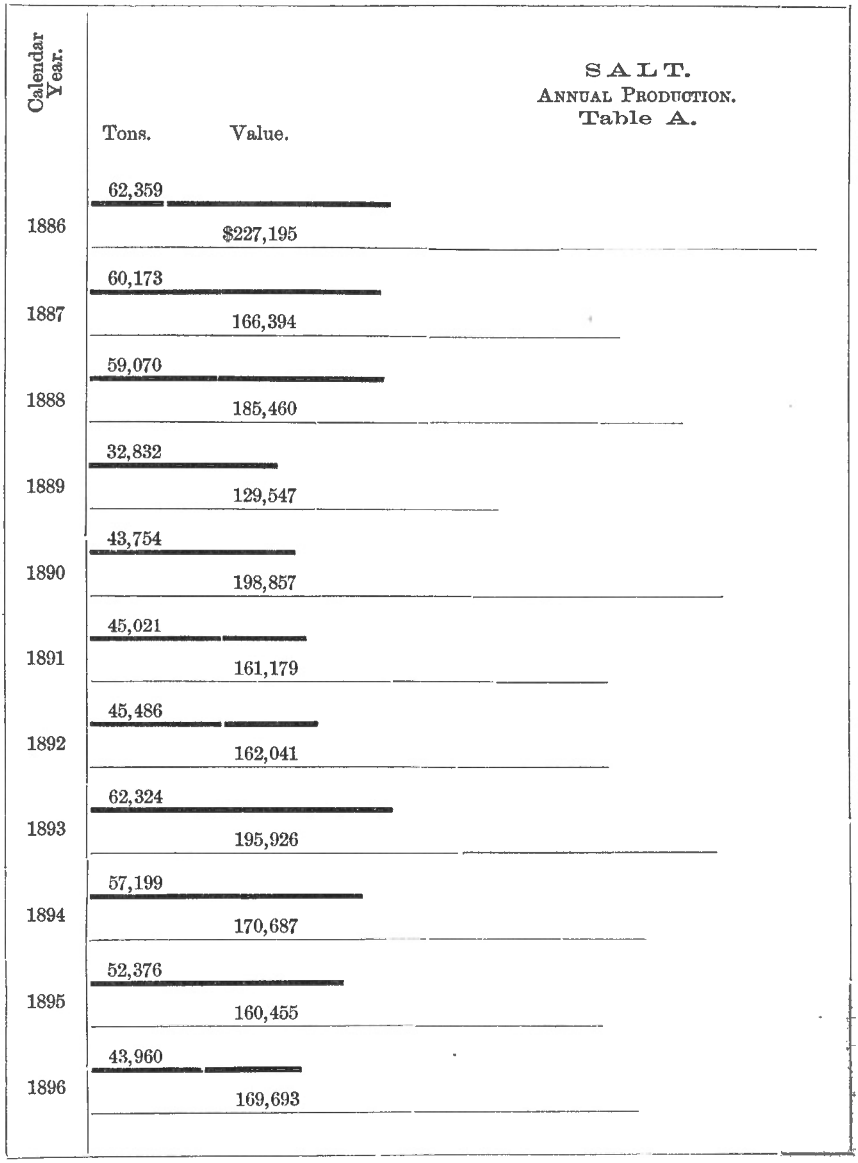
As this industry has been fully described in former Reports of this Section, no further details are necessary here. The production of 1896, compared with that of 1895, has decreased 8,416 tons, while the value has increased $9,238.

As heretofore the production of salt in Canada was almost entirely from the Ontario salt fields.

A small amount of salt was manufactured in the Dauphin Lake district in Manitoba. The following extract is taken from the Department of the Interior Report for 1896, p. 144.

" Between four and five tons of salt have been manufactured by Mr. Paul Woods at the south end of Lake Winnipegosis, which has been disposed of to the surrounding settlers. With the increased local demand from the fishing industry, and the improved transportation facilities, it is highly probable that Mr. Woods will enlarge his works, as, with an increased capacity, there is no reason why his works should not supply the requirements of the district with that article."

Salt.
Production.



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

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
	Duty.		
1896 Salt, coarse, N.E.S.	5c. per 100 lbs.	3,314,920	5,874
1896 Salt, fine, in bulk	5c. "	1,466,290	2,238
1896 Salt, N.E.S., in bags, barrels or other packages	7½c. "	2,884,047	16,438
Total		7,665,257	$24,550

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

*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.

Building Stone.

Building stone.—The production of building stone in Canada for 1896 was much the same as in 1895. The home consumption, however, shows a slight advance, for not only were the exports less than the year before, but the imports were greater.

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

STRUCTURAL MATERIALS.
Building Stone.

TABLE 2.

STRUCTURAL MATERIALS.

EXPORTS OF STONE AND MARBLE, WROUGHT AND UNWROUGHT.

Province.	Wrought.		Unwrought.	
	Calendar Years.			
	1895.	1896.	1895.	1896.
Ontario	$5,165	$3,367	$37,166	$16,599
Quebec	3,196	931	1,925	... ...
Nova Scotia	126	636	9,534	8,623
New Brunswick	100	....	2,925	7,675
British Columbia	....	....	66	....
Totals	$8,587	$4,934	$51,616	$32,897

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
		Duty.	
1896	Flagstones, granite and rough freestone, sandstone and all building stone, except marble from the quarry, not hammered or chiselled	20 p. c.	$42,737
	Granite and freestones, dressed; all other building stone dressed, except marble	30 "	11,393
			$54,130

STRUCTURAL MATERIALS.

Stone or Granite.

TABLE 4.

STRUCTURAL MATERIALS.

IMPORTS OF MANUFACTURES OF STONE OR GRANITE, N.E.S.

Fiscal Year.	Value.
1880	$29,408
1881	36,877
1882	37,267
1883	45,636
1884	45,290
1885	39,867
1886	41,984
1887	41,829
1888	47,487
1889	61,341
1890	84,396
1891	61,051
1892	39,479
1893	49,323
1894	49,510
1895	51,050
1896 ....Duty—30 p.c.	51,499

Marble.

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

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
	Duty.	
1896 Marble and manufactures of :—		
Blocks or slabs, sawn on not more than two sides.	10 p. c.	$27,782
do do more than two sides.	20 "	37,356
Finished	30 "	5,707
Manufactures of, N.E.S	30 "	16,263
Rough blocks	Free	2,957
Total marble and manufactures of		$90,065

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

STRUCTURAL MATERIALS. Slate.

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

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	30	8,913

Structural Materials.
Slate.

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

Year	Article	Duty.	Value.
1896	Slate and manufactures of—		
1896	Mantels	30 p. c	$ 334
1896	Roofing slate, black or blue	30 p.c., not over 75c. per square.	8,274
1896	" red, green or other colour	30 p.c., not over 90c. per square.	1,674
1896	School writing slates	30 p. c.	5,042
1896	Slate pencils	25 "	2,660
1896	Slate of all kinds and manufactures of, N.E.S.	30 "	6,192
	Total slate		$24,176

Flagstones.

TABLE 11.

STRUCTURAL MATERIALS.

PRODUCTION OF FLAGSTONES.

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,[illegible]87
1894	152,700	5,298
1895	80,005	6,687
1896	....	6,710

TABLE 12.

STRUCTURAL MATERIALS.

IMPORTS OF FLAGSTONES.

STRUCTURAL MATERIALS.

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.

*Flagstones, dressed. Duty—30 p.c.

Cement.—Cements embrace those materials obtained by burning or calcining certain rocks or mixtures of clay and limestone, slag, etc., which, when mixed with sand and water to form a mortar, "set" or harden without exposure to air. Cements are thus divided into two classes, natural-rock cements and artificial or Portland cements. Cement.

The principal constituent of all cements is lime. Cement rocks are limestones, either magnesian or not, having intimately mixed with them from 15 to 35 per cent clay. The presence of a small amount of alkalies is essential, and is important in determining the cement forming qualities of these rocks. When the rock has been calcined to a "clinker," it is ground to a very fine powder, and is then ready for use.

Artificial or Portland cement is manufactured by making a mixture in certain definite proportions of some lime-bearing material, such as limestone or marl, with clay, shale or slag, substances which contain silica, alumina and alkalies, and then burning it to a cement clinker. The limestone used must be free from magnesia, as this substance is injurious to Portland cement. When the clinker has been powdered, it must be allowed to air-slack for some time, and the quality gradually improves with age. It thus differs from natural-rock cement which is ready for use as soon as ground, and which has a tendency to deteriorate when exposed to the air. The finer the cement is ground the greater the amount of sand it will carry.

STRUCTURAL MATERIALS.
Cement.

Portland cements are manufactured in Quebec, Ontario and British Columbia, while natural-rock cements are produced in Ontario alone. Ontario supplies about 85 per cent of the total cement production of the Dominion.

The following is a list of the cement manufacturers from whom production returns for 1896 were received:

Natural Cement.—

Thorold Hydraulic Cement Works, Thorold, Ont.

Queenston Cement Works, Niagara tp., Lincoln county, Ont.

The Toronto Lime Co., Ltd., Toronto, Ont.

Hamilton Cement Works, Hamilton, Ont.

Portland Cement.—

The Rathbun Co., Deseronto, Ont.

Owen Sound Portland Cement Co., Ltd., Shallow Lake, Ont.

The C. B. Wright Co., Hull, Que.

Crescent Cement Works, Longue Pointe, Que.

The C.P.R. Portland Cement Works, Vancouver, B.C.

Fire Cement.—

Messrs. Hardy & Dubord, Mastaï, Que.

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. Natural	70,705	60,500
1896. Portland	78,385	141,151
Totals	149,090	201,651

STRUCTURAL MATERIALS.
Cement.

TABLE 14.

STRUCTURAL MATERIALS.

EXPORTS OF CEMENT.

Province.	Calendar Years.				
	1892.	1893.	1894.	1895.	1896.
Ontario	$399	$ 718	$339	$662	$484
Quebec	539	386	42	30	625
Nova Scotia	....	68	101	245	219
Totals	$938	$1,172	$482	$937	$1,328

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

* N.E.S. Duty—20 p.c.

STRUCTURAL MATERIALS.
Cement.

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
Duty.		
1896 Cement, hydraulic or waterline..........40 c. per brl.	5,688	$ 8,948

TABLE 17.

STRUCTURAL MATERIALS.
IMPORTS OF PORTLAND CEMENT.

Fiscal Year.	Duty.	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 Portland or Roman	40 c. per bbl.	204,407	$ 242,409

STRUCTURAL MATERIALS.
Cement.

TABLE 18.

STRUCTURAL MATERIALS.

PRODUCTION OF ROOFING CEMENT.

Calendar Year.	Tons.	Value.
1890	1,171	$ 6,502
1891	1,020	4,810
1892	800	12,000
1893	951	5,441
1894	815	3,978
1895	....	3,153
1896	86	430

Lime and Bricks.—The production of lime and bricks is so much in the hands of small producers, and so widely scattered over the country that it has been found impossible to obtain complete figures for either of these industries. The totals given in tables 19 and 22 are therefore partly composed of carefully formed estimates :—

TABLE 19.

STRUCTURAL MATERIALS.

ANNUAL PRODUCTION OF LIME.

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

STRUCTURAL MATERIALS.

Lime.

TABLE 20.

STRUCTURAL MATERIALS.

EXPORTS OF LIME.

Province.	Calendar Year.		
	1894.	1895.	1896.
Ontario	$ 13,208	$ 25,257	$25,500
Quebec	30,294	23,047	18,067
Nova Scotia	3,482	1,468	3,195
New Brunswick	33,830	21,891	24,058
Prince Edward Island	3	....	....
Manitoba	....	30	....
British Columbia	2,853	4	....
	$83,670	$ 71,697	$ 70,820

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 ....Duty—20 p. c.	10,239	7,331

STRUCTURAL MATERIALS.
Building bricks.

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

TABLE 23.

STRUCTURAL MATERIALS.

EXPORTS OF BRICKS.

Province.	CALENDAR YEARS.									
	1892.		1893.		1894.		1895.		1896.	
	M	Value	M	Value	M	Value	M	Value	M	Value
		$		$		$		$		$
Ontario	1,347	8,784	552	2,462	280	1,257	1,053	4,420	266	1,473
Quebec	353	1,566	2,189	17,969	68	917	82	1,092	41	200
Nova Scotia	252	1,662	2,561	16,449	489	3,252	199	834	600	3,276
New Brunswick	10	170	767	7,185	258	1,979	321	2,319	76	729
P. E. Island	1	10	.....	.....	.....	.....	.....	.....	.....	.....
British Columbia	.....	.....	4	45	.....	.....	.....	.....	.....	.....
Totals	1,963	12,192	6,073	44,110	1,095	7,405	1,655	8,665	983	5,678

STRUCTURAL MATERIALS.

Building bricks.

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........Duty—20 p. c.	23,189

Terra cotta.

TABLE 25.

STRUCTURAL MATERIALS.

PRODUCTION OF TERRA COTTA.

Calendar Year.	Value.
1888	$ 49,800
1889	Not available.
1890	90,000
1891	113,103
1892	97,239
1893	55,704
1894	65,600
1895	195,123
1896	83,855

STRUCTURAL MATERIALS.
Sewer pipes.

TABLE 26.

STRUCTURAL MATERIALS.

PRODUCTION OF SEWER PIPES, &c.

Calendar Year.	Value.
1888	$266,320
1889	Not available.
1890	348,000
1891	227,300
1892	367,660
1893	350,000
1894	250,325
1895	257,045
1896	153,875

TABLE 27.

STRUCTURAL MATERIALS.

IMPORTS OF DRAIN TILES AND SEWER PIPES.

Drain tiles and sewer pipes.

Fiscal Year.		Duty.	Value.
1880			$ 33,796
1881			37,368
1882			70,065
1883			70,699
1884			71,755
1885			69,589
1886			57,953
1887			71,203
1888			101,257
1889			83,215
1890			77,434
1891			87,195
1892			59,537
1893			39,001
1894			24,625
1895			21,053
1896	Drain tile, not glazed	20 p. c.	$ 339
	Drain pipes, sewer pipes, chimney linings or vents and inverted blocks, glazed or unglazed.	35 "	18,957
	Total		$19,296

STRUCTURAL MATERIALS.
Pottery.

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

Earthenware.

TABLE 29.

STRUCTURAL MATERIALS.

IMPORTS OF EARTHENWARE.

Fiscal Year.		Duty.	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	Earthenware and china;—		
	Brown or coloured earthen and stoneware, and Rockingham ware	30 p. c.	$ 12,821
	Decorated, printed or sponged, and all earthenware, N.E.S.	30 "	180,910
	Demijohns or jugs, churns and crocks	3c. per gall. (holding capacity).	4,146
	White granite or ironstone ware, C. C. or cream coloured ware	30 p. c.	187,161
	China and porcelain ware	30 "	161,594
	Earthenware tiles	35 "	16,432
	Manufactures of earthenware, N.E.S.	30 "	12,429
	Total earthenware		$575,493

TABLE 30.

STRUCTURAL MATERIALS.

EXPORTS OF SAND AND GRAVEL.

STRUCTURAL MATERIALS.

Sand and gravel.

CALENDAR YEAR.		Tons.	Value.
			$
1893		329,116	121,795
1894		324,656	86,940
1895		277,162	118,359
1896	Ontario	224,003	77,909
	Quebec	458	1,115
	Nova Scotia	235	940
	New Brunswi k	73	146
	Manitoba	....	....
	British Columbia	....	....
	Total	224,769	80,110

TABLE 31.

STRUCTURAL MATERIALS.

EXPORTS OF SAND AND GRAVEL.

Calendar Year.	Tons.	Value.	Calendar Year.	Tons.	Value.
1877	11,998	$ 2,151	1887	180,860	$ 30,307
1878	50,140	8,381	1888	260,929	38,398
1879	46,999	9,438	1889	283,044	52,647
1880	53,951	11,177	1890	342,158	65,518
1881	58,693	15,129	1891	243,724	59,501
1882	60,158	16,218	1892	297,878	85,329
1883	55,346	14,065	1893	329,116	121,795
1884	73,741	19,978	1894	324,656	86,940
1885	110,661	22,878	1895	277,162	118,359
1886	124,865	24,226	1896	224,769	80,110

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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.