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GEOLOGICAL SURVEY OF CANADA
ROBERT BELL, M.D., Sc.D. (Cantab.), LL.D., F.R.S.

ANNUAL REPORT

(NEW SERIES)

VOLUME XIII

REPORTS A, D, DD, F & FF, K, L, M & MM, R, S.

1900

OTTAWA
PRINTED BY S. E. DAWSON, PRINTER TO THE KING'S
MOST EXCELLENT MAJESTY
1903

No. 830.

To the Honourable

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

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

The volume comprises 747 pages. It is accompanied by eight maps and is illustrated by fifteen 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,

ROBERT BELL,
Acting Director.

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SUMMARY REPORT

ON THE

OPERATIONS OF THE GEOLOGICAL SURVEY

FOR THE YEAR 1900

BY

THE DIRECTOR

OTTAWA
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1901

No. 717

SUMMARY REPORT

ON THE

OPERATIONS OF THE GEOLOGICAL SURVEY

FOR THE YEAR 1900.

OTTAWA, January 15, 1901.

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

SIR,—I have the honour to submit herewith the Annual Summary Report of the Geological Survey Department, which, in conformity with the Act, covers the proceedings and work of the Survey during the past calendar year. In this report, especial prominence is given to the results of field-work accomplished during the past summer, thus affording an early publication of a preliminary kind for any new facts obtained, whether of economic or of scientific importance. It must at the same time be remembered that this report relates merely to work done by the Geological Survey Department or in connection with which this Survey has taken some part. It can not therefore be regarded as in any sense a general review of the progress made in the subjects to which it relates in Canada as a whole. Nature of this report.

Although the printing of volume XI. (new series) of the annual reports of the Geological Survey (English edition) was stated to be in progress in my Summary Report of last year, the completion of the volume has unfortunately been delayed owing to circumstances not under the control of this Department. This volume is now, however, nearly ready for issue. Its constituent parts, with two exceptions, have already been separately made available to the public. They are as follows: Printing of Volume XI.

Summary report of the Geological Survey Department for 1898, by the Director. Separate reports contained in this volume.

Report on the Geology and Natural Resources of the country traversed by the Yellow Head Pass route, by J. McEvoy.

Report on the Geology of the west shore and islands of Lake Winnipeg, by D. B. Dowling.

Report on the east shore of Lake Winnipeg and adjacent parts of Manitoba and Keewatin, from notes and surveys, by J. B. Tyrrell.

Report on the Geology of the Three Rivers map sheet or north-western sheet of the 'Eastern Townships' map, Quebec, by R. W. Ells.

Report on an exploration of part of the south shore of Hudson Strait and of Ungava Bay, by A. P. Low.

Report of an exploration on the northern side of Hudson Strait, by R. Bell.

Report of the section of Chemistry and Mineralogy, by G. C. Hoffmann.

Report of the section of Mineral Statistics and Mines, by E. D. Ingall.

Maps.

The volume will be accompanied by four coloured geological maps pertaining to several of the above mentioned reports.

The French edition of volume X. (new series) has I regret to say not yet been received from the printers. The translation of the parts composing volume XI. is well advanced.

Special publications issued during 1900.

A number of special publications, distinct from those included in the annual volumes, have been issued during the past year. These are as follows, in the order of their publication.

Descriptive note on the Sidney Coal Field, Cape Breton, N.S., to accompany a revised edition of the Geological map of the Coal Field, by H. Fletcher.

Summary of Mineral production of Canada in 1899. Issued Feb. 27, 1900.

Preliminary Report on the Klondike Gold Fields, Yukon District, by R. G. McConnell.

Catalogue of Canadian Birds. Part I., by J. Macoun.

List of publications of the Geological Survey of Canada (revised to date).

Descriptive Catalogue of a collection of the Economic Minerals of Canada. Paris Exhibition, 1900.

Catalogue descriptif des minéraux du Canada. Exposition Universelle de 1900. Paris.

General index of the reports of the Geological Survey from 1863 to 1884, by D. B. Dowling.

Mesozoic Fossils, vol. I., part IV.—On some additional or imperfectly understood fossils from the Cretaceous rocks of the Queen Charlotte Islands, with a revised list of the species from these rocks, by J. F. Whiteaves.

The preliminary report on the Klondike Gold Fields, above alluded to, was subsequently embodied in the Summary Report for 1899, but the separate copies were widely distributed in advance. The general index of reports, as now issued, forms a volume of 475 pages. It is intended to be followed by a similar index of the first ten volumes of the new series, but as this is a work of much labour its completion will require some time. The catalogues of the Canadian minerals exhibit at Paris, in English or French, were prepared in this office and it is intended to distribute copies of them to our exchanges as a matter of record. They comprise 217 and 234 pages respectively, and are further alluded to in the sequel in connection with the exhibition work.

Report on Klondike.

General Index.

During the year 1900, twelve new maps have been completed and printed and eighteen are at the present time either in the engraver's hands or in press. These are enumerated in the report of the chief draughtsman on a later page.

Maps issued.

Some of the publications above enumerated have not yet been distributed to our exchanges or to those otherwise entitled to them, owing to the rearrangement of our lists of addresses, which has been in progress, but is now nearly completed.

Previous to his transfer from this Department to the Interior Department, Mr. James White had undertaken the preparation of a list of *Altitudes in the Dominion of Canada*. This, which has proved to be a most laborious work, has now been completed by Mr. White, and is among the publications actually in press at the present time.

Altitudes in Canada.

It is still unfortunately necessary to draw attention to the want of a safe or sufficiently commodious building for the museum and offices of the Geological Survey. The danger of the total destruction of the invaluable collections and records by fire continues, while the inadequacy of space for the display or even for the storage of valuable and interesting specimens becomes more serious daily. This matter has so often been urged and so fully explained in previous reports that it is unnecessary here to enter into detail. The need of a new building is, however, a very pressing one.

New museum building necessary.

The number of inquiries received and replied to continues to increase each year. Most of these relate to minerals of commercial value, some to points of a purely scientific character, some to geographical questions, and many can only be classified as miscellaneous. The familiarity of members of the staff with all parts of Canada, often renders it possible to afford information of a local kind to inquirers that may be of importance to them. In addition, large numbers of specimens of ores, rocks and natural objects of all kinds are received and examined for the senders, and requests are frequently made for the

Information supplied by correspondence.

addresses of the producers or purchasers of various substances. Much time is spent by several members of the staff in dealing with such matters by correspondence, but the results are of undoubted value to the public.

Minerals inquired for.

The following minerals are cited as having been specially inquired for during the year by intending purchasers or those wishing to employ the substances practically. Repeated inquiries have been received in regard to some of them :— Albertite, Asphaltum, Asbestus, Bituminous shale, Beryl, Bauxite, Chromic iron, Corundum, Chalk, Elaterite, Fire-clay, Felspar, Hæmatite, Iron sand, Iron-pyrites, Kaolin, Limestone, Magnesite, Magnetite, Manganese, Molybdenite, Mica, Marble, Monazite, Petroleum, Phosphate (apatite), Slate, Tin, Zinc, Zircon.

Parties in the field.

The following statement shows the number and distribution of the parties at work in the field during the past season :—

Yukon District	1
British Columbia	3
Mackenzie District	1
Ontario	3
Ontario and Quebec	1
Quebec	1
New Brunswick	2
Nova Scotia	1
	13

The above represent parties engaged continuously during the greater part of the summer in geological work. The selection of Messrs. Low and Faribault for special work in connection with the exhibition in Paris, the appointment of Mr. A. E. Barlow, as lithologist, the assignment of editorial work to Mr. D. B. Dowling, and the inability of Dr. F. D. Adams to continue work for the survey in 1900, reduced the ordinary number of field parties. The interruption in experimental boring operations in Alberta also reduced the number by one. It was endeavoured to compensate these temporary losses in the field force by arranging for special work by gentlemen not on the survey staff, but who had sufficient field experience, and Messrs. J. M. Bell, W. A. Parks and G. A. Young were thus employed, as detailed on later pages.

Field work of other kinds.

Geological work was also carried out for shorter periods during the summer by Messrs. Ami, Barlow, Ingall, Denis and Le Roy. At the suggestion of, and by special arrangement with the Hon. G. W. Ross, Premier of Ontario, Professor Macoun undertook a Natural History survey of the Algonquin Park area of Ontario. His preliminary statement is printed herewith, and a detailed report will be prepared by him on the area in question.

Report of Prof. Osann.

Professor A. Osann, of Mülhausen, Germany, has now practically completed his work on the apatite- and graphite-bearing rocks of that part of Quebec to the north of the Ottawa river, and a report embodying his results is expected shortly. The Survey is greatly indebted to Professor Osann for his labours in this connection.

Work by Dr. G. F. Matthew.

Dr. G. F. Matthew, has been able to continue during some weeks in the past summer his examination of the Cambrian rocks of Cape Breton island, with important results. It is hoped that after further work, which appears to be still necessary, he may be able to furnish a complete report upon the older rocks of this interesting region, and on their contained fossils.

Prof. J. A. Dresser.

Professor J. A. Dresser, of St. Francis College, Richmond, Quebec, is now nearly ready to complete his monograph on the structure and petrography of Shefford mountain; being the results of an investigation which he has carried on with but slight assistance from the Geological Survey. A brief report on this work is given on a later page.

Work on iron ores.

The work accomplished by Messrs. Ingall and Denis, bearing on the iron ore deposits of eastern Ontario, is further referred to in the report of the Section of Mineral Statistics and Mines, in the sequel. On a later page a short report by Mr. O. E. LeRoy, is also given, noting the progress made in the mapping of formations near Montreal, in connection with an investigation of artesian wells there, which have been made the subject of study by Dr. F. D. Adams, and upon which that gentleman offers a report for publication by the Geological Survey.

Geology of Montreal.

Collection of fossil vertebrates.

The late Prof. D. E. Cope had in his keeping, at the time of his death, some considerable collections of Cretaceous and Tertiary vertebrate remains made by officers of the Survey in the North-west Territories. He had examined and described some of these in *Contributions to Canadian Palæontology*, Vol. III., Part I. Since that time efforts had been made to obtain additional material, particularly from the Cretaceous beds of the Belly River formation, Mr. L. M. Lambe having spent parts of two seasons in the field with that object. With a view to getting this material dealt with under the auspices of a recognized authority, I communicated early in the year with Professor H. F. Osborn, Curator of Vertebrate Palæontology of the American Museum of Natural History, New York, who very promptly and kindly undertook to supervise the work on vertebrate fossils in the possession of the Survey. Prof. Osborn visited Ottawa in April, and since that time Mr. Lambe has been occupied, under his guidance, in working up and drawing these fossils for publication. The survey is deeply indebted to Professor Osborn for his wholly gratuitous assistance in this

Collaboration by Prof. H. F. Osborn.

matter. When the investigation is completed, it is intended to publish the Cretaceous material as a second part of the volume above referred to.

Acknowledgments for assistance.

Besides the gentlemen above named, the Survey has as usual been indebted during the past year to a number of scientific men for assistance given by them in connection with its work. Among these the following may be especially mentioned:—Dr. S. H. Scudder, Cambridge, Mass.; Dr. Wheelton Hind, Stoke-on-Trent; Professor J. B. Porter, Montreal; Mr. R. Kidston, Stirling, Scotland; Mr. David White, U. S. National Museum, Washington; Dr. Henry Woodward and Mr. A. Smith Woodward, of the British Museum.

Testing of economic minerals

During the year a number of specimens of mineral products have been obtained and sent out as samples or for purposes of examination by experts. In this connection, the following may be mentioned:—

Mica.

Mica.—The growing importance of the mica industry, particularly in the Ottawa district of Quebec and in parts of Eastern Ontario, has given rise to various questions in regard to the product of the mines and workings. This is an 'amber mica' or phlogopite, employed in the construction of electrical machinery. The market has been so far chiefly in the United States or in Canada, where higher prices have been realized than could be obtained in competition with Indian mica in Great Britain. As the Indian mica has throughout been equally available to customers in the United States, there appeared to be reason to assume that the preference for the Canadian 'amber mica' really indicated a superiority in quality for electrical purposes, dependent on the high degree of insulation afforded by this mica, with its flexibility and softness, the latter quality enabling sheets of requisite thickness to wear down equally with the adjacent copper.

Specimens reported on by Prof. W. R. Duncan.

Advantage was therefore taken of the kind offer of Professor Wyndham R. Duncan, F. R.S., Director of the Scientific and Technical Department of the Imperial Institute, London, to submit some specimens of the Canadian 'amber mica' to the special examination of experts. From Prof. Duncan's report upon these tests, lately received, the following extracts may be given. They appear fully to bear out the opinion formed as to the exceptionally high value of this mica for electrical purposes.

'The four samples consisted of very fine specimens of Canadian "knife-trimmed" amber mica, labelled as follows:—

1. Wallingford Mine.
2. Lake Gerard Mine.
3. Vavasour Mine.
4. Blackburn Mine

'They are stated to represent a fair average commercial quality and size.

'General physical and chemical examination showed that the samples were uniform in character, pliable and softer than much of the mica which appears in the English market.

'In order to ascertain its commercial value, and especially its fitness for electrical purposes, the samples were submitted to one of the largest electrical manufacturers in London, and also to one of the largest mica brokers in the city.

'The electrical manufacturers report that the mica is suitable for a variety of electrical purposes, but they refrain from quoting a price for it and recommend that this could be done better through mica merchants.

Electrical manufacturers.

'The mica merchants have taken considerable pains in examining the samples and have made a very full report. They state that the approximate values in the London market are as follows :—'

Mica merchants.

[The values range from 1s. to 5s. 6d. per pound for the actual samples sent, but as the values depended more on the size of the plates actually sent (which were far from uniform) than on the intrinsic peculiarities of the specimens, it might be misleading to publish these figures in conjuction with the names of the several mines.]

Prices.

'It is evident, however, that greater importance is attached to the size of the plates in the London market than in that of the United States.

'The brokers add that the Wallingford sample, being of especially fine quality, would be eagerly sought after in the British market. The product of the Vavasour Mine would also command a large sale here. The Blackburn sample, to which a large price is attached chiefly on account of the size of the plates, shows rather serious cracks and is not quite flat, otherwise it would have been of even greater value. It is also pointed out that the Lake Gerard mica ought to command greater success in the British market than has been hitherto the case. Its indifferent success is attributed by the brokers chiefly to an attempt to direct business through a London office, instead of proceeding through the usual channels.

Opinions on different samples

'On the general question of the uses and comparative value of the Canadian amber mica, the brokers remark that this variety of mica is of no other value than for electrical purposes, its special value being principally due to its softness and easy lamination. They are of opinion that Canadian amber mica is of greater value for electrical work than most of the Indian mica that comes to this country. They remark, however, that there are two or three varieties of Indian mica,

General character of Canadian amber mica.

such as White Bengal, Cochin, from the west coast of Madras and Ceylon amber mica, which compare very favourably with Canadian product, whilst the selling prices of these Indian varieties are often from one-third to one-half those asked for the Canadian mica. They confirm the opinions expressed in Dr. Dawson's letters of February 16 and April 4 of this year, that Canadian miners obtain a better price in the United States than in the London market, chiefly from the circumstance that American electricians prefer the Canadian product which is close at hand and can be depended upon for uniformity of quality and regularity of supply.

Markets.

'Although circumstances point to the United States as being the natural outlet of Canadian mica, nevertheless it would be worth while to take steps to make it better known in the British market, since there are several factors operating against the Indian product, especially in the matters of tariff and regularity of supply.

'If the proprietors of the mines represented by the samples now under consideration are of opinion that the values quoted are sufficiently encouraging to make it worth while to send trial shipments to this country, I shall be glad to put them in communication with the brokers who have expressed their willingness to give then any assistance in their power.'

Molybdenite.

Molybdenite.—A number of inquiries received during the past few years have drawn attention to known Canadian deposits of this mineral, but none of the owners of such deposits appear to have attempted to work them. Molybdenite often occurs in rather small proportions in the containing rock or vein-stone, and it seemed possible that such deposits might be utilized on a comparatively large scale, if the mineral could be obtained in pure form by any economic process of concentration. Professor J. B. Porter of McGill University, having offered to subject ores and minerals sent by the Geological Survey to practical tests in the finely equipped mining laboratory of the university, Mr. C. W. Willimott was instructed to obtain a couple of bulk samples of molybdenite ores from well known and accessible localities, for this purpose. These were secured from lot 69 Range IV. Egan township, Wright county, Quebec and from lot 22, Range II. Ross township, Renfrew county, Ontario, respectively. They were treated by Messrs. S. F. Kirkpatriek and W. A. Moore under Professor Porter's superintendence.

Tests made by Prof. J. B. Porter.

Ore from Egan township.

The first, or Egan township sample, weighing 289 pounds, and containing in all 15·92 per cent of molybdenite, was cobbed and hand-picked in the Survey, yielding 39 pounds of clean mineral in crystalline flakes. The remaining 250 pounds of the cobbed ore was then sent to Professor Porter, who ascertained that it still contained 2·8 per cent of molybdenite. By a dry process of rolling and screening, followed by jigging, nearly all the molybdenite was extracted from this ore, in a series of concentrates ranging from 70 per cent to 15 per cent in molybdenite. It is not necessary to refer to the details of treatment here, but the results appear to show that in the case of molybdenite ore of this class, in which the crystalline masses are of considerable size, it would not be economically possible to employ any crushing and concentrating process. The problem resolves itself into one of cobbing and hand-picking at remunerative rates. The associated minerals in this case were, pyroxene, iron-pyrites and mica.

Ore from Ross township.

The second, or Ross township sample, weighed 250 pounds. The gangue was chiefly quartz, and, although the molybdenite made a considerable showing, it was found by Professor Porter to amount to only about one per cent. This specimen was not cobbed or hand-picked. By concentration it was determined that about 52 per cent of the molybdenite could be saved in the form of a concentrate containing 33·50 per cent of the mineral. The grade of this concentrate appears, however, to be too low for present commercial requirements.

Auriferous sands from Atlin.

Auriferous Black Sands.—Some samples of auriferous black sands from sluice-boxes in the Atlin district, British Columbia, were collected by Mr. J. C. Gwillim. From these, after the coarser gold is secured, the very fine gold is separated with difficulty, amalgamation being in some cases employed. The samples were, through Professor J. B. Porter's kindness and under his superintendence, subjected to treatment with the Wetherill Magnetic Separator by Dr. A. E. Barlow and Mr. Andrews. The results are interesting, and satisfactory in showing that by this method a very large proportion of the heavy minerals may readily be removed, leaving a very rich auriferous product. The results seem to suggest the possible utility of the employment of this new machine in treating black sand concentrates obtained in gold dredging operations. Professor Porter's report is as follows:—

Treatment.

'The several samples received were all treated exactly alike. Each was passed through the Wetherill Magnetic Separator three times. The first time with a current of ·15 ampere or 1,207 ampere turns; the second with 1·5 amperes or 12,075 ampere turns and the third with 3·8 amperes or 30,590 ampere turns in the magnets.

'The distance between the main and cross belts was the same in each case, $\frac{2}{10}$ inch for A magnet and $\frac{11}{100}$ for B magnet.

'In the first pass only one product was made, the B magnet removing so little that it was not weighed and was permitted to go in with B product of the second pass. In the other cases two products were made for each pass, and the non-magnetic materials from the last pass constituted the "tails" which in these tests were the valuable portions.

'As the samples were all very small, we did not make any attempt to keep separate the various magnetic portions. Each was examined by the eye and its character noted, and then all of the magnetic portions of each sample were mixed, ground and assayed.

Pine creek.

'*Pine Creek*, Black sand.—Atlin.

Total weight of sample	9·40	grammes.
Magnetic portion	5·25	"
Non-magnetic	4·15	"

'*Assays.*—Non-magnetic, 916 oz. gold per ton. Magnetic, not assayed.'

Stephendyke.

'*Stephendyke*, Black sand.—Atlin.

Total weight of sample, 22·90 grammes.

Pass	I.	A.,	1·35 grammes,	chiefly magnetite.
		B.,	A few grains mixed with II. B.	
"	II.	A.,	5·30 grammes,	chiefly ilmenite.
		B.,	3·40 "	ilmenite and garnet.
"	III.	A.,	2·20 "	yellow garnet and some ilmenite.
		B.,	0·10 "	serpentine, epidote, &c.
Non-magnetic,			10·55 "	= 46·3 p.c.

'*Assays.*—Non-magnetic, 5,985 oz. gold per ton. Magnetic, 0·4 oz. gold per ton.

'*Remarks.*—The non-magnetic portion carries about 37·5 oz. per ton of platinum or metals of the platinum group, but this cannot be taken as an accurate quantitative result, as the platinum assay was somewhat unsatisfactory.'

Willow creek.

'*Willow Creek*, Black sand.—Atlin.

Total weight of sample, 128·95 grammes.

Pass	I.	A.,	49·65 grammes.	Nearly pure magnetite.
		B.,	A few grains mixed with II. B.	
"	II.	A.,	14·10 grammes	serpentinous grains and grains of black mineral (ilmenite and chromite).
		B.,	11·75 "	serpentine and dark grains.
"	III.	A.,	35·65 "	serpentinous grains, &c.
		B.,	3·70 "	" " "
Non-magnetic,			14·10 "	=10·95 p.c. of total.

'*Assays.*—Non-magnetic, 0·5 oz. gold per ton. Magnetic, trace of gold.

'*Remarks.*—The magnetic portion contains a small amount of platinum. This sample was marked "after amalgamation

'*Spruce Creek*, Black sand.—Atlin. Spruce creek.

Total weight of sample, 359·50 grammes.

Pass	I. A.,	311·30 grammes, almost pure magnetite.		
"	B.,	A few grains mixed with II. B.		
"	II. A.,	11·00 grammes magnetite and hæmatite.		
"	B.,	14·15	"	specular hæmatite and a little magnetite.
"	III. A.,	13·55	"	a mixture of hæmatite and serpentine grains.
"	B.,	1·10	"	serpentinous grains.

Non-magnetic, 8·40 " = 2·3 per cent.

'*Assays.*—Non-magnetic, 52 oz. gold per ton. Magnetic, 0·20 oz. gold per ton.'

'*Boulder Creek*, Black sand.—Atlin. Boulder creek.

Total weight of sample, 90·25 grammes.

Pass	I. A.,	16·00 grammes magnetite.		
"	B.,	A few grains.		
"	II. A.,	9·15 grammes, a little magnetite.		
"	B.,	47·05	"	chiefly ilmenite.
"	III. A.,	5·50	"	ilmenite with some brown garnet.
"	B.,	0·20	"	garnet, &c.

Non-magnetic, 12·35 " = 13·7 per cent.

'*Assays.*—Non-magnetic, 231·0 oz. gold per ton. Magnetic, a trace of gold.'

'*McKee Creek*, Black sand.—Atlin. McKee creek.

Total weight of sample, 57·4 grammes.

Pass	I. A.,	18·35 grammes, nearly pure magnetite.		
"	B.,	A few grains.		
"	II. A.,	8·90 grammes, chiefly magnetite.		
"	B.,	10·35	"	dark minerals containing some magnetite.
"	III. A.,	10·85	"	chiefly serpentinous.
"	B.,	0·40	"	" "

Non-magnetic, 8·55 " 14·9 per cent.

'*Assays.*—Non-magnetic, 748·5 oz. gold per ton. Magnetic, 1·4 oz. gold per ton.'

Discovery of salt near St. Grégoire.

In the summary report of this survey for 1887 (p. 33 A), the record of a well bored to a depth of 1,115 feet, near St. Grégoire, Beauce county, Quebec, is quoted from Mr. J. Obalski, Inspector of Mines for the province of Quebec. This well was sunk in search of natural gas, and since that time further sinkings have been made in the same region, but so far without very important results. In March last, however, Mr. Obalski kindly drew my attention to a well bored by Mr. E. Bergeron, on the Concession Pointu, in Bécancour, about two miles east of St. Grégoire village, which was of interest in yielding a rather strong brine. This locality is situated near the western border of an area geologically mapped as of Medina age, characterized at the surface by reddish rocks. The section, according to Mr. Obalski, is approximately as follows:—

Section in well.

	Feet.
Clay (Pleistocene)	35
Gray calcareous sandstone	25
Red shale	545
Bluish shale	5
Reddish 'salt rocks'	50
Yellowish-gray calcareous shales	25
	685

At 195 feet and 240 feet, small quantities of gas were observed. The so called 'salt rock' was supposed to consist in large part of rock-salt and said to dissolve. It appears to have been associated, however, with some limestone.

Salt in the Medina formation.

The log of the boring is evidently imperfect, but, taken in conjunction with some specimens received, it appears that the Medina extends to the depth reached, and that the brine obtained comes from that formation. The thickness of the Medina in the previous boring was supposed to be 565 feet. So far as I am aware this is the first occurrence of salt in the Medina of Canada, although in the state of New York numerous brine springs have been noted in that formation. These are enumerated in a report by Mr. D. D. Luther,* but none of them appear to have possessed any permanent importance for the manufacture of salt, and some are recorded as yielding only impure brines. The brine obtained from the present boring, examined in the laboratory of the Survey, proved to contain 3,546 grains (or a little more than eight ounces) of common salt to the imperial gallon, but this was accompanied by considerable quantities of chlorides of calcium and magnesium, besides other impurities in lesser amounts. There is therefore little reason to believe that the salt deposit of this place is likely to be of commercial value.

Brine impure.

*The brine springs and salt wells of the state of New York and the geology of the salt district, 1898, p. 177.

The Act of Parliament authorizing a subsidy to a railway through the Crows Nest pass, having assigned the duty of selecting a certain area of the coal lands of the Crows Nest pass coal basin for the Government to the Director of the Geological Survey, it appeared to be necessary to obtain at an early date all the information requisite for this purpose—particularly in view of the fact that the Crows Nest Pass Coal Company was already actively at work in some parts of the field. Mr. J. McEvoy was, therefore, intrusted with this work. The co-operation of Mr. A. O. Wheeler of the Topographical Surveys Branch, for the necessary survey of the district, was also secured and the methods of work arranged with the Surveyor General. Surveys of Crows Nest coal basin.

In the latter part of August I personally visited the district to ascertain the progress made and the general nature of the results arrived at. As long ago as 1883 I had outlined the area of the Cretaceous coal-bearing rocks of this part of the Rocky mountains, and in 1891, after some exploratory work had been done upon the outcrops of seams, these were visited by Dr. Selwyn, late Director of the Survey. Inspection by the Director.

Mr. McEvoy's more detailed work has necessarily to some extent modified the outlines as originally drawn, and has already added much to the precision of our knowledge both in this regard and in respect to the thickness and succession of the seams. His preliminary report is given on later pages, and it will be found to more than justify the earlier statements as to the exceptionally great value of this remarkable coal field, which he estimates to contain over 22,000,000,000 tons of possibly workable coal. Estimated quantity of coal.

The great value of this coal depends largely upon its excellent coking character and low percentage in ash or other deleterious substances, combined with its position in regard to growing centres of metalliferous mining. It must be added, however, that great skill and care will evidently be needed in properly developing and fully utilizing the field, which in some respects present peculiar conditions. The highly bituminous character of the coal, already gives evidence that very effective ventilating apparatus will require to be installed as the workings extend, in order to avoid dangerous accumulation of gas. The great thickness of some of the seams, with the often tender character of the coal composing them, will present difficulties in the way of cheap and complete extraction; while the fact that levels run in the seams from the bottom of the intersecting valleys are at a depth of 3,000 feet or more below the general level of the surface of the intervening plateau-like areas, may probably render it necessary to contend with exceptional pressure upon the workings as these progress. Special conditions met with.

The output of the Crows Nest pass coal mines is at present over 1,000 tons per diem. Coking ovens to the number of 360 are in operation and large additions are in contemplation. Present output.

Discoveries of coal in British Columbia.

In connection with the subject of coal in British Columbia, it may be mentioned here that recent explorations, taken in conjunction with information previously obtained, lead to the belief that large and important coal-fields will be available, when required, in the northern part of that province. The explorations particularly referred to are those which have been carried out for the Department of Railways and Canals under Messrs. J. S. O'Dwyer and A. H. Dupont. Notes and specimens brought back by these gentlemen and handed over to the Geological Survey, show that the coal-bearing Cretaceous rocks occupy a much larger area than had been supposed between the 55th and 57th parallels of latitude, while anthracitic coals have actually been found in the region about the head-waters of the Skeena and Stikine rivers. This northern region may eventually add materially to the already great wealth of British Columbia in coal.

Specimens of bituminous and coking coal of good quality, indicating a new and perhaps important locality for this fuel in British Columbia, have also lately been received from the south side of the Tulameen river, west of Granite creek. This is a fuel of Tertiary age that has been subjected to local condition of alteration, and resembles in this respect and in its character that of the Nicola valley, which has previously been described in the reports of this Survey.

Coals in Yukon district.

The specimens of mineral fuel so far obtained from the Klondike region and from the vicinity of Forty-mile creek on the Yukon, have proved to be lignite-coals, possessing only a medium economic value; but, quite recently, samples have been received of an anthracite coal from a locality west of Lake Marsh and near the new line of railway. This proves on assay to contain a very large percentage of ash, but it affords reason to hope that better fuels may be found by search in the same vicinity. It is further referred to in Mr. McConnell's report, in the sequel.

Canadian Mineral Exhibit at Paris.

Preparations for Paris Exhibition.

The preparations made, under the auspices of the Geological Survey, for the representation of the minerals of Canada at the Paris Exhibition of 1900, were referred to in the last Summary Report. These continued to occupy much of my own time in the early months of the year, for, in addition to the receipt and repacking of the exhibits a they came in, which was particularly attended to by Mr. C. W. Willimott, every detail of the installation in Paris had to be provided for in advance, in conformity with the plans received of the part of the Canadian pavilion that they were to occupy. Show-cases of various patterns had to be made, as well as special supports for the heavier specimens. Index maps, showing the localities from which each mineral came, were printed and coloured, and series of cards, coloured differently for each province in the Dominion were also prepared.

Catalogue, etc.

As the specimens arrived at Ottawa they were examined and listed, and when the greater number had been despatched to Paris, the preparation of a descriptive catalogue was begun with these lists as a basis. The work on this catalogue was necessarily somewhat hurried, but a arge amount of information was condensed in it. Owing to delays in printing, and to the necessity of publishing an edition in French as well as in English, a supply of the catalogues was not received in Paris until some time after the opening of the exhibition, but this could scarcely have been avoided under the circumstances. A pamphlet of a general and popular character on the economic minerals of Canada was also prepared for distribution in Paris, and large editions of this were printed both in English and French. It appears that there was a great demand for these pamphlets and for the catalogue, particularly for the French editions.

Arrangements for supervising the exhibit.

The collection sent to Paris was the largest and most comprehensive ever brought together in Canada for exhibition purposes, and it consisted exclusively of minerals of commercial value, either for export or for use in the country itself. When it had been despatched, it was arranged that Mr. E. R. Faribault should follow in time to carry out its installation, in association with Mr. Willimott, while Mr. A. P. Low was to relieve Mr. Faribault at a later date, complete the attendance on the collection at the exhibition and supervise its packing and shipment in the autumn. During the progress of the exhibition at Paris, it was decided by the Minister of Agriculture that most of the exhibits should (instead of being returned directly to Canada) be sent on to Glasgow for the International Exhibition to be opened there in May next. This decision affected practically the whole of the specimens of minerals, and these are now, therefore, either in storage in Glasgow or on their way to that city.

Reports made by Messrs. Low and Faribault.

The following report on the mineral exhibit at Paris combines separate reports made by Messrs. Faribault and Low. The first part is entirely due to the first-named gentleman, while many of the notes referring to inquiries for certain mineral substances and possible markets have been supplied by Mr. Low. The joint report of these gentlemen will be read with interest. Particular attention may be directed to the large number of awards obtained by Canada in the mineral group.

Officers at Paris.

Mr. E. R. Faribault left Ottawa for Paris on the 15th of February, in company with Mr. C. W. Willimott, to superintend the installation of the collection of minerals from Canada.

The space allotted to the Canadian mineral exhibit covered about 3,550 square feet and occupied the greater part of the ground floor of the second wing of the Canadian pavilion, situated in the Trocadero gardens.

Installation of exhibit.

On arrival, the gentlemen named immediately began the erection of the necessary stands and cases to receive the various groups of minerals, the greater part of which had already reached the Canadian pavilion. The unpacking was then proceeded with, and the specimens were sorted and classified. The collection sent, filled over 325 boxes and barrels and the weight of minerals contained in these was in all about seventy tons. The specimens for the most part arrived uninjured, although many of them, particularly those of large size, required to be re-trimmed in order to expose fresh surfaces.

Character of exhibit.

The collection comprised over 1,200 separate exhibits, many including large suites of specimens representing associated minerals or various products. It was thus much larger than any shown by Canada at previous international exhibitions, embracing in fact twice as many localities as were represented in the Colonial and Indian Exhibition of 1886, or at the Chicago Exhibition of 1893 ; and, as a whole, it afforded a very complete representation of the economic minerals of the Dominion, so far as these are at present worked or known, from the Atlantic to the Pacific coast.

The arrangement adopted in installing the exhibits followed, as far as possible, that adopted in the descriptive catalogue of the collection prepared by the Geological Survey, by which the various minerals were primarily placed in natural groups according to composition and the purposes for which the several ores and other substances are employed. Each group was then subdivided geographically, the order followed being from west to east.

An analysis of the exhibits, as finally installed under the several classes and sub-classes of the descriptive catalogue, is given in the following table :— Exhibit of Canadian minerals.

—	British Columbia.	North-west Territories and Yukon.	Manitoba.	Ontario.	Quebec.	North-east Territories.	New Brunswick.	Prince Edward Island.	Nova Scotia.	Total.
I. Metals and their Ores.										
Gold, alluvial	77	34			6					117
Gold, milling ores	81			73					30	184
Gold, smelting ores	110									110
Silver ores	6			3						9
Silver-lead ores	148									148
Silver-copper ores	22									22
Copper, native	1			2						3
Copper ores	100	1		6	6				13	126
Lead				6	1				6	13
Zinc				1	1					2
Platinum	3			2						5
Mercury	2									2
Antimony					1		1		1	3
Nickel				15	2		1			18
Cobalt	1									1
Iron					1				1	2
Magnetite	7			30	4	1			10	52
Hæmatite	1			17	3		1		11	33
Limonite and bog-iron ore	1				1		1		5	8
Other iron ores		1			3				1	5
Manganese							3		8	11
Chromite or chromic iron ore					7					7
Tungsten					1				1	2
Molybdenite	1			2	2	1			1	7
II. Materials used for Light and Heat.										
Anthracite coal		1								1
Bituminous coal and lignite	7	4					1		11	23
Anthraxolite				1						1
Albertite							1			1
Bituminous shales							1		1	2
Peat				1			1			2
Petroleum		1		4	1					6
III. Minerals for Chemical Manufactures, &c.										
Pyrites				1	3					4
Magnesite					1					1
Celestite				1	1					2
Strontianite				1						1
Lithia					1					1
Apatite				1	3					4
IV. Mineral Pigments.										
Iron ochres				1	1					2
Baryta					1				3	4
V. Salts and Brines.				5			1			6

Exhibit of Canadian minerals.

—	British Columbia.	North-west Territories and Yukon.	Manitoba.	Ontario.	Quebec.	North-east Territories.	New Brunswick.	Prince Edward Island.	Nova Scotia.	Total.
VI. Refractory Materials, Pottery and minerals applicable to mfr. of, &c.										
Asbestus	....	....	....	....	3	....	....	....	..	3
Mica	1	....	....	3	12	....	....	....	....	16
Graphite	....	....	....	1	3	....	....	....	2	6
Fire-clay	1	....	....	....	....	....	....	....	1	2
Felsite	....	....	....	....	....	....	....	....	1	1
Felspar	....	....	....	2	2	....	....	....	....	4
Soapstone	....	....	....	....	2	....	....	....	....	2
Potstone	....	....	....	....	1	....	....	....	....	1
Talc	....	....	....	2	....	....	....	....	....	2
VII. Materials for Grinding and Polishing.										
Corundum	....	....	....	5	...	....	....	....	....	5
Grindstone and pulp-stone	....	....	....	....	....	....	2	....	1	3
Infusorial earth	....	....	....	....	1	....	1	....	4	6
Garnet rock	....	....	....	....	1	....	....	....	....	1
VIII. Materials for Fine Arts and Jewellery.										
Cut and polished stones	2	....	....	10	13	2	1	....	12	40
Amethyst	....	....	....	1	....	....	....	....	....	1
Lithographic stone	....	....	....	1	1	....	....	....	....	2
Sodalite	....	....	....	1	....	....	....	....	....	1
Mountain cork	....	....	....	....	1	....	....	....	....	1
Amber (chemawinite)	....	1	....	....	....	....	....	....	....	1
IX. Materials Applicable to Construction.										
Granite, gneiss, &c	3	....	....	9	9	....	4	....	....	25
Serpentine	....	....	....	....	14	....	1	....	....	15
Quartz-andesite	1	....	....	....	....	....	....	....	....	1
Breccia and conglomerate	1	....	....	2	1	....	....	....	....	4
Sandstone	6	3	1	8	2	....	5	....	10	35
Roofing slate	....	....	....	....	1	....	....	....	....	1
Limestone	2	....	4	15	5	....	1	....	....	27
Marble	3	....	....	13	17	....	....	....	2	35
Lime and cement	1	....	....	12	5	....	3	....	1	22
Shell marl	....	....	....	2	....	....	....	....	....	2
Gypsum	....	....	....	....	....	....	3	....	9	12
Brick and terra-cotta	....	....	....	3	2	....	....	....	....	5
Total	589	46	5	263	147	4	33	..	146	1233

Arrangemen of cases, etc.

In carrying out the installation of the mineral exhibit, it was endeavoured, while following the general classification, to give prominence to the most attractive exhibits, as well as to the most important mineral products of the country; also to vary the arrangement of the specimens so as to present a generally pleasing appearance and to avoid the formal aspect of a permanent museum collection. With this object in view, different kinds of stands, pyramids, trophies, monuments, tables-cases and upright-cases had been designed to received the specimens, and on these they were arranged so as to obtain the best possible effect. The upright glass cases of British Columbian woods, made in Ottawa and shipped in sections, measured 12 feet long, 2½ feet wide and 8 feet high, and those designed for the mineral specimens had four superposed shelves extending their whole length and width. Special iron standards had been prepared in order to support the considerable weight of the shelves in these cases.

Gold-exhibit.

The most prominent position along the central aisle of the mineral section was accorded to four protected steel and plate-glass cases which had been made specially to contain the large series of valuable gold specimens. This fine collection, valued at some $30,000, proved to be the greatest attraction of the whole Canadian pavilion and was constantly surrounded by an interested and admiring crowd of visitors.

British Columbia placer mines.

The British Columbian placer mines were represented by a large collection of nuggets, gold-dust and models of nuggets contained in two of these cases, which included also, for safe keeping, several specimens of gold-amalgam, platinum, arquerite, cinnabar and mercury from the same province. The exhibit represented the results of dredging as well as of sluicing, and included all the more important localities in the mining divisions and districts of Atlin, Liard, Omineca, Cariboo, Yale, Lillooet, East and West Kootenay, etc.

Klondike exhibit

In the next case was displayed a fine exhibit from the principal gold-bearing creeks of the Klondike, including Bonanza, Eldorado, Hunker, Last Chance, Dominion, Sulphur, Gold Run, Eureka, Livingston, Forty-mile and Quartz creeks. This collection naturally attracted much attention from the fact that the fame of the Klondike is now wide-spread, and on account of the size of most of the nuggets and the explanatory statements printed on the accompanying cards, such as: "Gold dust value $61.19, one-tenth part of the amount recovered by four men sluicing for seventeen hours." One great attraction was a rosary lent by Rev. F. P. E. Gendreau, made entirely of nuggets in the rough from various diggings. A part of this case also contained fine gold dust from the Saskatchewan River, N.W.T., and samples of dust and models of large nuggets washed from the tributaries of the Chaudière River and from Ditton, Que.

Section of auriferous gravels.

Adjoining the Klondike collection and explanatory of it, was an upright glass-casing holding a section showing the whole depth (about sixteen feet) of auriferous gravels and other deposits from a part of Bonanza creek, and illustrating the actual conditions under which the gold is found in the Klondike. This had been obtained by Mr. R. G. McConnell. It was accompanied by a few explanatory notes in English and French and could be readily understood by the general public. It proved very instructive and attracted much notice. Two other exhibits from the Klondike were large glass jars holding rich gravels with nuggets scattered through them.

Gold-bearing quartz from Nova Scotia.

In the fourth protected case were placed valuable and beautiful specimens of gold-bearing quartz coming from several districts of Nova Scotia. Most of these samples were small, but exceedingly rich, and contained nearly as much gold as quartz. The display presented a very fine appearance and was much admired, especially by jewellers and mineralogists.

Milling ores.

The bulk of the milling ores were, however, contained in the first upright case on the east side of the central aisle and included large collections from Nova Scotia, Ontario and British Columbia; while some of the larger specimens from British Columbia and Ontario were placed on the gold pyramidal stand. Most of the Nova Scotian ones showed gold freely, and the specimens included samples of gold concentrates, associated minerals, wall-rock and 'barrel' quartz. Seventeen gold districts were represented, from the counties of Guysborough, Halifax, Hants, Queens, Lunenburg and Yarmouth.

Model of Goldenville gold district, N.S.

In connection with the Nova Scotian gold and explanatory of the formation in which the quartz is found, was exhibited near by, in a large case, a model of the gold district of Goldenville, sent by the Geological Survey and made from plans and sections prepared by Mr. Faribault. The model is composed of ten rectangular blocks, seven inches square and thirteen inches deep, adjusted in two rows, and representing, when brought into contact, the surface plan of that district on a scale of 150 feet to one inch. By means of a key the blocks separate at will and present six transverse and three longitudinal sections to a depth of 2,000 feet, and clearly illustrate the 'saddle' structure, so characteristic of the Nova Scotian deposits and similar to that of the famous saddle-reefs of Bendigo, Australia. It shows that deep mining is possible by following well-defined zones of special enrichment through the succession of superposed veins.

Milling ores from Ontario.

The collection of milling ores from Ontario was very complete and represented a great number of localities from the gold districts to the north-west of Lake Superior, principally from the Lake of the Woods, Rainy river, Seine river, Michipicoten, Thunder bay and Manitou lake, and also from a few localities in the counties of Hastings and Peterborough. A large number of specimens showed free gold, but few carried associated minerals. Those from the Hastings district, however, showed much mispickel, pyrites, galena, tetrahedrite, copper pyrites and blende.

The milling ores of British Columbia formed a large and varied collection from many localities, and included all the mining properties of any prominence being worked by stamp-mills, concentrating or cyaniding processes. Milling ores from British Columbia.

The collection of gold smelting ores came altogether from British Columbia. Some of the specimens were of considerable size and they covered tbe greater part of the gold pyramidal stand, 15 ft. long and 7 ft. wide. They presented a great variety of ores, classified as gold-silver and gold-silver-copper smelting ores, and altogether they formed a very prominent exhibit, especially admired by the technical visitors who made many inquiries concerning their extent, nature and treatment. The Rossland and Boundary districts were largely represented by gold-copper smelting ores, and included all the principal producing mines, among others the Le Roi and War Eagle, represented by extra large specimens, Iron Mask, Columbia-Kootenay, Centre Star, Nickel Plate, &c The Alberni, Clayoquot, Texada and Yale districts and several other localities were specially represented by specimens of gold-silver-copper ores. Gold smelting ores.

General information in regard to the extent and richness of the various gold fields of Canada was given to many persons who had, or wished to make investments in mines of this character, with all the facts available in regard to particular mines or localities.

In close proximity to the collection of smelting ores, a fine exhibit was displayed from the Canadian Smelting Works, Trail, B.C., illustrating the processes followed in the treatment of the Rossland ores, consisting of samples of ores, fuels, fluxes, roasted ores, granulated mattes, flue-dusts, slags and high-grade copper-silver-gold matte. Illustration of treatment of Rossland ores.

The Van Anda Copper and Gold Co. also had an excellent exhibit of gold-copper ores from properties on Texada island and gold-copper matte and copper, the products of their smelter.

The silver and the copper ores were exhibited near one another on the west side of the main aisle and filled two separate stands, one upright case and one flat case.

The silver ores proper consisted of but few specimens: some arquerite nuggets and models from Omineca and argentite from Slocan, B.C., also a few but very handsome specimens of argentite and native silver, from Thunder bay, Ont. Exhibit of silver ores.

The silver-lead ores all come from British Columbia and formed a large collection, the bulk of which was composed of large specimens of clean galena. Those coming from the Slocan district alone formed a very striking exhibit on a pyramidal stand, six feet square and five feet high. The rest of the collection filled more than half the upright Silver-lead ores.

case south of it and a small flat case, and it well represented all the other mining divisions of West and East Kootenay as well as localities in northern British Columbia.

Silver-copper ores.

The collection of silver-copper ores, especially valuable on account of their silver contents, completed the series of silver ores in the upright case. This again was entirely made up of specimens from British Columbia, and chiefly consisted of chalcopyrite, chalcocite, bornite, and galena from Nelson and from other localities in the West Kootenay, East Kootenay and Yale districts. The collection included a very complete exhibit from the Hall mines smelter, Nelson, illustrating the metallurgical work carried on at that place. It consisted of silver-copper ore from the Silver King mine, fuels, fluxes, mattes white metal, copper bar, anode, lead bullion and copper and lead slags. Altogether, the display of silver ores formed a very conspicuous and prominent feature and led to a good many inquiries particularly as to the silver-lead industry in British Columbia.

Galena ores.

The galena ores not derived from British Columbia generally carry small silver values, and these formed a separate series of lead ores in the above mentioned upright case. The collection was composed of specimens from Ontario, Quebec and Nova Scotia. Some special inquiries were made in regard to lead mines, but as a whole not much interest was exhibited in this metal.

Copper ores.

Great interest was taken in the exhibit of copper ores, and information was asked concerning the various copper mining regions, the size and character of the mines, the amount of output of smelted copper, prices, etc. Several inquiries were also made for copper ore from eastern Canada for shipment as such to European refineries. The collection of copper ores was exhibited beside the silver-ores and filled the upright case partially occupied by the latter, while the larger specimens also covered a pyramidal stand six feet square. The native copper-bearing rocks of the north shore of Lake Superior were represented by two samples, and a fine sample of native copper from Atlin, B.C., was exhibited by Mr. Achile Daumount, Paris.

Variety of copper ores.

The collection of copper ores proper was especially remarkable for the great number of varieties included in it. British Columbia contributed a large exhibit representing all the best known mines and many localities yet undeveloped in East Kootenay, Yale, Cassiar and Vancouver island. It included chalcopyrite, bornite, malachite, azurite, cupriferous quartz, chalcocite and tetrahedrite. Ontario, Quebec and Nova Scotia exhibited smaller collections from such well-known localities as the Bruce mines in Algoma district, Ont., the South Ham and Harvey Hill mines in the Eastern Townships, Que., and the Coxheath mine in Cape Breton, N.S.

Next to the upright case containing the silver, lead and copper ores, was a large pyramidal stand fifteen feet long and five feet wide, both sides of which were covered with collections of the different iron ores, while the ends were occupied respectively by the nickel ores and the chromic iron ores.

The iron ores were divided into five series: magnetite, hæmatite, limonite and bog-iron ores, other iron ores and their products, iron and steel.

Magnetites.

The magnetite series was the most conspicuous, and included a good collection from Ontario, several specimens from British Columbia, Quebec and Nova Scotia, and one interesting specimen from the extensive deposits of the Nastapoka islands, east coast of Hudson Bay. In the hæmatite series, Ontario and Nova Scotia were well represented, while British Columbia, Quebec and New Brunswick exhibited only a few specimens. Limonite, bog-iron ores, clay iron-stone, ilmenite, titaniferous ores, magnetic sand and siderite were shown from various provinces. Constant inquiries were made as to the extent and richness of the various deposits of iron ores, especially in the eastern portions of the Dominion, and the chances of the profitable exportation of such ores to Europe for smelting. Numerous inquiries were also made in regard to finished iron and steel, especially to the finer grades corresponding to Swedish iron, and the products of the charcoal furnaces of the Canada Iron Furnace Co. Much interest was expressed in the installation of the large furnaces in Nova Scotia now in progress and the likelihood of an export trade in iron to Europe from Canada.

Iron industr illustrated.

Adjoining the iron stand, Quebec and Nova Scotia had two interesting displays, illustrative of the iron industry in Canada. The Canada Iron Furnace Co. exhibited a cabinet of specimens from the Radnor Forges, St. Maurice, Que., consisting of bog-iron ores, lake-ore and different samples of charcoal pig-iron and of wrought iron, together with a series of photographs illustrating the dredging of the lake-ore deposits. The other exhibit was sent by the Nova Scotia Steel Co. New Glasgow, N.S., and consisted of many specimens of iron ores from Nova Scotia, imported magnetite from Cuba and hæmatite from the company's mine at Wabana, Newfoundland, samples of different kinds of coal and coke, pig-iron and a large collection of steel bars, angle irons, &c., of various sizes and shapes, cut in lengths of two feet. The whole made a very complete and representative display, illustrative of the mines, blast furnaces, coking plant and steel works.

Chromic ores.

On the steps at the west end of the iron stand, was shown a series of specimens of chromite, including concentrated ore and tailings from the recently operated chromic iron deposits of the Eastern Townships of Quebec. The collection attracted the attention of many metallurgists, there being a ready demand for this ore if of sufficiently high grade.

Nickel-copper ores.

The nickel-copper ores occupied a prominent place at the east end of the iron stand facing the central aisle. With the exception of a few samples from Calumet island and Memphremagog in Quebec and St. Stephen, N.B., the ores all came from the Sudbury region and consisted of nickeliferous pyrrhotite and chalcopyrite with associations of bornite and niccolite. The exhibit from the Lake Superior Power Co., Sault Ste. Marie, Ont., included samples of ferro-nickel pig.

Exhibit of products of nickel-copper ores.

Close to this collection and facing the southern entrance, in the middle of the central aisle, was placed, in a large cabinet, a joint exhibit made by the Orford Copper Co. and the Canadian Copper Co. The display was very attractively arranged in pyramidal shape, and did credit to the importance of the industry which it represented. Not only were the native ores and the refined products shown in numerous different forms, but the intermediate stages of roasting, smelting and refining were illustrated and the processes employed explained. Besides the ores, the exhibit showed various grades of copper-nickel mattes, slag waste, nickel oxides, nickel sulphides, different forms of refined nickel, including cathodes and anodes and a very artistic railing, sixteen feet long and four feet high, made of solid nickel, valued at $5,000. The exhibit of nickel ores and smelting products received, next to the alluvial gold exhibit, the greatest amount of attention from visitors, and information was required not only as to the extent and value of the deposits but also as to the composition and mode of occurrence of the ores and their associated ores of platinum and palladium, and also in regard to the mode of mining and treating the ores.

Exhibit of coal.

Facing the southern entrance, on each side of the nickel exhibit, stood two large columns of coal, each over two tons in weight, one from the Nanaimo field, B.C., the other from the Sydney field, N.S. These together formed a fitting illustration of the excellent fuel resources of the Dominion on the Pacific and on the Atlantic seaboards. Nearby stood a large cube of coal surmounted by a pyramid of excellent coke from Comox, B.C., while the remainder of the collection of fuels from the west, formed a prominent trophy in an upright glass case, six feet square, and included large specimens of anthracite from Anthracite, Alberta, coal from Nanaimo and Thompson river, B.C., and from Canmore and Lethbridge, Alta., coal and coke from Crows Nest pass, lignite-coal from the Yukon district, N.W.T., and lignite from Souris river, Assa., as well as peat from Welland county, Ont.

The Nova Scotian and New Brunswick coal exhibit occupied the lower shelf of an upright glass case placed between that last mentioned and the iron pyramidal stand. It consisted of a series of specimens representing several collieries of the Sydney field in Cape Breton worked by the Dominion Coal Co., and the General Mining Association, the Pictou, Springhill, Joggins and Cumberland fields in Nova Scotia, and the Newcastle field in New Brunswick. With these were albertite and bituminous shales from Albert, N.B., oil-shales from East bay, Cape Breton, and peat from Northumberland county, N.B.

The present high prices of fuel in Europe, with the prospect of an increasing demand and diminution of supply, has caused attention to be turned to possible new sources from which coal may be obtained, and the Canadian exhibit representative of coal-fields on the Atlantic coast has led to many inquiries from continental dealers regarding the probable shipping of Nova Scotian coal to Europe. Conversation with gentlemen from all parts of Europe, engaged directly or indirectly in the coal trade, leads to the belief that the present great demand for fuel and the consequent advance in its price is only partly due to the storing up of large quantities of coal for naval purposes by the different European governments, the chief cause being the natural expansion of manufactures, the increased use of steam-generated electrical power and the constantly increasing mileage of railways. These causes are all permanent and the increasing demand promises to be constant, while the output of the European coal-fields has reached or is rapidly approaching its possible maximum. Almost daily inquiries as to Canadian coal were made at Paris by persons interested in the trade from France, Belgium, Germany, Russia, Austria, Hungary, Italy and other countries of Europe, and surprise was expressed that with the natural advantages of the coal-fields practically on the sea-board and at least 700 miles nearer to Europe than those of the United States, a large export trade in coal had not already sprung up. Such information as could be afforded was given, and the persons interested were put in communication with the various coal mining companies of Nova Scotia. Demand for coal in Europe.

The exhibit of pressed peat from Ontario led to many questions, not with respect to the possibility of trade in that fuel, but rather as to the method of preparation and the success of the manufacture from a commercial standpoint. Pressed peat.

The graphite exhibit, consisted of specimens of the disseminated amorphous and columnar varieties from Ontario, Quebec and Nova Scotia. The Walker Mining Co., had a good exhibit of crude and manufactured graphite from Buckingham, Que., consisting of crucibles, nozzles and stove polish, and the Keystone Graphite Co., exhibited a series of different grades of prepared graphite from Grenville, Que. Inquiries were especially made with regard to the suitability of the Canadian graphite for the manufacture of crucibles. Graphite exhibit.

Petroleum and products.

The petroleum exhibit was composed of three collections, viz., two large jars of maltha and tar-sands from Athabasca River, N.W.T., three samples of crude petroleum from Gaspé, Que., and a large collection of crude and refined oils from the western Ontario fields sent by the Imperial Oil Co. of Sarnia. The last-named exhibit was very complete and comprised crude samples from the Petrolia oil springs and Bothwell fields, and no fewer than 59 products of refining and distillation, consisting of different grades of illuminating and lubricating oils, paraffin oils and wax, gas and fuel oils, benzine and naphtha. The products were exhibited as they are put up for the market as well as in special glass tubes. This exhibit attracted much attention, and concerning the naphthas, grease and wax there were inquiries, especially for deodorized naphtha and for gasoline for use in motor-cars. Many questions were asked concerning the Gaspé oil fields by persons holding stock in the Petroleum Oil Trust Ltd.

Corundum.

The second upright case on the east side of the central aisle was devoted to specimens of corundum, asbestus, ochres and miscellaneous metalliferous ores. The lower shelf showed an extensive collection of crude and concentrated corundum from Raglan, Renfrew county, Ont., together with a large series of various kinds of corundum and emery wheels, the products of experiments made by three manufacturers with the Canadian corundum at the instance af the Ontario Bureau of Mines, by which Bureau the exhibit was supplied. Considerable interest was shown in regard to this new source of corundum and the various emery wheels manufactured from it were a surprise to all visitors who appreciated the value of the material. It is understood that the exhibit has already led to commercial results in connection with this new Canadian product.

Asbestus.

Asbestus was shown as it occurs in the rock and cobbed, from the districts of Danville, Thetford and Coleraine, Que. A special exhibit of a series of manufactured products was also displayed by the Asbestos and Asbestic Co., Danville, Que., in a table case standing near by, consisting of different qualities of crude, fiberized and fibre asbestus and asbestic wall plaster. The superior quality of the Canadian product compared with that of other countries was recognized by the members of the jury, and a mass of long white and silky cobbed asbestus resting on large pieces of vein, exhibited by the Bell's Asbestos Co., became especially an object of interest. The whole display of asbestus, both crude and manufactured, met with a great deal of attention especially from naval and military men, and specimens were given to several persons who were trying to adapt this mineral to new pur poses.

A part of the third shelf showed a collection of ochres from St. Malo, Que., sent by the Canada Paint Co., in the natural and ground state, and manufactured into paints of different shades. This exhibit attracted some little attention and a number of visitors, especially those from Great Britain, asked for information concerning the baryta deposits of Canada. Ochres.

The remainder of this case contained miscellaneous metalliferous ores not already exhibited elsewhere, and included the following :— Miscellaneou metalliferous ores.

Blende or zinc ore from the Zenith mine, Ont., and from Calumet Island, Que.

Stibnite and other antimony ores from South Ham, Que., Prince William, N. B., and West Gore, N.S.

Cobalt bloom from Goat mountain, B.C., pyrolusite from King and Albert counties, N.B., and several specimens of pyrolusite and manganite from Tenny Cape, New Ross, East River Pictou, Sydney and Stellarton, in Nova Scotia.

One specimen of scheelite, from Beauce county, Que., and one of wolframite from Margaree, Cape Breton. Information was given to several persons engaged in the iron industries in regard to manganese, chromite, and the above mentioned tungsten ores, for use in the manufacture of steel.

Several fine specimens of molybdenite from Grand Prairie, B.C., Haliburton and Renfrew counties, Ont., Pontiac and Wright counties Que., the east coast of Hudson bay and New Ross, N.S. Inquiries in regard to this substance were directed rather to obtaining specimens for mineral cabinets than to its economic utilization.

Platinum ores, gossan and sperrylite with palladium ore from Vermilion mine, Algoma, Ont. These rare minerals were especially interesting to the scientific visitors. A great deal of interest was also expressed in the occurrence of platinum and mercury in British Columbia, and inquiries were made concerning their mode of occurrence and the extent and value of the deposits.

This case also contained an important exhibit of iron-pyrites and chalcopyrite, used as sulphur ore in the manufacture of sulphuric acid, from Renfrew county, Ont., and from the Eustis and Albert mines, Quebec., the latter worked by the Nichols Chemical Co., operating important chemical and fertilizer works at Capelton, Que. Sulphur ores.

The third upright case on the east side of the main aisle, contained the bulk of the remaining miscellaneous minerals, viz.:—

Magnesite from Bolton, Que.

Celestite from Leeds county, Ont., and from Chicoutimi, Que.

Strontianite from Carleton county, Ont.

Lithia mica (lepidolite) from Wakefield, Que.

Apatite from Lanark county, Ont., and from the counties of Labelle and Wright, Que. These interested scientific and industrial visitors, who where specially impressed with the beauty of the specimens, and the high percentage of phosphoric acid contained in the mineral.

Baryta from Wright county, Que., and Lake Ainslie and Middle Stewiacke, N.S.

Salt and brines.

Salt and brines formed an important group of exhibits from Windsor, Wingham, Exeter, Parkhill and Clinton, Ont., and from Sussex, N.B. The Windsor Salt Co., had a particularly attractive exhibit of different grades of salt on a special stand.

Fire-clay from Comox, B. C., and Brooklyn, N.S.

Felsite, also well adapted to the manufacture of fire bricks from Coxheath hills, N.S.

Felspar, natural and vitrified, suitable for the manufacture of pottery and glazes from Nipissing district, Carleton county, Ont., and Wright and Labelle counties, Que.

Steatite and potstone from Brome county, Que.

Talc, equal to the best imported French mineral, from Hastings county, Ont.

Infusorial earth from different lake deposits in Quebec, New Brunswick and Nova Scotia, as well as different grades of manufactured products known as 'fossil flour' and 'tripolite.' Numerous inquiries were made about this material, and there appears to be a considerable market for it in Europe.

Garnet rock from Wakefield, Que., used as an abrasive for special purposes.

Lithographic stones from Hastings, Ont., and Temiscaming, Que.

Lime and cements.

Lime and cements formed a large group of exhibits, principally from Ontario, Quebec, New Brunswick and Nova Scotia, composed of the raw materials used, such as limestone, dolomite, clay and marl and the products, limes and cements of different qualities and suitable for different purposes. Special mention may be made of cements exhibited from Owen Sound, Thorold, Queenston and Limehouse, Ont., and from Hull, Que.

Gypsum and products.

Gypsum was well represented, including specimens of selenite, and calcined samples from Tobique and Hillsborough, N.B., and

Windsor, Newport, Wentworth and Enfield, N.S. The Albert Manufacturing Co., of Hillsborough, N.B., had a specially attractive exhibit, apart from the others, composed of a large stand covered with specimens of gypsum, and anhydrite, also fine samples of alabaster under glass globes and barrels of plaster of Paris as it is put up for the market. Bricks and terra-cotta of different kinds and shades, and the varieties of shale and clay used were exhibited from Humber river, Milton, Beamsville, Ont., and from Laprairie and Montreal, Que. The Milton Pressed Brick Co. had a good exhibit of ornamental pressed bricks on a separate stand.

Polished gem stones.

The space at the north-east corner of the mineral section was devoted to the exhibits of building and ornamental stones, grindstones and mica. The collection of cut and polished stones applicable to fine arts and jewellery was exhibited by the Geological Survey and filled two flat cases along the central aisle. It was composed of a great variety of such stones from various localities in Canada, comprising agates, jasper, aventurine, sodalite, amazon stone, peristerite, serpentine, porcelanite, labradorite, grossularite, vesuvianite, asteriated quartz, tourmaline, zircons, porphyry, brecciated jasper, chalcedony perthite, dyssyntribite, amethyst, mountain cork and chemawinite or amber. The collection was much admired by the general public, and many special inquiries were made as to the possibilities of getting large supplies of sodalite, labradorite, brecciated jasper and jasper conglomerate for interior decoration, furniture and other ornamental purposes.

Building and ornamental stones.

Behind this collection stood a pyramidal stand six feet square, covered with a large and varied collection of cubes and slabs of building and decorative stones representative of the most important quarries and known deposits of Canada. The collection consisted of granite, gneiss, syenite, diorite, serpentine, quartz-andesite, breccia, jasper-conglomerate, sandstone, limestone, dolomite, marble and serpentine-marble of various colours and shades. Most of the specimens were six-inch cubes, with faces differently dressed and polished where the material admitted, while the slabs measured one foot by two feet and represented polished marbles. A large collection of paper-weights was also exhibited in a flat case, representing specimens of serpentine and marble. The stone exhibit was completed by a number of columns, bases and monuments of polished granite, gneiss, serpentine and marble, distributed through the section at the foot of the pillars and elsewhere.

Polished granites and marbles.

Of the long list of specimens of stones exhibited, the following may be specially mentioned :—A column of red granite from Kingston, Ontario, and base of gray granite; a card receiver and pedestal four feet high of red granite from St. Philippe, Que., exhibited by J. Brunet, Montreal; two bases of gray granite from Stanstead, Quebec; a prominent and beautiful monument of red granite from St. George, N.B., exhibited by the Bay of Fundy Red Granite Works, which received special attention. Two polished columns of serpentine, dark-green veined with white, and five specimens from Melbourne, Quebec, as well as several specimens of serpentine from other localities were much admired. A cube of quartz-andesite from Haddington island, B.C., and a polished slab of jasper-conglomerate, from Bruce mines, Ont., attracted much attention. Other interesting specimens were, five well dressed cubes of sandstone from Sault Ste. Marie, Ontario; a monument formed of three different kinds of dolomite from St. Andrews, Tyndall and Lake Manitoba, Manitoba; a slab, one cube and three small specimens of serpentine marble of different shades of green, (Eozoon marble) from Grenville, Quebec; a column, base, slab and paper-weight of gray marble from Maniwaki, Quebec; a column, five slabs and four small specimens of marble from Dudswell, Quebec, some varieties resembling the black-and-gold Porter marble from northern Italy, and a slab and paper-weight of red marble from St. Joseph, Beauce county, Quebec.

Slates.

On the wall behind the grindstone exhibit were arranged several samples of roofing slate 12 x 24 inches, from the New Rockland Slate Co.'s quarry, representative of the excellent slate deposits of the Eastern Townships, Quebec.

Inquiries made.

The collection of building stones, slates, lime, cement, gypsum and bricks as above described, was the object of study for many persons engaged in the building trade, and all expressed surprise and admiration at the variety and value of the building materials available in Canada. Inquiries of a business character, were made chiefly for granite, gneiss, anorthosite, the various serpentines and other building or ornamental stones capable of being polished and used for decorative purposes. These elicited favourable comments and the addresses of the producers were given to a number of visitors.

Grindstones.

Behind the building-stone stand was an exhibit of grindstones from Cumberland Basin, N.S., Gloucester Junction, N.B., and a 'pulp' stone, from Newcastle, N.B., used in the manufacture of wood-pulp and weighing over a ton.

Mica exhibit.

The mica exhibit made a particularly attractive display along the transverse aisle, the samples being framed on coloured cloth on upright stands. The great size of some of the specimens was especially remarked. The greater part of the collection was composed of the phlogopite variety or 'amber mica' from the counties of Wright, Pontiac and Labelle in western Quebec, and Lanark in eastern Ontario, where it is extensively mined, and exported mostly for electric use. Specially fine exhibits were sent from western Quebec by the Wallingford Bros. & Co., and Blackburn Bros. mines in Templeton, Rev. Mr. Guay's and W. H. Sills's mines in Wright township, and from the Vavasour and the Gracefield mines in Hull township. Good samples of the muscovite variety were shown from Yellow Head pass, B.C., and from the Villeneuve mine and the county of Saguenay, Que. One interesting exhibit of mica boiler- and pipe-covering was also sent by the Mica Boiler Covering Co., of Montreal and Toronto.

Constant demands were made for information as to the supply and prices of mica, chiefly by persons engaged in the manufacture of electrical machinery, and there is no doubt that the exhibition will prove beneficial to the owners of mica mines in opening up a market for this mineral in France and in other countries of Europe.

Reports, catalogues, pamphlets, etc

The south-west corner of the section was made the centre of information on all matters appertaining to the mineral resources of the Dominion. In a book-case was placed a complete set of reports published by the Geological Survey, the mining reports issued by the provincial bureaus of mines, and other literature connected with the exhibit. Several pamphlets prepared to accompany the Canadian mineral exhibit were placed on a table for free distribution. They were the Descriptive Catalogue of the collection of the Economic Minerals of Canada at the Paris International Exhibition for 1900, compiled by the Geological Survey; the Economic Minerals of Canada, prepared by the Director of the Geological Survey, both published in English and French; the Mineral Industries of the province of Quebec, by Mr. J. Obalski; Minerals for the Paris Exhibition, by Dr. E. Gilpin, &c. These pamphlets were very much appreciated and greatly in demand.

Survey maps.

A representative series of maps and plans published by the Geological Survey was also exhibited on rollers in a rack and on available wall spaces. Many gratifying opinions were expressed by the members of the jury and other visitors competent to judge, regarding the work performed and the publications issued by the Geological Survey of Canada, and they were especially impressed with the practical nature of the work accomplished.

Photographs, and transparencies.

The collection was also made attractive by a large number of framed photographs decorating the pillars and other suitable space, and by numerous transparencies on glass, filling the windows, and illustrating the various mining industries of the Dominion from the Klondike region to Nova Scotia.

Labels.

All the specimens of minerals and ores were neatly labelled with cards of different colours for each of the provinces, giving the catalogue number and the name of the specimen in English and French, the locality from which it came and the name of the owner of the particular mine or property. One officer was also at all times in attendance in the mineral section and was constantly employed in answering inquiries regarding the exhibit and in giving information on other matters connected with the mining industries, as well as on the climate, geography, geology and the natural productions of Canada.

Opening of Exhibition.

The exhibition was officially opened on the date appointed, the 17th of April, although very few buildings or sections had their installation nearly ready on that date, and many of the buildings were not even completed. The Canadian exhibit was, however, one of the most advanced, and it may be stated that the mineral section was sufficiently well arranged to be opened to visitors from the first.

Work by Mr. Low at Exhibition.

Mr. Low arrived in Paris in the last week in June, and when he took over the charge of the Canadian exhibit he found that, owing to the delay in arrival of the official catalogue, considerable work remained to be done in order that the arrangement of the specimens might correspond with that of the catalogue. All the specimens had not at that time been labelled, and owing to the crowds attending the exhibition, work could be carried on only in the morning, so that the installation was in reality not fully completed in detail until the end of July. Mr. Low acknowledges the able assistance of Mr. A. K. Stuart, who proved of great value owing to his knowledge of British Columbia and the mineral resources of that province; while his familiarity with French and German enabled him to give much information to many of the visitors.

Mr. Low remained in charge of the exhibit until the close of the exhibition, and then superintended the repacking of the entire collection and its shipment to Glasgow for the coming exhibition in that city next summer. The packing was finished on the 14th of December.

Character of visitors.

Many observations made by Mr. Low are embodied in the foregoing pages. In addition, he states that the Canadian mineral collection was much larger and more varied than that from any other country, while the arrangement, classification and labelling were also superior to those employed in the displays made by other countries. The exhibit was specifically confined to the economic minerals of Canada, each specimen being a fair sample from some mine or mineral occurrence, and it attracted consequently the particular attention of practical inquirers. Many appreciative comments from visitors might be cited. A number of scientific societies and associations, as well as groups of students or graduates from educational bodies, made collective visits to the Canadian mineral court. These included both French and German organizations, but private inquirers interested in mining and metallurgy, or in the supply of materials for industrial enterprises from all parts of the world were also numerous. Where items of information desired could not be supplied on the spot, inquirers were referred to the addresses of the producers represented in the collection, or to the Director of the Geological Survey in Ottawa. It is not too much to assume that the result of the Canadian mineral exhibit at Paris will be of great practical benefit to mining and its dependent industries in Canada.

The greater part of the Canadian mineral exhibit came under class 63, including the working of mines and quarries, while the products of metallurgical industries came under class 64, the lime, cement, plaster and bricks under class 28, and products of petroleum and brines under class 87. Awards to Canadian exhibits.

The awards actually accorded to the Canadian mineral exhibits are as follows:—

6 Grand Prizes—

Geological Survey Department.—Minerals, publications, maps, models, photographs, etc.

Canadian Commission at the Exhibition.

Ontario Bureau of Mines, Toronto.—Minerals and publications.

Department of Mines of British Columbia.—Minerals and publications.

Department of Mines of Nova Scotia.—Minerals and publications.

Department of Mines of Quebec.—Minerals and publications.

10 Gold Medals—

Canadian Copper Co., Sudbury, Ont. (Two gold medals.)—Nickel ores and products.

Orford Copper Co., New York.—Nickel ores and products.

Canada Iron Furnace Co., Montreal.—Iron ores and iron.

General Mining Association, Sydney Mines, Cape Breton, N.S.—Coal.

Dominion Coal Co., Glace Bay, Cape Breton, N.S.—Coal.

Le Roi Mining Co., Rossland, B.C.—Gold ores and products.

Montreal-London Gold and Silver Development Co., Montreal.—Gold ores.

Nova Scotia Steel Co., New Glasgow, N.S.—Iron ores and iron.

Awards to Canadian exhibits-*Cont*.

New Vancouver Coal Mining and Land Co., Nanaimo, B.C.—Coal.

18 Silver Medals—

Albert Manufacturing Co., Hillsborough, N.B.—Gypsum and plaster of Paris.

Asbestos and Asbestic Co., Danville, Que.—Asbestus, &c.

Bell's Asbestus Co., Limited, Thetford Mines, Que.—Asbestus and products.

Crows Nest Pass Coal Co., Fernie, B.C.—Coal and coke.

Jack and Bell gold exhibit, Halifax.—Gold quartz from Nova Scotia.

Milne, Coutts & Co., St. George, N.B.—Granite monument.

Union Colliery Co., Limited, Comox, B.C.—Coal and coke.

Union Industrielle et Métallurgique du Labrador, Quebec.—Ores, etc.

Wallingford Bros. & Co., Ottawa—Mica.

Windsor Salt Co., Limited, Windsor, Ont.—Salt.

Walker Mining Co., Buckingham, Que. (Two silver medals).—Graphite crude and manufactured.

Hall Mines Smelter, Nelson, B.C.—Silver and copper ores and products.

Canadian Smelting Works, Trail, B.C.—Gold and copper ores and products.

Owen Sound Cement Works, Ont.—Cement.

Queenstown Cement Works, Ont.—Cement.

Battle Bros., Thorold, Ont.—Cement.

Toronto Lime Co., Limehouse, Ont.—Lime.

9 Bronze Medals—

Blackburn Bros., Ottawa, Ont.—Mica.

Coleraine Chrome Mfg. Co.. Black Lake, Que.—Chromic iron and concentrates.

Mac Machine Co., Belleville, Ont.—Rock drill.

Milton Pressed Brick Co., Milton, Ont.—Bricks.

Nichols Chemical Co., Capelton, Que.—Pyrites.

Samuel Winter & Co., Moncton, N.B.—Yellow Head Pass mica.

Canada Paint Co., Montreal—Mineral pigments.

C. E. Fish, Newcastle, N.B.—Pulp-stone.

Key-stone Graphite Co., Grenville, Que.—Graphite.

4 Honourable Mentions—

Laurentide Granite Co., Côte des Neiges, Que.—Worked granite

Eustis Mining Co., Eustis, Que.—Copper- and iron-pyrites.

Fossil Flour Co., Bass River, N.S.—Tripolite, etc.

Canadian Peat Fuel Co., Toronto, Ont.—Peat.

Gold medals were also awarded to Messrs. Low and Faribault as collaborateurs in classes 63 and 64.

An excellent description of the Canadian Mineral Exhibit from the pen of Mr. A. K. Stuart, has appeared in the British Columbia *Mining Record* (December and January numbers). He speaks in highly appreciative terms of the work done by the Geological Survey in connection with the exhibit and of the pamphlets supplied for distribution, and in conclusion says :— Description of exhibit by Mr. A. K. Stuart.

'To return to the mineral collection : Quite one of the most gratifying features has been the immense amount of interest taken in it by technical people. This was the more noticeable at the period (during the summer months) when a great many Germans were visiting the exhibition. Of all nationalities they seem to have the greatest thirst for information. The questions they put were all of a practical nature, and it was interesting to remark that few, if any, were without a special note-book for jotting down anything which appeared to be of the slightest value either from a commercial or scientific standpoint. Moreover, each one knew to a great extent, exactly what he wished to find out and wasted no time over the matter. * * * * Of course, in many other minor details it would be easy to profit considerably by the experience gained here in order to somewhat improve our system of advertising our mineral resources, but it is rather doubtful that, whatever changes are made at any other exhibition, any greater success will be obtained by our exhibit than has been gained here. The effort made to attract attention to Canada and its hidden treasures has had, as a result, that nearly all who have seen our exhibits have gone away with a totally different idea of our country and the importance of our resources than they had before. This in itself should be a compensation for the expense of making this Canadian exhibit the best mineral display here.'

YUKON DISTRICT.

Mr. R. G. McConnell was occupied during the winter of 1900 exclusively in work connected with the elaboration of his observations Work by Mr. R. G. McConnell.

Yukon District.

in the Klondike region. During the past summer he was again occupied in the exploration of this and other parts of the Yukon district, with interesting results, of which a pretty full preliminary account is given by him in the following report :—

'I left Ottawa on May 27th, but was delayed at Skagway and White Horse for some days by the lowness of the water at the head of Lake Laberge, and did not reach Dawson until June 20th. I was accompanied by Mr. J. F. E. Johnson, who acted as topographical assistant.

Examination of Stewart River valley.

'A few days were spent in the vicinity of Dawson, completing the geological mapping of the surrounding district, and in making a hasty examination of the principal producing creeks. On July 13th, I started with one man and a pack-horse, for the mouth of Clear creek, a tributary of the Stewart, examining on the way the great gravel plain east of the Klondike hills, commonly described as the old bed of the Stewart. The mouth of Clear creek was reached on July 21st, and on the 25th Mr. Johnson, who had ascended the Yukon to the mouth of the Stewart in a steamer, and the latter river in a canoe, making a track-survey on the way, joined me. Mr. Johnson returned overland while I continued up the Stewart to the Frazer falls, which were reached on August 3rd. On the return journey, a geological examination of the Stewart valley was made from the Frazer falls down to its mouth, and a few days were also spent on the Yukon between the mouth of the Stewart river and Dawson.

Indian river.

'After returning to Dawson, trips were made to the Indian river for the purpose of examining the reported gold-bearing conglomerates opposite the mouth of Quartz creek, and to the Coal creek and Cliff creek coal mines. The Yukon valley was also examined from Dawson down to the mouth of Cliff creek. On the way out a stop was made at White Horse, and a preliminary examination was made of the important copper belt recently discovered west of that point.

Production of gold.

'The Klondike gold-bearing gravels were described in last year's Summary Report, and as no important discoveries of new creeks were made during the season, it will be unnecessary to dwell on them here. The production of the old creeks and benches has been large and is expected to exceed the great yield ($16,000,000) of the preceding year, but as the full returns have not been received it is impossible to give the exact figures. The increased use of machinery, more especially steam hoists and thawing machines, has largely contributed to the result. No attempt has yet been made to work any of the concessions on a large scale, and very little preparatory work is being done on them.

'The gravel basin east of the Klondike hills, extending north-west of the Stewart to the Klondike river, was prospected in a couple of places during the season, but so far as could be learned with indifferent results. This great body of gravel, measuring from ten to fifteen miles in width and in places exceeding 600 feet in thickness, carries fine colours nearly everywhere, and there is a possibility that in places the gold may be found concentrated in paying quantities. The extent and thickness of the gravel deposit will however necessitate expensive prospecting work. The gravel consists principally of quartzites, hard schists and various kinds of eruptive rocks, among which granite is conspicuous, and has been derived principally from the east and south-east. The sources of the contained gold must also be looked for in the same direction.

Yukon District—*Cont.* Gravel basin east of Klondike Hills.

Stewart River.

'The Stewart is one of the main tributaries of the Yukon. It rises in the unexplored Pacific-Arctic watershed ranges lying between the heads of the Peel and Pelly rivers, and flows in a general westerly direction towards the Yukon valley. From Frazer Falls to its mouth, a distance of nearly 200 miles, it is a large stream, seldom less than 150 yards in width and often more than double this breadth. It is navigable throughout the season by ordinary shallow-draugh river steamers all the way to the Frazer Falls. From the Mayo to its mouth, the current flows from three to five miles an hour with occasional accelerations on the bars. Above Mayo river, the current decreases to a rate of from two to three miles an hour and bars are almost entirely absent. At the Frazer falls, the Stewart flows for a third of a mile with great velocity through a narrow cañon bounded by vertical walls of hard quartzose schist. The word falls is a misnomer, as the grade in the cañon is fairly uniform and the total descent was estimated to be only thirty feet. Above the falls the river is interrupted by occasional short riffles for several miles, but, farther up, its course is reported to be clear to the main forks, a distance of about sixty miles, and up the north branch for a considerable stretch beyond. The east branch is reported to be a rapid stream constantly interrupted by rapids and cañons. The principal tributaries of the Stewart below Frazer Falls are the McQuesten and Mayo rivers, both fair sized streams, and Clear creek from the north, and Crooked river, Lake creek and Scroggie creek from the south.

Stewart River.

Character of stream.

'The country bordering the lower part of the Stewart river is nearly everywhere of a mountainous character, and may be described as a high plateau deeply dissected by a multitude of wide and often interlocking valleys. The hills project above the valleys in isolated

Country bordering lower part.

Yukon District—*Cont.*

masses, in irregular shaped groups, and in well defined ranges. The outlines are generally rounded and the elevations range from about 2,500 feet to 4,000 feet above the main valleys. The lower slopes are clothed with a forest of spruce, poplar, birch, willow and alder. Above a height of about 2,500 feet the surfaces are usually bare. The bottom-lands of the Stewart often exceed two miles in width and are seldom less than a mile, and those of many of the tributaries, notably Crooked river and Lake creek are even wider. Below the mouth of Clear creek, the Stewart has cut a comparatively narrow rock-walled channel through the bottom of the older valley. The deepening of the valley is evidently due to the same elevatory movement that affected the Klondike region and gives evidence of the wide extent of that uplift.

Character of valley.

Rocks exposed.

'The Stewart River valley affords a good geological section, but as the rock-specimens have not yet been examined, this can only be briefly described here. At the Frazer falls the river cuts through hard, quartzose, greenish schists, apparently partly crushed eruptives, alternating with bands of softer green chloritic schists and dark argillites. These schists, including in places beds and bands of quartzites, are exposed along the valley all the way down to a point five miles above Moose creek. At Canyon creek a hard slightly squeezed basic eruptive is included in the series, or overlies it. The dips as a rule are not high, seldom exceeding 45°, and the general strike is to the south-east.

Granitoid rocks.

'Above Moose creek, the schists are cut by granite, and along the valley down almost to Lake creek, granitoid rocks of various kinds occur. The principal variety is a coarse-grained grayish granular rock consisting principally of orthoclase, a plagioclase felspar, (probably oligoclase) quartz and biotite. A reddish variety occurring above the mouth of the McQuesten contains a good deal of hornblende in addition to the biotite. At many points the granite becomes strongly porphyritic. The gray granite alternates with, and in many places appears to cut a dark eruptive of a dioritic character, but it is probable that the latter simply represents a more basic phase of the same magma. Both the dark-coloured and gray rocks are cut by a system of dark diorite dykes. The granites are massive in character and do not exhibit evidence of much squeezing.

Granite-gneisses.

'At the mouth of Lake creek, the granitoid rocks are replaced in the valley by a series of old looking schists, largely of the character of granite-gneisses. They vary in texture from fine- to coarse-grained and often pass into augen-gneisses. They are associated with coarse mica-schists, green chloritic schists and dark hornblende-schists. The beds dip at high angles and usually exhibit the short sharp foldings characteristic of the old Archæan gneisses. They have a width in the Stewart valley of about nineteen miles, and are probably a continuation to the south of the band of augen-gneisses described in last year's report as occurring on the upper part of Australia creek, but they have not been traced across the interval. Similar granite-gneisses have been observed by Mr. Spurr* in the Forty-mile region, and by Mr. Brooks† on White river, and are described by them as being probably the oldest rocks in the district. The evidence on this point is not clear in the Stewart River valley, and there is a possibility that they represent a great intrusive mass older than the massive granites described above, but younger than the highly altered rocks exposed along the lower part of the Stewart valley.

Yukon District—*Cont.*

Age of gneisses.

'The granite-gneisses are succeeded by a group of rocks which, so far as known, include the oldest sedimentaries of the district. The characteristic variety is a gray fine-grained gneissic-looking schist consisting largely of angular quartz grains with some felspar. Biotite is nearly always present, but in variable quantities. In many sections the schists have a banded appearance, due to the alternation in thin beds of a light-gray quartz-schist, carrying a few scattered biotite scales arranged parallel to the bedding, with a dark-gray more micaceous variety of the same rock. These schists are everywhere highly altered and in many instances are so completely recrystallized that their origin is doubtful. A preliminary examination of a few thin sections, shows that both clastic and igneous rocks are present, the former probably preponderating. The metamorphism has, however, been so complete over large areas that the two kinds are often indistinguishable in the field. In addition to the gray schists, the series includes bands of dark diorite-schists, green chloritic and actinolitic schists, bright lustrous mica-schists and numerous beds of white crystalline limestone. The strata just described occupy the Stewart valley down to its junction with the Yukon and are also found west of the Yukon on the lower part of White river where schists of an almost identical character have been described by Mr. Brooks‡ under the name of the Nasina series. This name will be employed by the writer in referring to these rocks. In the Forty-mile district the Birch Creek series and the Forty-mile series of Mr. Spurr probably represent the same group, but no such line of division as that assumed by him could be drawn in the Stewart River section. The schists of the Nasina series apparently overlie the granite-gneisses which border them on the east. The dips are usually moderate, seldom exceeding 40°, and there is a marked absence

Sedimentary rocks schists and gneisses.

Nasina series

Position of series.

* U.S. Geological Survey, Eighteenth Annual Report, Part III, p. 134.

† U.S. Geological Survey, Twentieth Annual Report, Part VII, p. 460.

‡ Ibid, p. 465.

Yukon District—*Cont.*

of the sharp foldings so prevalent in the granite-gneiss area. The apparent superior position of the Nasina series and the small amount of deformation its rocks have suffered as compared with the granite-gneisses, leads to the inference that they are younger than the latter, but is not conclusive proof. The contact of the two formations was nowhere seen, and bosses of sheared granite, similar to and possibly of the same age as the granite-gneiss, cut the Nasina series at several points.

Eruptive rocks.

'The Nasina schists are cut in all directions by numerous dykes and stocks belonging to several distinct periods of eruption. The oldest are the sheared granites referred to above. A younger looking gray massive granite also occurs in dykes and considerable areas all along the lower part of the valley. A group of acid dykes, probably mostly rhyolites, crosses the valley a few miles below the eastern boundary of the Nasina schists. They have been silicified and mineralized to some extent and form conspicuous yellow and red bluffs along the north bank of the river for some distance. Dark andesitic dykes were also noticed in a number of the exposures.

Glaciation of Stewart valley.

'The glacial features of the Stewart valley are interesting, as the upper part is in a glaciated and the lower in an unglaciated region. At Frazer falls the rocks are strongly glaciated in a direction nearly parallel to that of the valley and groovings also occur at several points lower down. Typical boulder-clay occurs in banks at intervals down to a point about ten miles below Mayo river. Below Mayo river a wide ridge 200 feet in height crosses the valley. The ridge is several miles in width and is built of silt, sand and gravel alternating with and often capped by bands of boulder-clay. A narrow depression bordered by steep scarped banks has been cut through it by the river. This ridge must have formed at one period a great dam across the valley, as above it the flats bordering the river are low and the drift deposits occur only in narrow terraces along the sides of the valley. It still acts as a dam to some extent, as the Stewart is sluggish above the Mayo river almost to Frazer falls. Below the ridge, the boulder-clay and accompanying glaciated boulders soon disappear, but high terraces of silt, sand and gravel continue along both sides of the valley down to the McQuesten and are occasionally cut by the river at the elbows of the bends. A high cut-bank two miles and a half below the mouth of Moose creek includes a thick bed of hard sandy clay resembling boulder-clay but containing rolled, instead of glaciated pebbles. In the lower part of the valley the gravel banks, consist entirely of ordinary stream wash.

Auriferous bars.

'The Stewart River bars were found to be auriferous as early as 1885, and in that and the two succeeding years it is estimated the yield amounted to about $100,000. Prospecting has been carried on to some extent ever since, but the production has been small. Bars have been worked from the Mayo forks down almost to the mouth of the river. Steamboat bar, the richest one discovered on the river, is situated about four miles below the McQuesten and is reported to have yielded for some time at the rate of $140 per day per man, as worked with a rocker. The gravels on this bar were auriferous to a depth of somewhat over two feet. In most of the other bars which were worked, the auriferous deposit was less than a foot in thickness, and was confined to a small area near the head of each bar. The extreme shallowness of the gold-bearing gravels accounts for the rapid exhaustion of the Stewart River diggings. During the past season no work of any kind was being done on the main stream below the Frazer falls. On the tributaries, some work was done on Scroggie creek, on some creeks near the head of the McQuesten, where some gold was taken out, and, late in the season, a strike was reported on Clear creek. A number of prospectors are wintering above Frazer falls and a good deal of prospecting will be carried out, on the upper waters of the river, during the coming season.

Yukon District—*Cont.*

Character of bars.

Prospectors.

'The gold on the Stewart River bars is fine, and there is every reason to believe that it has been concentrated from the high gravel and sand banks described above as occurring along the valley from the Mayo down to the McQuesten. The gravels nearly everywhere contain scattered colours, and they are constantly being undermined and carried away by the river. During the past season a prospecting party under Mr. Morley Ogilvie, examined the lower part of the river for dredging purposes and the results are reported to be very favourable. The gold in the bed of the river proved to be coarser than on the bars and was found in encouraging quantities. The conditions on the river are favourable for dredging as the current, except in a few places, is not swift and the gravel is comparatively fine with few large boulders.

Origin of river gold.

Gold in bed of river.

The Yukon River Section.

'The rocks outcropping along the Yukon river were examined with some care from the mouth of the Stewart down to Cliff creek, eleven miles below Forty-mile river. It was intended to continue the examination to the boundary but time did not permit. Below the Stewart the quartz-schists, crystalline limestones, hornblende-schists and other schists of the Nasina series, undulate in broad folds along the valley down to a point about four miles above Indian river, when they are overlain by the dark siliceous slates described in the Summary Report of 1899 as the Indian River series. The Indian River beds occupy the same position as the Nisconlith slates of southern British

Section of rocks along the Yukon.

Indian River slates.

Yukon District—*Cont.*

Columbia. They rest, apparently, conformably on the schists of the Nasina series and differ from them principally in being less completely altered and in their darker coloration. They include occasional bands of limestone and green schist.

Klondike series.

'Two miles below Ensley creek, the Indian River slates are cut off and replaced by the light colored sericitic schists or squeezed quartz-porphyries of the Klondike series. The latter, holding in places irregular-shaped inclusions of the older slates outcrop, in continuous sections along the valley down almost to the Klondike river. They extend in a wide band south-easterly to Australia creek, and constitute, as stated in last year's report, the gold-bearing rocks of the Klondike district. The Klondike schists are succeeded by a set of green, mostly diabasic rocks which the writer, for purposes of local description, has called the Moosehide group, and which are apparently older than the quartz-porphyries of the Klondike series. They occur both in a massive and schistose condition and are often altered into serpentine. Below Moosehide mountain, the section down nearly to Forty-mile river consists principally of thick bands of green schists and dark lead-coloured argillites alternating above with gray limestones. A few miles above Forty-mile river, the upper part of the Nasina schists and overlying Indian River slates are exposed for some distance in the axis of a broad anticline which crosses the valley in a diagonal direction. Below Forty-mile river the upper and less altered green and dark schists resume and continue down to Cliff creek, where the examination ended.

Moosehide group.

Nasina schists

Igneous rocks.

'In addition to the bedded or schistose rocks described above, igneous rocks, in great variety, are displayed along the Yukon Valley section. Sheared and massive granites occur in considerable areas at many points and granitic and pegmatite veins are seldom absent. Effusive rocks are represented by an area of andesite below Indian river and a basaltic area a few miles above Forty-mile river. Dykes of andesite, basalt, quartz-porphyry and allied rocks are also common, especially between Indian river and Forty-mile river.

Lignite areas.

Lignite areas.

'Lignite-bearing beds outcrop on the Klondike river six miles below Flat creek and extend in a north north-westerly direction in a long narrow basin or series of basins to Cliff creek a distance of sixty miles and probably for some miles beyond. They follow in a general way the course of the Yukon valley, from which they are separated by a narrow strip of the older rocks. Wide valleys are cut across them by all the streams entering this portion of the Yukon from the north-east, but owing to their soft character exposures are infrequent. In their normal

On Klondike river

condition the beds consist of soft slightly coherent sandstones and conglomerates, alternating with light- and dark-coloured clays and shales. In places where the beds have been strongly folded, the clays and sands are altered into sandstones and shales. The age of the lignite beds is uncertain as no fossils were found in them, but they probably belong to the Tertiary. Yukon District—*Cont.*

'A lignite horizon, with one or more seams, occurs in this formation at a number of widely separated points, and apparently accompanies it throughout its whole extent. Seams of lignite outcrop on Rock creek and its tributary Coal creek at the northern end of the area, on Cliff creek at the southern end, and on Twelve-mile creek, Fifteen-mile creek and Coal creek at intermediate points, and it is reported from a number of other localities. The total area underlain by lignite is estimated to considerably exceed 200 square miles.

Coal lands on Coal creek.

'The Alaska Exploration Co. has taken up a block of coal lands on Coal creek, and has commenced mining operations at a point a little over seven miles from the Klondike river following Coal Creek and Rock Creek valleys, and about twenty miles from Dawson. Lignite outcrops at this point in the face of a low rounded hill, part of which has been cut away by the stream. The hill seems to be due to a recent uplift, as the dips of the strata approximately follow its slopes. The section on the exposed face of the hill is of soft, slightly coherent micaceous sandstones and brownish clays, holding a broken bed of lignite. The workings of the mine consist of an incline about 400 feet in length, descending in a south-easterly direction at an average angle of about 25° for the first 200 feet, beyond which the angle gradually decreases to about 4°. A short drift has been driven in a north-easterly direction, following the seam, at a point 225 feet from the mouth of the incline. The seam dips to the north-east in the drift at angles of from 3° to 10°.

Workings on Coal creek.

'The strata in the upper part of the incline have been disturbed and faulted to some extent, and the lignite beds occur in a broken condition. In the lower part of the incline and in the drifts, the beds are continuous although the dips are still irregular. The disturbance appears to have been quite local and will probably not affect the beds for any considerable distance. It is impossible, however, to speak definitely on this point, as no surface sections are available for study. Two seams of lignite are present in the lower part of the incline and in the drifts. The upper seam has three feet of hard lignite, and the lower from two to three feet. The two seams are separated by a clay parting about a foot thick and are roofed and floored with clay. The lignite is hard and compact and shows no traces of the woody fibre so common in lignites. It is probable, as suggested by Dr. Hoffmann, that it originated largely from mosses and other low forms of vegetable

Coal seam at Coal Creek mine.

Yukon District—*Cont.*

growth. It is of good quality, burns freely and can be used both for heating and steam purposes.

Analyses of lignite.

'The following analyses of the two seams have been furnished by Dr. Hoffmann :—

Lignite from upper seam Coal Creek mine :—

Hygroscopic water	18·31
Volatile combustible matter	34·96
Fixed carbon	40·88
Ash	5·85
	100·00
Coke per centage (non-coherent)	46·73

Lignite from lower seam, Coal Creek mine :—

Hygroscopic water	19·37
Volatile combustible matter	33·85
Fixed carbon	37·45
Ash	9·33
	100·00
Coke per centage (non-coherent)	46·78

'In working Tertiary lignites it is well to bear in mind that the seams as a rule are not so regular or so persistent as in the older formations and the use of the diamond drill for exploratory purposes is strongly recommended before commencing operations on a large scale. In the case of the Coal Creek mine the precaution is rendered all the more necessary by the almost complete absence of surface sections in the neighbourhood.

Workings on Cliff creek.

'The North American Trading and Transportation Co. has opened up a group of lignite seams at Cliff creek, a small stream which enters the Yukon from the right, fifty-five miles below Dawson. The workings are situated about a mile and three-quarters from the mouth of the creek and consist of two long tunnels with a number of drifts and "upraises." The lower tunnel is on the right side of the creek and the upper a short distance farther up the creek on the left side. The distance along the zone from the mouth of the first tunnel to the end of the second is 2,800 feet, and the seams appear to be continuous for this distance and probably extend much farther.

'The tunnel at the upper workings has been driven mostly along the lignite zone, for a distance of 800 feet. At one point, 225 feet from the mouth of the tunnel, the coal seams are bent to one side and probably faulted. The lignite zone, consisting of alternating beds of lignite, clay and carbonaceous shale, measures over forty feet in thickness in places. The included lignite seams vary in thickness from a few inches up to five feet. A section 300 feet from the mouth of the tunnel showed over eleven feet of coal, in seams separated by clay partings and beds, as follows :— Yukon District—*Cont.*

Section on Cliff Creek tunnel.

	Feet.	Inches.
Lignite	1	6
Thin parting—	—	—
Lignite	0	5
Carbonaceous shale	0	3
Lignite	0	6
Shale	0	1
Lignite	2	0
Clay	1	3
Lignite	1	3
Clay	3	0
Lignite	1	0
	15	10

'The beds have a nearly east-and-west strike and dip in a southerly direction at angles of from 50° to 75°.

'A section in the lower workings showed :—

Section in lower workings.

	Feet.	Inches.
Shales		
Lignite, one thin parting	9	0
Shales	2	0
White clay	2	9
Alternating clays and shales	3	0
Grayish clay	13	0
Carbonaceous clay	3	3
Lignite, one parting	3	0
Carbonaceous shales and clays	6	0
Soft sandstone with layers of grit	10	0
	51	9

'The dip of the beds in the lower workings is much less than in the upper, and in places they are almost horizontal.

'The Cliff Creek lignite is very similar in appearance to the Rock Creek variety. It is dark in colour, compact, and probably somewhat harder than the latter, as the inclosing rocks are more indurated. Dr. Hoffmann describes it as a lignite of superior quality closely

Yukon District—*Cont.*

approaching to a lignitic coal. The following analyses were made in the laboratory of the Survey :

Analyses of lignite from workings.

Lignite from upper and lower workings, Cliff creek.

An analysis by fast coking gave :

	Upper Working.	Lower Working.
Hygroscopic water..........	8·57	10·58
Volatile combustible matter..	42·04	40·10
Fixed carbon..............	45·77	46·74
Ash....................	3·62	2·58
	100·00	100·00
Coke per cent..............	49·39	49·32

Coke of lignite from upper working,—feebly coherent, tender.
" " lower working,—non coherent.

'A considerable quantity of coal from the Cliff creek mines was shipped to Dawson during the past season for heating purposes, and it is also used by a number of the river steamers with satisfactory results. The coal is sold on the wharf at the mouth of Cliff creek for $10 a ton, and in Dawson for $20 a ton, and upwards. A narrow gauge railway has been built from the workings to the river, and the mine is now in a condition to supply a large demand.

'The coal outcrops on Coal creek and Fifteen-mile Creek were not examined. The Tertiary area on Indian river, opposite the mouth of Quartz creek is also reported to contain coal. The beds in this area are cut and hardened by igneous intrusions, and if they carry coal, it is likely to be harder and of a better quality than in the less disturbed districts.

Lignite seams on Lewes river.

'Lignite seams occur on the Lewes above Rink rapid, and during the last season a possibly important discovery of anthracite coal was made west of Dugdale station on the White Pass railway and only a few miles from the White Horse copper district. The specimens sent in for examination are crushed and coarsely foliated. The following is the result of an analysis made in the laboratory of the Survey :—

Analysis of coal from White Pass railway.

Hygroscopic water..	2·31
Volatile combustible matter.............	5·59
Fixed carbon........	67·20
Ash...............	24·90
	100·00
Coke per centage (non-coherent.)..........	92·10

'The percentage of ash in the specimen assayed is high, but it is possible that a purer variety may be discovered in the course of the exploration now in progress.

Yukon District—*Cont.*

White Horse Copper Deposits.

'The White Horse mineral area is situated west of the White Horse rapids on the Lewes river. The principal discoveries have been made along a belt about ten miles in length, running in a north-westerly and south-easterly direction or nearly parallel to the course of the Lewes and from two to four miles distant from it. The Lewes is bordered at this point, on the left, by a strip of rough plateau country closed in on the south-west by a range of mountains. The portion of the plateau adjoining the mountains may be said to constitute the mineralized district so far as known at present.

White Horse copper deposits.

'The geology of the district is simple, in its main features at least. West of the river and occupying the greater portion of the plateau is a lenticular area of gray often hornblendic granite. The eastern edge of the granite is mostly covered by drift, but on the west it cuts and often holds inclusions of gray crystalline limestone of unknown age. The limestones alternate with, and at one point are underlain by, hard flaggy ferruginous slates. Both the granites and limestones are cut by numerous dykes, which appear to belong to one period of eruption, but range from typical andesites and augite-porphyrites to a dark-green almost purely augite rock. A white or light-green dyke-rock is also common, composed almost entirely of epidote, zoisite, chlorite, secondary felspar and other alteration products. The granites opposite the upper end of Miles canyon are covered in places with basalts of the same age as those at the canyon and at White Horse rapids.

Geology of vicinity of White Horse rapids.

'All the rocks mentioned above, except the basalts, have been affected in the mineralization of the district. The ore is seldom contained in well defined veins, but occurs as a rule scattered irregularly through wide zones and patches. These are often situated at the contact of the limestones and the granites, but are not confined to this position, as they occur frequently in the dyke-rock and occasionally also in both the granite and limestone. The most striking feature of the district is the great scale on which alteration of the country-rocks has been carried on. In many places zones or irregular patches a hundred yards or more in width have been almost completely altered, usually into a garnet-rock holding bunches of epidote, actinolite and tremolite and ores of iron and copper. Some quartz is also usually present, but this mineral is not prominent. The alteration and replacement of the country-rock and the attendant mineralization are evidently parts of

Mineralization of district.

Yukon District—*Cont.*

the same process and have probably been produced in most cases by ascending heated waters charged with the required materials Subsequent surface alterations of the ores from sulphides to carbonates and oxides, due to atmospheric agencies, are also conspicuous at most of the openings.

Prospects visited.

'Among the prospects visited and hastily examined, are the Puebla, Rabbits Foot, Anaconda, Copper King and Carlyle near the northern end of the belt, the Valerie at the southern end, and the Arctic Chief, White Horse, Empress of India and Spring Creek claims at intermediate points.

Puebla claim.

'The Puebla consists of a great mass of hæmatite of the specular variety, nearly fifty yards across, situated at the contact of the granite with the limestones and slates. The hæmatite is flecked all through with green copper-carbonate and in places with grains of bornite and grains and small bunches of chalcopyrite. The claim is opened up by a shaft 62 feet deep, and a drift from the bottom of the shaft 123 feet in length. The upper part of the shaft is in ore and the lower 32 feet in country-rock. The drift reaches the ore 23 feet from the foot of the shaft, and is continued from that point through almost pure hæmatite. Near the end of the drift a second shaft has been sunk to a further depth of 25 feet, also through hæmatite. The lode at the shaft dips away from the granite at an angle of about 45°.

Origin of copper ore.

'The origin of this great mass of hæmatite and included copper minerals is somewhat obscure, but it appears to belong to the class of replacement lodes. No well-defined walls, marked by fissures were anywhere noticed. On the contrary the ore passes gradually into the inclosing country-rocks, although the latter are of several kinds. On the foot-wall the transition is from ore to altered granite, and on the hanging wall from ore to slates and limestone. The replacement has been very complete, as only traces of the original rock remain in the main mass of the lode.

Copper King lead.

'The Copper King lead follows a wide fine-grained dyke, the character of which has not been determined, traversing the granite in a northerly and southerly direction. The dyke contains a number of small limestone inclusions and is filled with secondary minerals, among which garnet and epidote are conspicuous. The lead has been opened up by a number of shallow pits, all of which show more or less ore, for a distance of 200 yards. The ore is not continuous on the surface and appears to be concentrated at points where cross fractures intercept the main lead, and at the limestone inclusions. At the principal workings a shaft 18 feet in depth has been sunk near the contact of one of those inclusions. The dyke-rock at this point is almost completely replaced by garnet and quartz impregnated with grains and bunches of bornite and chalcopyrite and occasionally with stibnite. The limestone to the east has also been well mineralized to a distance of twenty feet or more. A shipment of several car loads of ore which it is expected will run 14 per cent in copper will be made from this mine during the present winter. In addition to the copper contents, the ore is stated to carry some values in gold. Yukon District—*Cont.*

'The Carlyle lead is situated about 300 yards east from the Copper King and is of a somewhat similar character. The workings consist of a shaft 50 feet in depth and a short drift along the lead. The ore consists principally of grains and bunches of bornite and chalcopyrite distributed through a gangue of garnet, quartz and country rock. The ore is banded in places. Carlyle lead.

'The Anaconda and Rabbits Foot to the north of the Copper King have both been developed to some extent. The workings on the Anaconda consist of an open cut and a short tunnel. The lead cuts through granite, limestone and a fine-grained light-coloured dyke-rock, and is fairly well defined. It carries green carbonate of copper, bornite and chalcopyrite and is reported to yield fair values in gold. The Rabbits Foot follows along a fine-grained dyke cutting the granite and holding some limestone inclusions. The dyke has been altered in places into a mass of garnet, epidote, hornblende, &c., usually carrying more or less green carbonate of copper, bornite and chalcopyrite. In addition to the copper minerals erythrite or cobalt bloom was found at one of the openings. The workings consist of a number of shallow pits. Workings on the Anaconda and Rabbits Foot.

'The Valerie is situated west of the head of Miles canyon. The lead occurs in a green basic dyke, consisting largely of augite, cutting limestone. The dyke has been mineralized in places for some width principally with magnetite and chalcopyrite. The chalcopyrite often occurs in bunches in the magnetite. A couple of surface openings and a shaft a few feet in depth constitute the workings. Valerie claim.

'The Arctic Chief, a couple of miles north of the Valerie, is situated in a wide porphyrite dyke cutting limestone and granite. The dyke-rock has been greatly altered and is now largely replaced by garnet, epidote, hornblende and other secondary minerals. Lenses of magnetite occur at several points. The largest of these has a width of fully 20 feet and carries chalcopyrite in grains, bunches and small veins. The workings consist of surface openings only. Arctic Chief claim.

The White Horse, to the south-west of the Arctic Chief, shows a fairly well defined lead 6 to 8 feet in width cutting granite. The gangue is more siliceous than usual and is heavily copper stained. The workings are confined to a single small surface cut. White Horse claim.

Yukon District—*Cont.* Empress of India claim

'The Empress of India is situated about a mile north of the Arctic Chief in a confused area of limestone, porphyrite and granite now altered and largely replaced by garnet, epidote quartz, calcite, hornblende and tremolite. The altered area is fully 150 feet in width and carries in places grains and bunches, some of considerable size, of bornite and chalcopyrite. The Spring Creek claim adjoining the Empress of India is similar in character. The work done on both claims is confined to surface openings.

'In addition to the claims referred to above, a large number of others have been staked along the mineral belt, and on a few of them a small amount of development work, usually in the form of shallow surface cuts, has been done.

'The district taken as a whole may be characterized as one of considerable promise, and as being well worth the attention of mining men. It is situated only 110 milles from the sea with which it is now connected by rail, and the expenses of mining need not be much greater than in the camps of southern British Columbia.'

BRITISH COLUMBIA

Atlin District.

British Columbia

In the Atlin district, in the extreme north of British Columbia, Mr. J. C. Gwillim was again employed during the entire season available for field-work. His report upon the work accomplished and the present state of mining operations in this gold district is as follows :—

Work by Mr. J. C. Gwillim.

'My instructions for the season were to complete, as far as possible the working out of the geology and topography of the Atlin district, already covered by my reconnaissance survey during the preceding year.

'I was accompanied by Mr. W. H. Boyd, to whom was entrusted the topographical survey of the district under examination This work was carried out by him in an able manner, and the material for a sufficiently accurate map of the country between Teslin lake and Taku arm, including all the Atlin gold field, can now be compiled.

Surveys made.

'We left Vancouver on June 1st, arriving in Atlin on June 7th. The season was somewhat earlier than in 1899, but the mountains were still covered with snow, so that we set about the lake work until conditions for mountain work became more favourable. The conspicuous peaks of Birch mountain and Mount Minto were taken as the limits of a base line on which to build up a triangulation of the district, and this triangulation was carried eastward to Teslin lake by Mr. Boyd. At the same time the local topography was fixed from each mountain station, and the geological features were examined as carefully as time permitted.

'From June 7th until July 10th was spent on Atlin lake, and its surrounding mountains. On July 10th we went over to Taku arm, returning to Atlin on the 19th, from which time we travelled with pack animals through the country between Atlin and Teslin lakes. British Columbia—*Cont.*

'After spending a week in the mountains adjacent to Pine creek, another man was engaged, and we set out for Teslin lake, by way of Ruby and Consolation creeks, thence north of Gladys lake, and down along the north side of Gladys river to its outlet into Teslin lake, some sixteen miles south of Dawson peaks.

'Returning, we crossed the Sucker river south of Gladys lake about two miles up from its mouth, thence proceeded up the Zenazie creek to within a few miles of Surprise lake and across a low pass southwards into the Terra Heena creek, which flows parallel to the Zenazie. In the report for last year this more southern stream was called Zenazie but the name Terra Heena appears to be the right one. From Terra Heena creek we crossed the upper branches of O'Donnel river and thence over another low divide into the valley of Wright Creek and the Pine Creek basin on August 26th. Routes.

'At this time Mr. Robertson, the provincial mineralogist, was examining the gold-bearing creeks, and I spent one day with him and Mr. Weir, on Spruce creek.

'On August 30th we began a circuit of the country lying to the southeast of Atlin, in order to trace up a probable extension of the gold-bearing slates of Wright and Otter creeks and to fill in the district between the Taku trail and our more northern traverses. This circuit followed Spruce creek and down Slate creek, across O'Donnel river, twelve miles from its mouth. Thence we went over the low massive granite range called McMaster Mountain to the upper waters of the Silver Salmon river and Ruth lake of the older maps. Returning, we followed the great north-and-south valley of Sucker river for some fifteen miles, then crossed the low ranges west of it, reaching Otter creek and Pine creek on September 19th.

'The remainder of the season was spent in a closer examination of the conditions of the producing gold creeks, in which I received much assistance from Mr. Frank Weir, of Stephendyke.

'On October 4th we left Atlin and reached Vancouver on October 11th.

'A more detailed examination of the northern portion of Atlin lake brought out no facts of special interest. As stated last year, the shores are chiefly granitic, and without evidence of any mineral value, as far as observed.

'A set of soundings taken along mid-lake from Atlin, north towards the base of Mount Minto—25 miles—showed a general depth of about Depth of Atlin lake

British Columbia—*Cont.*

500 feet for the more southerly portion, and about 250 feet for the northern. The greatest depth found was 650 feet at a point ten miles north of Atlin.

Mount Minto.

'On July 4th Mount Minto was ascended, being almost clear of snow at this date. Its height is about 4,700 feet above the lake. The lower portion of this great isolated mountain, for 3,000 feet up, is granite. The upper portion and summit are composed of a dark, basic, eruptive, hornblende-porphyrite. Granite boulders were noticed on the highest points of this mountain. They are well rounded and are more acidic than the granite of the lake shore.

Atlin Mountains.

'The abrupt range of mountains immediately south of the Atlin river, known as the Atlin mountains, has a height of 4,390 feet above the lake, or 6,590 feet above the sea. The mountains were found to consist of quartzites, limestone and greenstone along the eastern base and flanks, with a core or interior mass of granite-porphyry similar to the other isolated areas of Birch and Cathedral mountains. The peculiar weathering of this rock has caused an immense slide of gray rock on the eastern face of Atlin mountains.

Cretaceous rocks.

'South and west of the Atlin mountains is the first appearance of the sedimentary rocks on this lake, and these are probably Cretaceous in age. They are well shown in a rude anticline on the sides of two mountains. Observation of the different beds here exposed tends to show that the upper strata are of somewhat uniform material, usually a greenish sandstone, while the lower beds contain more conglomerates. The section as exposed here must be over 5,000 feet thick. No evidence of coal was observed in this possibly coal-bearing series of rocks. Neither are reports of coal and petroleum discoveries, so far as learned, well founded. A few fossils were collected along the lake shore. These appear to confirm the Cretaceous age of the series.

Eruptive rocks.

'To the west of Atlin lake is a high, well rounded group of mountains, composed chiefly of eruptive rocks of a basaltic and porphyritic character. They illustrate a common arrangement of the rocks in this district, having the older and often sedimentary rocks along the lower flanks of the mountains, while the central and higher mass is of eruptive origin, later in age than that of the Coast Range granites.

General character of the geology.

'Generally speaking, the southern portion of Atlin Lake district consists of sedimentary rocks along the lower levels and lake shore, and sometimes for two or three thousand feet up the mountain sides. The main mass of these mountain groups, however, is eruptive and consist of various basalts, porphyrites and porphyries, both acidic and basic in composition.

'In some of the augite-porphyrites and allied rocks are found zones and seams impregnated with native copper. Such a condition is found on the Noel claim on the south shore of Copper island. The rock has been fissured, and now carries seams of quartz and calcite, with a zone of altered country-rock partly impregnated with copper. Other deposits of copper-pyrites and magnetite exist on the western arm of the lake near William creek. The chief development work done, on the quartz claims, has been on the Noel claim, otherwise there is nothing except a little assessment work done south of McKee creek. These creeks all flow over the eruptive rocks or Cretaceous sedimentaries characteristic of this locality, which, so far as known are unproductive of gold.

British Columbia—*Cont.*

Native copper.

'Moose creek flows in from the south over porphyrites and basalts of the Sloko lake character. It has been staked for several miles but is now abandoned.

'An extension of the magnesian gold-bearing rocks of Pine creek was traced westwards into Taku arm. These appear to continue westwards in a more broken manner and may be connected with the placer discovery on Graham creek near Golden Gate this season. They cease to constitute an important set of rocks, however, outside the basin of Pine creek.

Gold-bearing rocks.

'The rather flat-topped group of mountains west of Taku on the north side of Taku inlet is porphyritic in character, and is flanked on the north by the extension of the Tagish Lake Carboniferous limestone. To the south of this eruptive area is the outcrop of the Pine Creek magnesian rocks, and further south the great mass of Cretaceous sandstones, which continues out to Golden Gate and the southern end of Taku arm.

Mountains of Taku.

'Eight miles south of Golden Gate, on the eastern shore, the Engineer Mining Co. is developing the Hope mineral claim, under the superintendence of Mr. John E. Ryan. The ore-body is composed of quartz and has an extensive outcrop at the point of operation. The country-rock is a twisted clay-slate, a part of the Cretaceous sedimentary series, which at this place lies between the granites of the Coast range, four miles to the west, and a large area of porphyritic eruptives immediately to the east. Some acidic dykes were noticed in the vicinity, these being rare in other parts of the stratified series.

Development work by Engineer Mining Co.

'The company was driving a cross-cut from the lake-shore to the ore-beds at the time of my visit. High values in gold are said to be found, and the presence of gold telluride has also been reported, but was not observed in specimens collected and examined in the laboratory of the Survey. Across the arm on the west shore another prospect is being developed, but this was not seen.

British Columbia—*Cont.*

'A belt of schistose rock follows the west shore down to and along Fantail lake. These are chiefly chloritic schists and appear to be mineralized by small quartz veins carrying some pyritic minerals.

'The route followed in going over to Teslin lake in August was taken in order to trace up the northern granitic boundary of the Pine Creek series of rocks and their extension in a north-easterly direction. Also to determine the course of the Gladys or Thirty-mile river, which drains Gladys lake into Teslin lake.

Pine Creek magnesian rocks.

'The Pine Creek magnesian rocks and actinolite-slates have their northern boundary along the summit of Munro mountain, thence across the extreme head of Birch creek. From Birch creek it crosses to near Discovery claim on Boulder creek, and on Ruby creek the series is completely cut off by the granite which passes southward across Surprise lake.

'These Pine Creek rocks re-appear at the upper branches of Ruby creek, but not very extensively. Proceeding north-easterly, much of the district is underlain by a quartzite rock, which has so far as known been unproductive of gold in paying quantities.

'The typical Pine Creek rocks are again met with in the mountains south of Gladys lake. Here they are again limited and cut off by granites to the south and east. Apparently the great flats which lie west of Dawson peaks and north of Gladys lake are floored with quartzite rocks, which are in contact with limestones to the north and are probably conformable with them.

ladys river.

'Gladys River is the name given to what has been called Thirty-mile river by the miners and on some earlier sketches and maps. This river leaves Gladys lake from its north shore eight miles from the western end. At the time of our traverse in August this stream was estimated at 60 feet wide by 2 feet deep flowing 4 miles an hour.

'The river has a cañyon-like valley across a low range of quartzitic rocks flowing in a northerly direction for six miles. After crossing this low range into the great flats west of Dawson peaks, it turns abruptly to the eastward, and continues to flow parallel to this low range which separates it from Gladys lake. This course takes it through some large lakes with many islands, the chief of which is Hall lake.

'About five miles from its outlet into Teslin lake the Gladys river turns abruptly to the north again. At this point are falls of a few feet, causing the only portage necessary on the river for a strong boat. The point at which Gladys river enters Teslin lake is about sixteen miles south-east of the Dawson peaks or Three Aces.

'Nearly the whole length of the river-bed passes over quartzitic rocks, often cherty in character. Three miles from the mouth it crosses limestone, which apparently underlies these peculiar quartzites. Much of the wide low country through which the river flows is underlain by gravels.

British Columbia—*Cont.*

'Returning to Atlin, the traverse crossed the country south of Gladys lake. Most of this is rugged, mountainous and granitic.

Snowdon mountains.

'The Snowdon group of mountains lies between Sucker river and Teslin lake. The north and south flanks of this group are quartzitic, the central and more prominent portions granite. So far as known no mineral discoveries have been made in this locality.

Sucker river.

'The Sucker river was forded at a point two miles south of its entrance into the east end of Gladys lake. This river rises about thirty miles south of Gladys lake and lies in the same great north-and-south valley as the upper eastern branch of the Silver Salmon river. By this valley a low pass is formed from Teslin lake over to the waters flowing into the Nakina and Taku rivers and thence to Taku inlet, the greatest elevation being about 3,000 feet above the sea in the pleasant vàlley at the head of Silver Salmon. Zenazie creek flows into Sucker river from the west through a very rough group of granite montains that form the eastern extension of the Surprise lake granites. It is sometimes used as a route to Altin from Teslin lake, but has not much to recommend it.

Barren granite.

'Excepting the small area of Pine Creek rocks, south of Gladys lake, the block of country between Surprise lake, Terra Heena creek and Sucker river, is composed of a granite, presumably barren. The 'slates' re-appear at Terra Heena creek and south of it for many miles.

'The district lying south-east of the Pine Creek productive basin appears to offer some chance of an extension of the gold field in this direction. The characteristic rocks are often very similar to those of Wright and Otter creeks, but on the whole are more quartzitic. The presence of dark clay-slates of the Wright Creek variety on Ptarmigan flats points to a still further development of these "slates" in a south-easterly direction. In this district there are many small creeks often with shallow bed-rock. These have been prospected very little and are not yet staked.

McMaster mountains.

'McMaster mountains consist of granite, and constitute a massive easy-sloping range, between O'Donnel river and the upper Silver Salmon or Tawina. Farther south between the Silver Salmon and Ruth lake are the Merlin mountains. These are conspicuous and of a rugged character, green in colour and with many deep basins or cirques. They are composed of greenstone and serpentine, with some patches of black limestone, and are surrounded by quartzitic slates, clay-slates and crystalline limestone, characteristic of the O'Donnel River basin. The

British Columbia—*Cont.*

government Yukon telegraph line passes along the northern flank of these mountains on its way from Atlin lake to Telegraph creek.

Granitic plains.

'To the east of Merlin mountains and on the Taku trail are the great granitic plains or plateaus mentioned in last year's report. These extend in a northerly direction to within twelve miles of the granites of the Snowdon group, The intervening rocks being the widely spread slates, quartzites, clay-slates and patchy limestone.

Clay slates of Silver Salmon and Sucker rivers.

'The upper valley of Silver Salmon and Sucker rivers is in somewhat softer rocks, often approaching clay-slates. These are found in all the low ranges westwards towards the upper O'Donnel river and Wright creek. There are a few areas of gray limestone and some intrusive rocks of the nature of greenstone. Some sluicing has been done on the eastern branches of O'Donnel river where the bed-rock is very similiar to that of Wright creek, but these claims are now abandoned, and at present no part of the O'Donnel river, or Dixie creek, is productive, but much of it is under hydraulic lease.

'The rocks of the entire district, as far as determined at present, are roughly, as follows :—

Rocks of the district.

'1. Sandstones and argillites of probable Cretaceous age, in the basins of southern Taku arm and Atlin lake, with an expected continuation to the south-east by Pike lake, and the Nakina river.

'2. The characteristic rocks of Pine Creek basin are different varieties of magnesian combinations, together with some greenstones of a diabasic character. Magnesite, serpentine, dunite, greenstone, actinolite slates and a very friable gray limestone are the chief rocks. These were not seen outside of the Pine Creek and McKee Creek basins excepting in two or three localities. They extend in patches across Atlin lake westward into Taku inlet and possibly over towards Taku arm to a point five miles south of Toochi river. Another area of these typical rocks is found about Chehalis creek, south of Gladys lake as mentioned previously.

'3. Cherty quartzites and various kinds of clay-slates, together with patches of gray or black limestone, distributed over the great flats west of Dawson peaks and Gladys lake, O'Donnel River basin and eastwards to Teslin lake at its southern end.

'4. Great masses of crystalline limestones on northern Taku arm, Little Atlin lake, Lower O'Donnel river and at the junction of Silver Salmon and Nakina rivers.

'5. Late eruptive rocks of basaltic and porphyritic characters, all about the southern parts of Atlin lake, constituting the central portions of most of the groups of mountains there.

'6. Granites of the Coast range at the south end of Taku arm, and isolated masses of granite from the northern end of Atlin lake eastwards across Surprise lake, and Snowdon mountains to near Teslin lake, also McMaster mountains east of lower O'Donnel river, and the boulder-strewn plateaus seventeen miles eastward, from Ruth lake on the Taku trail. British Columbia—*Cont.*

'Concerning the auriferous gravels and placer mining: there has been no extension of the productive gold-field this season except the discovery of Graham creek, on Taku arm near Golden Gate, some portions of which are said to pay wages. Area of productive gold fields.

'On Pine creek and its tributaries, much the same ground was being worked as last year, excepting where hydraulic leases have covered stretches of the creeks.

'Placer mining was active on Boulder, McKee, the upper portion of Wright, and the lower middle portion of Spruce creeks. Mining was also in progress from Stephendyke to Gold Run on Pine creek, and a few men were at the upper cañons of Spruce and other creeks.

'Most of Birch creek, the lower portions of Boulder and Wright creeks and portions of Willow and Pine creeks were under active hydraulic development. These, however, with the exception of Brackett's hydraulic concession on Willow creek, hardly got further than the preliminary stages of installing the plant and reaching bed-rock.

'The other unoccupied portions of the above-mentioned creeks, together with various runs or supposed former channels and benches are under hydraulic lease. Apparently the chief difficulties are want of water, and some interference due to opposing interests.

'On Pine creek a considerable amount of work has been done along the southern banks from Gold Run down to Stephendyke. This has opened up a good deal of moderately paying ground, in the form of benches and older stream-gravels of different horizons.

'The existence of pre-glacial yellow gravels is shown at different points from Stephendyke to Gold Run, a distance of about two miles and a half. This old channel appears to be much wider than that of the present stream. Apparently it passed over the rocky benches between Stephendyke and Pine City, thence along the southern banks opposite the town and over the rocky bench which divides Pine from Willow creek. It is not so far shown in Willow creek itself, but follows Pine creek on both banks up to the mouth of Gold Run, which enters from the south as a boggy little valley. Apparently the yellow gravel follows Pine creek to a point above Gold Run, as it is seen in workings. Pre-glacial gravels.

'A shaft sunk for 30 feet on the "Deadwood group," some distance up Gold Run, passes through a yellowish gravel, and good pay is

British Columbia—*Cont.*

reported from the rim or bed-rock at the bottom. Many men are planning to continue sinking along this possible old channel during the present winter.

'On the average it is said the yellow gravel hardly pays for ordinary placer mining, but not being cemented may be valuable for hydraulicing. It is stated that the Sunrise Gulch Hydraulic Co. took out $3,482 from an area 100 feet square on the yellow gravel bed-rock, at the head of Willow creek. A somewhat similiar but better defined yellow gravel deposit exists on Spruce creek and can be traced from above the lower cañyon (at 101 below Discovery,) to the benches on the south bank of Discovery and somewhat higher up the stream. Its course and grade (between 2 and 3 per cent.) appear to be about the same as that of the present stream.

Yellow gravels on Spruce creek.

'The present stream flows between high banks of clay and partially sorted gravels, apparently of glacial origin, and the stream has cut down through these and the underlying yellow gravels, leaving the latter exposed at points. Many tunnels have been driven into the banks, with more or less favourable results.

Workings on Spruce creek.

'Prouse's tunnel penetrates the western bank near claim 100 below Discovery, and the yellow gravel excavated from its drifts is said to run $6 to the cubic yard. Active work and sluicing is being carried on at 94 below Discovery on the east bank in yellow gravel, and it appears that much of the gold found in the present stream-bed is a reconcentration from the older yellow-gravel channel, the bed rock of which is also the bed-rock of the present valley in places. Below the lower cañon the yellow gravel has not yet been traced, but there is some evidence to show that it may pass to the west of the cañon at Prouses point. These gravels are lost sight of both on Pine and Spruce creeks after the more level terraced flats are reached, and it appears possible that they do not now exist at a much lower level than that to which they have been traced.

Recent concentration.

'Besides the yellow gravels there are more recent concentrations along water courses which have existed during and since the deposition of the heavy drift which now fills the broad valleys of Pine and Spruce creeks. The regular depressions of Stephendyke, Gold Run, Willow creek, Thron gulch and several lateral courses have been at one time the channels of drainage for the waters of these valleys, and along them there has been more or less concentration of gold.

Hydraulic companies.

'The hydraulic companies which put in a complete plant and began operation during the past season are: the Syndicat de Lamare on Boulder creek, Atlin Lake Company on Birch creek, Pendugwig Syndicate on Wright creek, Sunrise Gulch Company on Pine and Willow creeks and Brackett's Willow Creek Company.

'Quartz mining has been undertaken to some extent by the Nimrod Syndicate, and by the Engineer Mining Company, the latter developing the Hope and Toronto claims on Taku arm. The Nimrod Syndicate has been engaged in developing and testing various prospects of promise within the Pine Creek basin. Operations have been suspended on these, owing to various difficulties met with. British Columbia—*Cont.* Quartz mining.

The Paris Exhibition claim belonging to the Imperial group is situated on Munro mountain. The vein being worked in July last, consisted of quartz and magnesite containing gold and silver values. The returns of mill-tests made by the Nimrod Syndicate, according to their published report were somewhat over $10 per ton. The strike of this vein is about east-and-west magnetic, dipping south at 70°. It varies in width from 2 to 7 feet and appears to be a well-marked fissure vein.

'The Yellow Jacket mineral claim contains a large vein or body of mixed magnesite and quartz, which outcrops along the bed of Pine creek about half a mile above Pine City. A shaft has been sunk by the Nimrod Syndicate, but work is suspended on account of litigation. The gold values of this rock are said to be high.

'Work is reported to have been carried on at the Canyon claim on Crater creek last winter. The vein carries galena and is said to look well.

'The Ivy May claim is situated at the head of Little Spruce creek and was being worked on September 22, when visited by Mr. Boyd. The vein is quartz, striking nearly east-and-west (magnetic) and dipping 60° to the south. High assays in gold are reported from this vein.

'By the opening up of bench gravels and the older channel gravels during the past year, the extent of productive ground has been increased, so that the conditions for hydraulic mining at least, appear more favourable than they did a year ago. Some of this ground is rich enough for individual placer mining, and has the advantage of being workable during the winter by means of drifting. During the present winter a number of men are driving prospecting tunnels and drifts which will do much to reveal the older courses of the streams of these valleys. Bench grav and old channels.

'The greater portion, however, of this bench and yellow gravel appears better suited for hydraulic mining, as soon as the way is clear for operations.

'Specimens from the district examined in the laboratory of the Survey have failed to confirm the presence of tellurides or of nickel where they were supposed to exist. A light-green rock commonly stated to carry nickel in this district consists of magnesite and chromiferous mica. Some specimens of cassiterite (wood tin) from Klondike district were examined for Mr. Foster of Wright Creek.

British Columbia—*Cont.* Mineral spring.

'A sample of water from the mineral spring at the north end of Atlin town was collected in order to prove, if possible, the relation of such waters to the hydromagnesite deposits in the vicinity. This has since been examined in the laboratory of the Survey and is reported upon as follows by Dr. Hoffmann :—

Analysis of water.

"'This water was found to contain :—Potassa, traces ; soda, very small quantity ; lime, very small quantity ; magnesia, somewhat large quantity ; ferrous oxide, trace ; sulphuric acid, very small quantity ; carbonic acid, large quantity ; chlorine, very small quantity ; silica, trace ; organic matter, faint traces. The magnesia amounted, approximately, to 1·834 parts in 1,000, an amount which would correspond to 3·851 of magnesium carborate, or 5·869 of magnesium bicarbonate. It is more than probable that it is to the water of this and similar springs in the vicinity, that the deposits of hydromagnesite occurring back of Atlin townsite owe their origin."

Mountain plants.

'During the season a collection of flowering plants was made, more especially of mountain species found above the timber-line on the bare grassy ridges. Fifty-four species have been determined by Prof. Macoun of which six are of special interest,—*Anemone Richardsoni, Pedicularis pedicellata, Claytonia sarmentosa, Pedicularis capitata* as also a *Claytonia* and an *Erigeron* which appear to be new. These are all mountain species from altitudes of about 5,000 feet above the sea, collected between June 21st and July 14th.

'The common spruce of the district, found of fair size in flats, is the white spruce, *Picea alba.*

'Acknowledgments are due to Messrs. Fraser and Wheeling, and to Mr. Gillard of the Bank of British North America at Atlin, for their courtesy and assistance during the season.

Kootenay District.

Work by Mr. R. W. Brock.

Mr. R. W. Brock has now been at work on the geology of the area covered by the West Kootenay map-sheet for some years. During the winter of 1899-1900 his time was chiefly devoted to an examination of the rocks from this field, and as a result of the field-work of the past summer the information required for the compilation of the map-sheet is now practically complete. The topography of this new map is chiefly due to Mr. W. W. Leach. Upon the work of the summer Mr. Brock makes the following interim report :—

Topographical work by Mr. W. W. Leach

'On May 22nd I left Ottawa with instructions to complete, if possible, the work on the West Kootenay map-sheet, after which, if any time remained, to extend the geological observation westward toward the Boundary district. As in the previous years, I was accompanied by Mr. W. W. Leach, of this office, who took charge of the topographical work. The portion of the West Kootenay sheet still remaining unsurveyed included, roughly, all the area lying between the longitude of Rossland and Lower Arrow lake, and the North fork of the Kettle river, from the International boundary line to about the latitude of Monashee mountain and the head of the main Kettle river, and also part of the area in the north-east corner of the sheet, east of Kootenay lake.

British Columbia—*Cont.*

Geological work accomplished.

'The west shore of Lower Arrow lake, and Whatshan lake were not included, as these had been surveyed last year. The examination of these areas, with some degree of accuracy and detail, where the economic conditions seemed to warrant it, has been accomplished and it will now be possible to issue the complete West Kootenay map-sheet. Owing to the large area embraced in the sheet, the extremely mountainous character of the greater portion of the country, and the complicated nature of its geology, the geological portion of the work, in many portions of the district must, however, yet be considered as only a reconnaissance.

'Although the season as a whole was unusually favourable, it was found impossible to do much more than complete the work on the West Kootenay sheet. Indeed, had the weather at the end of the season permitted it, some additional time might have been well spent in this district. Some information, particularly of a topographical kind, was, however, obtained regarding the country to the west, which will be valuable in carrying on the work in the adjoining sheet.

Work in the Boundary district.

'Before the regular field-work was undertaken, a few days were spent between Penticton and Grand Forks, in ascertaining some main facts respecting the distribution of the formations in the Boundary district, which were needed for the general geological map of Canada then in course of preparation.

Routes followed areas examined.

'The regular work of the season was begun at Rossland. Using the Dewdney trail as a base, the country between Rossland and Christina lake was surveyed. My operations were then transferred to the district about Gladstone, from which point expeditions were made first east, and then north through Burnt and North basins to Badger and Gladstone mountains. Grand Forks formed the next base. From here the North Fork of the Kettle river was ascended. A wagon road, with branches to Volcanic, Pathfinder and Little Bertha claims, extends up the east side of the river to Knights camp on Cedar creek. From Cedar creek the North Fork trail continues to Bunch Grass mountain, where it forks, one branch ascending the main North Fork, while the main trail runs up the east branch of the North Fork to McKinley, Franklin, and Newby camps. After lightening the packs for our horses at Newby's, the end of the trail, we explored the country lying north through to Fire Valley. Fire Valley, and the

British Columbia—*Cont.*

Kettle river, to the west, as far as Monashee mountain, were next surveyed. From here Mr. Leach went to Crawford creek to fill in the blank remaining in the north-east corner of the sheet, while I ascended the Kettle to its head, to connect with the work of last year from Whatshan lake. Returning from the head of the Kettle to Fire Valley, the men were sent back to Grand Forks with the horses by the route we had explored, while I proceeded to Rossland *via* Arrow lake. From Rossland a trip was made to Old Glory mountain to complete the survey between Murphy and Sheep creeks. Returning to Grand Forks, where Mr. Leach rejoined the party, the North Fork was again ascended to Newby's, to complete the surveys of the trails, and of the Arrow Lake divide. When this had been completed the Columbia and Western railway (Canadian Pacific Railway) from Brown creek to the Bull Dog tunnel was gone over and a survey made of Christina lake. This ended the regular field-work of the season. A few days were spent on special work in the vicinity of Rossland and Nelson. Observations on Arrow, Slocan and Kootenay lakes, for the purpose of fixing the levels of these waters were also taken. Ottawa was reached on October 31st.

General description.

'As the map of West Kootenay embracing the area examined this summer, will soon be published, it will be unnecessary to go into detail regarding the topography of the particular area examined this season. While wholly mountainous, it is less rugged than the country to the east, its topography being that of an older district. The mountains are not so high and they have lost most of their alpine characteristics. Outside of the range between the main and east branches of the North Fork, few of the mountains exceed 7,000 feet in height. The summits, lying below the region of excessive denudation are more inclined to be dome-shaped with gentle slopes. The ridges, notably those between the head of the east branch, of the North Fork, Eagle creek and Fire Valley, are often wide and comparatively flat and plateau-like.

Physical features.

'As might be inferred, the valleys have departed more or less from the simple longitudinal and transverse system; the stronger creeks have invaded and captured territory formerly belonging to the weaker, thus complicating the structure of the valley system as well as that of the ridges. The latter system is rendered still more intricate by differences in resistance of the component rocks, more distinctly brought out by long exposure to denudation. Owing to these causes, peaks are found at the end of low ridges or they rise unexpectedly in the valleys so that, viewed from an elevation, the topography, in many places, seems very complex.

'Near Grand Fork, and at a few other points, the mountains have drift-covered, grassy slopes, broken by brushy draws, through which knees and elbows of rock protrude. The Kettle valley about Grand Forks and Cascade is a prairie or park country, but with these exceptions, and that of the summits of the higher ranges, none of the country may be said to be without timber.

British Columbia—*Cont.*
Open country.

'The valley occupied by the North fork and its eastern branch is remarkably level, rising only about 1,000 feet between Grand Forks and the mouth of Franklin creek, a distance of thirty-four miles. The main branch, however, rises rapidly above the forks at Bunch Grass mountains. It is evident that this valley was formerly occupied by a lake as the paralled valleys, Okanagan, Christina, Arrow, Slocan and Kootenay, now are. Formerly the North fork discharged into the Kettle river west of Observation point, its present channel to the east being comparatively recent, as the gorge at the Smelter dam indicates. Were this dam about twenty feet higher, this river would again discharge through the western channel.

Character of valleys.

'The main branch of the North fork heads in a ridge south of Fire valley, near Galloping mountain; the east branch, cut off at its head by Eagle creek, rises in a plateau with some smaller tributaries of Eagle creek, and Johnson creek which discharges into Arrow lake.

'Christina lake, of which a log-survey was made, proved smaller than usually supposed, being little more than twelve miles long.

Christina lake and pass to Kettle valley.

'McRae creek, which discharges into Christina lake at English point, occupies a very narrow, steep-walled valley, heading with the south fork of Dog creek, which discharges into Arrow lake. These two creeks have cut away the neck formerly separating their cirques and now head together in a low pass (about 4,000 ft.). This pass, affording an easy entrance into the Kettle valley, has been utilized by the Columbia and Western railway.

'Fire valley, through which the trail from Lower Arrow lake to Vernon runs, leads through two passes into the Kettle valley. Of these, one enters the Kettle valley near Kettle River bar, the other, which is followed by the improved trail to Vernon, opens on Kettle river, about six miles or so above the bar. The new trail after crossing Kettle river at Red Paddy's town-site, passes over the low ridge running south from Monashee mountain, joining the old trail in Pass valley about one and a half miles south of Monashee mine.

Trails.

'About eight miles above the new trail-crossing, on Kettle river, is Keefer lake, a small sheet of water about one mile and three quarters long. Three-quarters of a mile above Keefer lake is Pooler lake, a marshy tract three-quarters of a mile long, which may be considered

Kettle River valley.

British Columbia—Cont.

the head of the main Kettle river. Several small streams from the hills north and south enter this lake. Only about one-quarter of a mile of flat, marshy ground separates this lake from Barnes creek, which flows south-east into Whatshan river, entering the latter about three miles from its month on Lower Arrow lake. A stream from the hill to the north, discharging into the head of Pooler lake, meanders through this marshy ground to within a few feet of Barnes creek, so that in high water it is probable that Kettle river and Whatshan waters intermingle. Barnes creek heads in the Cherry Creek Pinnacles, where Pooler creek, flowing eastward into the head of Whatshan lake, also takes its rise.

Vegetation.

'The vegetation is, generally speaking, similar to that already described in other portions of West Kootenay. The open hillsides are generally overgrown with bunch-grass, not commonly found farther east. The high open summits where vegetation can secure a foothold are gay in summer with sub-alpine flora. The valley of the North fork to about Franklin camp is well timbered with red pine (*Pinus ponderosa*), white-pine (*P. monticola*) hemlock (*Tsuga Mertensiana*), cedar (*Thuga gigantea*), with some tamarack (*Larix occidentalis*), Douglas fir (*Pseudotsuga Douglasii*) and spruce. Some timber also occurs along the Kettle valley, but with these and a few other exceptions, beside wood useful for mining purposes, there is little timber of commercial importance, since the greater portion of the district has been overrun by forest fires.

Game.

'In some portions of the country game is still plentiful, especially in the unprospected areas, such as the district between Franklin camp and Fire valley. There, numerous deer and caribou range, as well as beasts of prey. The smaller animals are also plentiful. Game shot while in this rough region supplied us with food and thus proved of great assistance in carrying on the work there.

Rocks observed in district.

'While granitic rocks cover the greater part of the district examined during the season, the range and variety of rocks represented is very great.

'Going north from the Dewdney trail along the ridge between Sophie and Record mountains, for the first mile and a half the principal rock encountered is a brown-weathering serpentine. On fresh fracture it is seen to be a compact, generally dark, green rock. The weathered surface is usually spherulitic. To the west of the summit of the ridge is a dark, heavy, partially altered peridotite-like mass which probably represents the parent rock through whose decomposition the serpentine has originated. A band of this serpentine runs north castward across Ivanhoe ridge.

Serpentines.

'From the northern border of the serpentine to Record mountain the rocks are fresh-looking volcanics, which, judging from their megascopic character, are andesites and porphyrites with accompanying agglomeratic tuffs. The rocks extend north of Record over Old Glory mountain, the dominant peak of this region. Dykes of porphyry cut all of the above mentioned rocks.

British Columbia—*Cont.*

Granites.

'The mountains at the head of Rock creek and the south fork of Murphy creek, are composed of the rock which has, in previous summary reports, been spoken of as the younger granite. It is a pink salmon coloured or reddish rock usually with large prominent crystals of felspar whose colour determines that of the rock. Frequently the cleavage planes of this felspar exhibit a beautiful iridescent sheen, such as labradorite often shows. Often more than one variety of felspar is to be noticed in the hand specimen. Biotite is usually a conspicuous component, hornblende may or may not be. Quartz is sometimes to be detected in considerable amount. In some of its characteristic developments this seems to be a granite, but it may show considerable range in composition. For the sake of convenience it will be referred to as the Rossland granite.

Rocks of Sophie mountain.

'Going south from the Dewdney trail to Sophie mountain, the rocks are a mixture of gray granite, serpentine and greenstone, the latter being apparently an augite-porphyrite or andesite. These rocks extend westward through the Velvet concessions to Sheep creek. The east side of Sophie mountain proper consists of a volcanic breccia, the base of which is an andesite-like rock. The included fragments are porphyrite, chert, argillite and crystalline limestone. The summit of Sophie mountain is capped by a conglomerate which extends west to within a few hundred feet of Sheep Creek valley, and north to about the 'draw' between the Douglas and Victory-Triumph claims. The conglomerate is usually coarse, but fine grained grit bands occur. The pebbles which are generally a few inches in diameter, but sometimes over a foot, consist of quartzite, chert, argillite, serpentine and older conglomerate, while a few are of gray granite, sandstone and jasper. Along its western border, near the base, are some of a porphyrite-like greenstone. These latter are to be expected, as the conglomerate near Sheep creek rests on a brecciated porphyrite-like rock. This conglomerate resembles that found by Mr. McConnell south of Lake mountain, and no doubt both are remnants of what was once a continuous band of rock. Possibly a small outlier of Tertiary volcanics might be found overlying this conglomerate, as is the case on the North fork of the Kettle river.

Greenstones and granites of Sheep creek.

'All the Sophie Mountain rocks are cut by dykes of light-coloured porphyries, especially along the western slope. In Sheep Creek valley, south of the Dewdney trail, and on Santa Rosa mountain to the west,

British Columbia—*Cont.*

the rocks are also greenstone. But north of the trail to about Norway mountain, on both the Sheep Creek slopes, and northward along the Sheep Creek and Christina divide, from the Dewdney trail to the north of Mount St. Thomas, is a large area of the rock referred to as the Rossland granite. Near its contacts it becomes highly porphyritic, and then it resembles closely some of the larger porphyry dykes, of which, indeed, this younger granite is the parent rock.

Rocks of trail from Sheep creek to Cascade.

'From the Dewdney trail at the Christina divide, to the Boundary line, and westward along the ridge north of it, the rocks are very similar to those on the Sophie and Record Mountain ridge, viz., a little gray granite, greenstones, with some argillites or phyllites, cut by porphyry, and dark lamprophyre dykes. Westward from the divide, the red (Rossland) granite extends to Bitter creek, holding near its western contact innumerable small inclusions of greenstone. From Bitter creek west to the ridge above Cascade (Castle mountain) the rocks are greenstone and more or less altered argillites, cut by acid and basic dykes.

'On Castle Mountain ridge, south of the trail, the rock is a somewhat granitic rock, with greenstone down the Kettle River slope. About the Boundary line, serpentine comes in, which across the line becomes almost noble serpentine. North of the Dewdney trail, on Castle mountain, is an area of serpentine, some of it finely mottled, of a dark-green colour, cleavable into large masses. In places this serpentine is fractured into lenticular fragments about 6 x 42 x 1½ inches. In these the serpentine is light green in colour, sometimes approaching the noble variety.

Rocks near Baker and Sutherland creeks.

'North of the serpentine the rocks are altered argillites and allied rocks, and porphyritic greenstones. The greenstones are often packed with inclusions of the argillites and limestone. A gabbro-like rock cuts the above, and between Sutherland and Baker creeks this is extensively developed. Along the south side of Baker creek is a belt of limestone, altered or replaced along the contact, and showing garnet and porphyritic greenstone.

Cascade to Coryell.

'North of Baker creek are greenstones, limestones, cherty quartzites and altered argillites, while along the summit between Baker and McRae creeks, is a coarse biotite felspar-rock which closely resembles the Rossland monzonite. The greenstones and altered sedimentary rocks extend up McRae creek to within two miles of Coryell station, where the gray Nelson granite comes in, but this rock does not extend far west of the creek.

Rocks near Coryell.

'The greenstone, with some limestone, extends north of McRae creek, up the basins of Day and Josh creeks, most of Burnt basin being composed of these. Dykes of the gray granite and porphyries cut these rocks to some extent. A little of the monzonite-like rock is found in the Mother Lode claim. At Coryell, the greenstone crossing over to John Bull mountain, replaces the granite, but does not extend far north, being replaced two miles above the station by the gray granite which crosses McRae creek and forms the rock of North basin, and the country west to Christina lake. Badger mountain and the Arrow Lake divide north of it, is composed of the Rossland granite.

British Columbia—*Cont.*

Rocks west of Christina lake.

'The rocks west of Christina lake are mostly crystalline, consisting largely of hornblendic and micaceous schists and gneisses with some crystalline limestone, extensively cut by and interbanded with pegmatites, and often more or less gneissoid granites. In places the gneisses appear to be crushed greenstones. Toward the north end of Christina lake, these rocks are largely replaced by a fine-grained acid granite, which is probably a facies of the Rossland granite. The crystalline rocks extend westward along the Boundary line to the edge of the map-sheet, west of Grand Forks. Their northern limit, which may be taken as extending roughly from near the head of Christina lake to about the smelter dam at Grand Forks, is indefinite, as with the increase in size and importance of the granite dykes and the pegmatites, the crystalline rocks gradually become less dominant and finally disappear even as inclusions in the granite.

Coarse pegmatites.

'On the Christina and North Fork divide, near the heads of Boulder and Volcanic creeks, the granitic rocks, in which inclusions of the schists and crystalline limestone are common, vary from a coarse-grained granite to a fine-grained aplite, or a coarse pegmatite. The constituent minerals of the pegmatites have segregated on a huge scale, so that the area exposed of a single quartz or felspar individual may almost be reckoned in fractions of an acre. Where quartz occurs in such mass it may easily be taken for an immense quartz ledge. Inclusions of quartzite may possibly occur, and such inclusions, recrystallized as they would be under the conditions, would also be misleading. About the Smelter dam, on the North Fork waggon road, and in the mountains to the east, granite replaces the schist to a considerable extent. But one-half mile north, greenstone from the west side of the river crosses over, but does not extend far east, and the Rossland granite sends apophyses westward into it. Some altered limestone occurs with the greenstone.

Contract between pegmatites and greenstone.

'Between Mud creek and Knight's camp, just north of Cedar creek, the greenstone, with some limestone and gray granite, obtains a firm foothold east of the river. The eastern boundary runs east of north, crossing Volcanic creek just north of the Earthquake claim, to the east end of Pathfinder mountain, overlooking the south-west fork of Cedar creek. From Pathfinder creek the contact turns west of

British Columbia—*Cont.*

north, recrossing the North fork about one mile north of Cedar creek The greenstone in some places contains numerous white crystalline limestone inclusions, while in others it is filled with cherty quartzite fragments.

Granites and volcanics.

The gray granite in this area is, in places, quite extensively represented. East and north is the Rossland granite, which sends a number of porphyry dykes through the rocks of the above area. Lynch Creek basin seems to lie entirely in this younger granite, but on the ridge just east of the North fork, between Rock-slide creek and the east branch, is a series of volcanic rocks, consisting of dark blackish to purplish basalt-like, and brown porphyritic andesite-like rocks, with accompanying tuffs and ash-beds. These rocks probably constitute one of the Tertiary outliers, not infrequently to be met with on the Kettle river. Some gray granite occurs on the river-slope of the hill. Bunch Grass mountain, and the mountains east of the main branch of the North fork, and the range constituting Arrow Lake divide, are all composed of the Rossland granite.

Tertiary outlier.

Mineral-bearing rocks of Franklin camp.

'In the basin of the east branch, however, commencing at Desolation park and extending in width until it includes a large portion of the river slope, on both sides of the east branch, is a large area with an entirely different lithological composition. It is in this area that the various prospectors' camps are situated, which for convenience are grouped together and known as Franklin camp. In this area the gray granite and a dark porphyritic greenstone are the older rocks most frequently met with, some crystalline limestone and highly metamorphic rocks which may have been argillites, are also present. A gray gabbro-like rock cuts these on the west side of Franklin mountain, and on the eastern lower slopes of McKinley, Franklin and Tenderloin mountains, is a reddish porphyritic rock, with lath-shaped felspars, probably near a gabbro in composition. Capping the above rocks and forming the summits of all three mountains, are beds of sandstone, grit, and coarse conglomerate, overlain by volcanic rocks similar to those north of Rock-slide creek, already mentioned. The conglomerate is a hard well-cemented rock, with pebbles usually a few inches in diameter, but occasionally as large as two feet. The pebbles of the conglomerate are of quartz, gray granite, greenstone, black limestone, argillites and fine-grained conglomerate, with a few of a pink quartz-felspar rock, and some of a purple sedimentary rock. The sandstone seems to form the underlying member of the series. In one or two places ash-like beds were noticed. The volcanic rocks consist of dark bluish and reddish basaltic rocks, sometimes with calcite and chalcedony-filled pores, reddish, grayish, and drab-coloured, porphyritic, andesite-like rocks, and some light-coloured rocks, possibly rhyolites (quartz phenocrysts are scattered through them), with beds

Conglomerates and volcanics.

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of ash and tuffs. Similar volcanics cover a small area on the mountain a little north-east of the McKinley forks of the Franklin trail, above Younger's claim. The older rocks in this area, and to some extent, the conglomerates also, are cut by the light-coloured porphyry dykes, but in these volcanic rocks no such dykes were observed.

Granites south of Fire Valley ridge.

'From near the head of Gloucester creek to Fire Valley ridge, the rock is a pink quartzose biotite-granite, seemingly related to the 'Rossland granites.' Some inclusions of gray granite are occasionally met with, but, except on the plateau at the head of the east branch, these are small and unimportant. Fire Valley ridge is composed principally of pink acid granite; the basin at the head of Goodwin creek, a branch from the north-east, is in the same rock, but north-west along the ridge gray granite comes in.

Rocks of Monashee mountain.

'This gray, generally porphyritic, Nelson granite, is the principal rock of Fire valley itself. It extents through to and across Kettle river, its northern boundary on the latter lying just above Paddy creek. North of this granite, from Monashee mountain, across the Kettle river eastward along the north side of Olds mountain and crossing Eight-, Ten- and Eleven-mile creeks, is a band of greenish, grayish and dark fissile rocks, consisting of quartzites, greywackes calcareous and slaty rocks and probably squeezed eruptives. These rocks are an eastern extension of the Cache Creek series from Monashee mountain. This band is more or less cut up by gray granite-apophyses and numerous dykes of other eruptives.

Nisconlith and Cache Creek series

'The Cache Creek rocks extend up the Kettle river to within about one and a half miles of Keefer lake, where the black argillites of the Nisconlith series come in. These argillites extend to the head of Pooler lake where they gradually become altered, assuming a dark grayish, knotted, phyllite-like appearance. The rocks on Barnes creek are more highly altered, being drab, glossy phyllites and nacreous schists. Across Barnes creek on the west end of the ridge running east to Whatshan mountain, the rocks are still more crystalline, being drab, biotitic schists, with interbanded bluish gray limestone and a blocky micaceous quartzite having a perfect columnar cleavage. These rocks appear to grade without a break into the unaltered Nisconlith. The Nisconlith rocks run eastward from the head of the Kettle to a point on Barnes creek a short distance below the Eureka forks. On Eureka creek, in the black slates and soft dark calcareous rocks, are dykes of a dark brown eruptive, and also some black, crystalline, tuff-like bands, so that the series at this point bears an unusually close resemblance to the Slocan series of the east. These Nisconlith and Cache Creek rocks are cut by the gray granite, and all these by porphyry dykes.

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'West of the North fork of the Kettle, above Brown creek, on the Strawberry claim, the rock is an altered greenstone, serpentinized, epidotized and garnetized, which holds irregular inclusions of lime stone, and possibly of other sedimentary rocks. Just south of the shaft-house, is a diorite-like apophysis from the gray granite. The greenstone extends south along the west side of the river toward Grand Forks. The rock-cuts on the C. & W. railway* afford fine sections. In these, inclusions in the greenstone, particularly of limestone, are seen to be exceedingly common. Often these inclusions take the form of long bands. When these bands are narrow, the limestone is apt to be white and crystalline, ; when wider, it is light coloured and crystalline only near the contact, being drab, blue or black and having marked stratification, in the centre. When cut by dykes the limestone is highly contorted or otherwise disturbed. Naturally its dip and strike is irregular, but frequently the inclusions of limestone, take the form of rounded to angular white crystalline fragments, rarely more than a few inches in diameter, closely packed as in a puddingstone, sometimes only the outside lager of the limestone pebble is crystalline, the core remaining dark and little altered.

Section on C. and W. railway.

Numerous limestone inclusions.

'Travelling south along the railway, the bands of limestone become more numerous and important until they form large rock masses. From one-thirteenth of a mile north of Mile Post 76, to three-sevenths of a mile north of Mile Post 75, the limestone is almost continuous. Fom here to almost one-third of a mile north of Mile Post 73, the greenstone obtains, often full of light green, epidotized fragments. (Sometimes only the periphery of the inclusion is epidotized.) From this point for the next half mile, limestone is the prevailing rock. Some of this is pure and white, but irregular dark serpentine masses occur in it. From this area lime has been quarried, for use as a flux, by the Grand Forks smelter. From two-thirds of a mile north of Mile Post 72, to a short distance south of it, is a massive-looking dark rock, in places full of pebble-like fragments of limestone, quartz, jasper, quartzite and slate. It has the appearance of being a conglomerate, but until the matrix has been studied it is impossible to come to a definite conclusion on this point. From the southern edge of this rock to the area of crystalline schists, the greenstone and limestone alternate.

'Except over the area of which the geology has just been outlined, little geological work was done, but a brief reference to the rocks noted in the hasty reconnaissance trip from Penticton to Grand falls may be made.

*Columbia and Western railway.

'East of Penticton the rocks appeared to consist largly of gneisses, cut by granite and pegmatites.* On the waggon-road west of Dry lake effusive rocks are met with. These consist mostly of dark purplish or reddish volcanic rocks with eyes of light coloured felspar, which are probably of Tertiary age. In them a little red porphyry was observed, but not *in situ*, and therefore its relationship to the basalts cannot be stated. These volcanics are also found east of the lake at the lower end. About Vaseau lake, on both sides, and continuing for some distance south, horizontally-lying gneisses are exposed. In this series dark hornblendic bands are interbanded with white-pegmatites.

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Rocks east of Penticton.

'All around the Fairview forks of the wagon-road near Incasnup creek, the rock is a medium grained acid granite, consisting largely of felspar and quartz and a small quantity of coloured constituents. It weathers readily to a gravelly mass. Along the road to Camp McKinney, as far as the summit, the rocks are gray granite, (resembling the Nelson granite of West Kootenay), augen-gneiss derived from it and a fine grained gneiss with acidic and basic bands which is probably a more highly metamorphosed derivation of the same rock. From the summit to Camp McKinney and for several miles beyond along the Rock Creek road, the rock is greenstone cut by granite and porphyry dykes. This is succeeded by basalts which continue almost to Rock creek, where, in the river bottom, the rock is again greenstone. A little above Rock creek on the Westbridge road, a quartzose grit of probably Tertiary age is encountered. One mile above Rock creek, dolomites, serpentine, argillites and greenstones, probably belonging to the Cache Creek series, occur. After continuing about a mile, these give place to a conglomerate, probably Tertiary. The conglomerate is soon succeeded by more of the Cache Creek rocks which continue to James creek. From James creek to Westbridge, and from Westbridge to Boomerang creek on the West fork of the Kettle, the dark purplish and reddish basalts (birds-eye porphryries of the prospector) obtain. From Boomerang creek to Ranch creek the rock is gray granite. From Rock creek to Beaverton it is mostly the reddish younger granite. At Beaverton is an important area of greenstone and some altered sedimentary rocks in the granite.

Rocks near Camp McKinney

Camp McKinney to Beaverton.

'Going south from Rock creek, the greenstone extends along the river-bottom to the bend in the river. From this point, almost to Boundary falls, volcanic rocks seem to predominate, greenstone forms the country rock from Boundary falls to Anaconda. Then the tongue of granite which cuts into the greenstone from the north, along Boundary creek, is encountered. About four miles and a half, north of

Rocks near Greenwood

* Cf. Report of Progress, Geological Survey of Canada, 1877-78, p. 101 B.

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Greenwood, the railway leaves the granite, and greenstone is the principal rock to the North fork of the Kettle river.

Relative age of rocks.

'The relative horizons of the rocks met with this season, so far as known, are as follows:—The crystalline gneisses and schists are of uncertain age and probably they include rocks of different age, but they are, at all events, among the oldest rocks of the district. The Nisconlith rocks are Lower Palæozoic, supposed to be about Cambrian. The Cache Creek rocks are Upper Palæozoic, probably Carboniferous. This is the period also assigned to most of the greenstones, (andesites, porphyrites, serpentines, etc.) and the limestones and argilites associated with them. Some of the andesite and agglomeratic rocks in the Trail creek district are no doubt younger, but there is no definite information regarding their age except that they are older than the conglomerates and the Rossland granite. The gray granite which cuts the greenstones is probably about Jurassic. The monzonite-like rocks appear to be younger than the gray granite, which would indicate that they belong to the Cretaceous.

Lake Mountain conglomerate.

'The conglomerates are amongst the younger rocks. The Lake Mountain conglomerate is supposed by Mr. McConnell to be Tertiary. It bears a strong resemblance, both lithologically and stratigraphically, to the conglomerates associated with the Tertiary volcanics on the Kettle river, which are supposed to be of Tertiary age. The Rossland granite, which sends dykes through the conglomerates both on Sophie mountain and on the Kettle river, is evidently younger than these. Dr. Dawson* has observed granite very much like the Rossland granite, cutting the Cretaceous rocks, in the Kamloops district. The Rossland granite, again, is newer than some of the basalts, as inclusions of the latter were found in it, and reddish porphyry dykes, seemingly identical with those from this granite, were observed cutting the lower volcanic beds. There seems good ground therefore for supposing this granite and the accompanying porphyries to be Tertiary.

Rossland granite.

Basatlic areas.

'The effusive rocks of the basaltic areas are probably extensions of the Tertiaryvolcanics of the Kamloops and Shuswap sheets. Numerous basic dykes are newer than the Rossland granite and are probably from the same sources as the volcanic rocks.

Glaciation.

'None of the mountains in the district examined this season are of sufficient altitude to support glaciers or large snow-fields, but glacial phenomena, due to the former great Cordilleran glacier, are everywhere in evidence on the summits of the highest mountains, on the lower isolated ranges and in the valleys. Along the Boundary line they are as well marked as farther north. In the larger valleys and

* Annual Report, Geological Survey of Canada, (N.S.) vol. VII., 1894, p. 241B.

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on the mountain slopes, are drift deposits, often terraced. Boulders of foreign rocks are scattered everywhere, occupying positions they could only have reached through ice transportation. The surfaces of the rocks, where they have escaped severe weathering, are fluted, polished and striated. The direction of ice movement, as indicated by transportation and striation, averages about S. 17° E., though varying from local causes from S. 1° E. to S. 45° E.

Prospecting and development.

'Over a considerable portion of the district examined during the season, prospecting and development work were being actively carried on, but none of the camps were beyond the initial stages in mining. A great many claims were examined, but since a statement of the amount of work done and such facts and figures are given annually in the Report of the Minister of Mines for the province, such statistics need not be duplicated here. Reference, however, may be made to a few of the claims in each district, to illustrate the conditions under which the ores are found in these particular localities.

Mineralization due to porphyry dykes.

'On the west slope of Sophie mountain are the Velvet and Portland claims. The country-rock, principally greenstone and gray granite, is cut by parallel pink porphyry dykes which run almost due south from the large Sheep Creek area of Rossland granite. These dykes are usually large and often lie close to each other with a narrow dyke-like band of greenstone or gray granite between, that might easily be mistaken for a true dyke in the porphyry.

'Along the contact with the porphyry dykes the adjacent country rocks are fissured, altered and often wholly replaced. In these fissures and replacing the country rocks, in favourable spots on a large scale, are deposits of chalcopyrite, pyrite, hæmatite, calcite and quartz, sometimes possessing a distinctly banded structure.

Porphyry dykes at the Velvet mine.

'On the Velvet, where development work had reached the 300 foot level, a large body of auriferous chalcopyrite had been disclosed, and it is expected that this property, with the Portland, operated by the same company, will soon be in a position to commence shipping, The porphyry dykes continue southward into the conglomorate area, where the same contact phenomena are observable. The Douglas claim furnishes a good example of this. Along the porphyry contact, the conglomerate is mineralized and replaced for a considerable distance from the dyke. All stages in the replacement may be seen, from the unaltered conglomerate, away from the dykes, through the partially replaced matrix, to replaced matrix, attacked pebbles to replaced pebbles, and to the solid banded ore near the dyke. The ore is pyrite, galena, hæmatite, chalcopyrite and sphalerite, in a calcite and quartzy gangue. It will be noticed that the Sophie Mountain deposits, while occurring in somewhat different rocks and showing some difference in mineralogical composition, are similar in their nature and origin to the Rossland ore-bodies.

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Sulphides, east of Christina lake.

'East of Christina lake, more particularly on Sutherland and Baker creeks, the rocks are in places heavily mineralized with iron sulphides and some chalcopyrite. The gabbroidal rock, as well as the ordinary greenstone, is mineralized. The limestone, as a rule, is only slightly so, but along the contact between the limestone and the greenstone, in the altered garnetiferous rock, mineralization seems to be particularly likely to have taken place. While the ore is said to be very low grade, some of the sulphide bodies are large and are on that account worth testing.

'On the Cannon Ball there is a steam hoist, and some work has been done, but beyond this, none of a serious nature can be said to have been attempted. The area between Christina lake and the Rossland granite of the Sheep Creek divide should be carefully prospected.

Claims near Gladstone.

'The serpentine spoken of, already may prove of some value as ornamental stone. Gladstone, on McRae creek, is the centre of an area of the older rocks showing wider-spread mineralization. On the mountains to the east of Gladstone, and north of Mount St. Thomas, the greenstone and gray granite are more or less mineralized, usually near the porphyry dykes. On the Talisman claims is a magnetite showing strong polarity. It has probably resulted from the oxidation of pyrite, which is also present. The gray granite furnishes some very pretty specimens of chalcopyrite.

Claims in Burnt and North basins.

'In Burnt and North basins, lying west and north-west of Gladstone, the rocks show the effects of great stresses. Owing to the diversity of rocks and consequent varying powers of resistance, the region is much broken and faulted. It is extensively dyked by porphyries from the surrounding areas of 'Rossland' granite. Owing to these causes mineralization is widespread, but often lacks concentration. On some of the properties, however, there is quite a fair showing, and if the ore carries the reported values, they are worthy of some attention. But for successful development, careful and intelligent supervision is indispensable. Free gold in quartz veins is found in both the greenstone and gray granite. Below the zone of atmospheric and ground-water weathering, a considerable amount, if not all the gold, will probably be found to be held by sulphides. The Mother Lode may be taken as a type of some of these deposits. The main vein, which is about two feet wide, lies in crushed and banded greenstone, between two large dykes of porphyry. The ore is principally quartz, carrying pyrite, sphalerite and galena, with a little chalcopyrite. Native copper is said to have been found in this as in some other claims. The oxidized ore at least, furnishes specimens of free gold. A little molybdenite and some calcite are also present. An incline on the vein is down 43 feet, from the bottom of which is a 75-foot drift. About 20 feet down the incline the vein faults. In the drift, ore, supposed to be part of the same vein, is again caught. Several veins occur on the claim. At the south end of the claim the greenstone is full of little stringers of zinc blende.

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'On the Tammany claim, is a vein of quartz of varying width, sometimes of several feet. It lies along the contact of a light-coloured porphyry. Galena and sphalerite become more prominent in the southern portion of the basin. Cooper's claims, on the south fork of Josh creek, have a dark fissile limestone as the principal country rock. The mineralization is often parallel to the foliation of the limestone, and frequently follows the contact of a dyke. Sphalerite, galena and chalcopyrite are the principal economic minerals, with a strong preponderence of sphalerite. One vein of pure sphalerite attains a thickness of about a foot. Little more than assessment work was being done in the Gladstone district.

Mineralization of crystalline rocks.

'In places the crystalline rocks, between Christina lake and Grand Forks, are mineralized to some extent by pyrite and pyrrhotite. The pegmatites grade into quartz veins and carry a little mineral. At a few points a little work has been done. A number of specimens were collected to be assayed for gold, as the quantity of material available and the accessibility of the region would enable rocks of a low grade to be successfully treated.

Volcanic claim.

'Up the North fork of the Kettle, on the east side, little mineralization of consequence was seen till the area of older rocks about Volcanic creek was reached. There several prospects upon which considerable work has been expended, are situated. Just north of Volcanic creek, on Volcanic mountain, one of the landmarks of the country by reason of its highly coloured surface, is the claim best known as the Volcanic.

'The iron oxide which stains the whole side of the mountain and gives its colour to the soil below, comes from the oxidation of pyrite and probably other iron sulphides, whith are exposed on the top of the cliff. The rock here is a mixture of limestone cut by greenstone, (probably a porphyrite) altered and partially replaced by the iron sulphides. The limestone, which is also altered, is not so heavily mineralized. Below this, and forming the western face of the cliff, are several hundred feet of bedded limestone, with intercalated dykes, squeezed and contorted, probably by the porphyrite which cuts it off. This limestone is not mineralized. Below the limestone the greenstone is again found. Into this greenstone, near the base of the cliff, hundreds of feet below the exposure of sulphides and separated from it by the belt of barren limestone, a tunnel had been run (which at the time of my visit was 700 feet long) with the expectation of striking the lead at great depth. The ore exposed at the top of the cliff is said to be very low grade, but such a strong showing as this is worthy of careful

British Columbia—*Cont.*

examination, which can be most effectively and economically accomplished at the point where the ore is known to occur.

Eagle claim.

'A short distance to the east and a little to the south of the Volcanic is the Golden Eagle claim. It also lies in the greenstone, which here contains small fragments of crystalline limestone. Two large wide dykes of porphyry, from the north east, cut the greenstone, and along the western contact of the west dyke, the Golden Eagle vein is found, The greenstone has here been altered by silicfication and pyritization. The pay-chutes are two narrow veins of saccharoidal calcite and quartz, bearing chalcopyrite, pyrite and probably arsenopyrite. In places the veins widen to about seven feet, by the replacement of greenstone with vein material. Even down to the deepest workings (150 feet) the sulphides are oxidized to iron oxide, malachite and chrysocolla. A little native copper has also been found. Some small shipments of ore were being made to the Grand Forks smelter.

Earthquake claim.

'The Earthquake claim lies south-east of the Golden Eagle claim. The geological conditions are similar, except that the Earthquake lies near the eastern contact of the east dyke of porphyry. The main vein on the Earthquake is unusually well defined. It preserves its width (2 to 3 feet with "gouge" along each wall) and its dip, of 85°, to the bottom of the shaft, down 33 feet at the time of my visit. The ore (iron sulphides and chalcopyrite) has not suffered oxidation like the Golden Eagle ore. Its average value is said to be about eighteen dollars to the ton.

Pathfinder claim.

'On the Pathfinder, situated on the first ridge north of Volcanic mountain, across Pathfinder creek, a considerable amount of work has been done, and machinery, embracing pumps, a compressor and a hoist have been installed to aid in the development and testing of the property. The geological conditions are similar to those obtaining on the above mentioned Volcanic mountain prospects.

'The greenstone country-rock is cut by the prophyry dykes. Along these contacts and the neighbouring fissures, the greenstone is altered and replaced. At certain points the mineralization has taken place on an extensive scale. Vein No. 1 is about 12 feet wide on the surface, and 11 feet wide at the 50 foot level. Prophyry dyke No. 1, towards which it runs at a low angle, is only a short distance away. Vein No. 3 lies parallel to, and generally speaking along the contact of dyke No. 1. Number 2 vein lies along the opposite contact of this dyke, in the greenstone bands between dyke No. 1 and dyke No. 2. The ore bodies are apt to be irregular, due to the mode of origin, the complicated fracturing of the country-rock and subsequent faulting. The ore is largely pyrrhotite with chalcopyrite, pyrite and arsenopyrite, in a gangue of quartz, calcite and country-rock. Some melaconite occurs in the weathered ore. The values are said to average from eleven to fifteen dollars to the ton. On the Little Bertha claim, near the river base of Pathfinder mountain, under conditions similar to those in the Pathfinder, a vein of quartz, with sulphides, etc., occurs in the gray granite. British Columbia—*Cont.*

'The district known as Franklin camp, on the east branch of the North Fork, about thirty-five miles from Grand Forks, attracted a great many prospectors this season. It is reached from Grand Forks by trail up the North fork, the natural supply route into this camp. A shorter trail for going and coming might be constructed over the divide to Arrow lake. A glance at the map will show that a feasible route from Christina lake does not exist. Broadly speaking, Franklin camp covers the area of older rocks in this east branch basin. It is locally subdivided into McKinley camp on McKinley mountain, Franklin camp proper, or McFarlane camp, on Franklin mountain, and Newby camp on Gloucester creek. Most of the available ground has now been staked, but beyond a little assessment work, the only claim having any development is the Banner, the pioneer claim of the district. On this a tunnel 194 feet long has been run, with the last thirty feet or so in ore. The ore is quartz, carrying sphalerite and chalcopyrite. In an open-cut a little to the east of the tunnel, is a large exposure of quartz, carrying some galena as well. The ore is reported to assay $18 to the ton. Franklin camp.

'On the Homestake claim, a little to the west of the Banner, the country rock is silicified often in large masses. This quartz carries pyrite oxidized in places to red ochre. It is said to assay from $2 to $50 to the ton. Homestake claim.

'On the Montreal claim, near the Homestake, is a quartz vein, two feet or so wide, carrying galena, sphalerite and chalcopyrite. A greenstone breccia is the country rock. Montreal claim.

'The McKinley claim, just over the north-east face of McKinley mountain, has greenstone exposed in a stream bed for over 100 feet. This rock is altered by silicification. The quartz occurs in stringers, blebs and irregular patches. In the quartz, and also in the greenstone, are small irregular patches of chalcopyrite and pyrite. No work of any consequence has been done on this claim, and not enough of the surface is exposed to furnish much information regarding the deposit. On the Gloucester claim, on the Gloucester Creek slope of Franklin, the country rock seems to be gray granite, calcified and silicified. At the bottom of a shaft, down fifteen feet at the time of my visit, several feet of solid chalcopyrite and pyrite, with a little molybdenite, were exposed. This ore is said to carry $5.60 in gold per ton and from eight to twenty per cent copper. On the G. H. claim, just east of the Glou- McKinley claim.

British Columbia—*Cont.*

cester, also in the gray granite, is a vein of magnetite with some pyrite. The vein of almost solid magnetite, in places at least, is forty feet wide, and it has been traced for several hundred feet. It is reported to carry only traces of gold, silver and copper.

Polass and Mineral Hill claims.

'On the slope of the mountain, north of Gloucester creek, the gray granite on the Polass claim shows considerable crushing, which has developed a kugel structure, giving the rock an agglomeratic appearance. Round these balls the granitic material has flowed. In a band about ten feet wide the granite, particularly along fracture-planes, is more or less impregnated or replaced with copper- and iron-pyrites. On the Mineral Hill claim, near the western end of this mountain, the crushed gray granite carries copper-pyrites. A ledge about one foot wide contains irregular masses of this mineral, of about one-half to one inch in diameter. Since the time of my visit some work has been done, which is said to have exposed a good showing of ore.

'A good deal of prospecting has been carried on at the heads of Fire valley and the Kettle river last fall and during the present season. The townsite of Wauchope has been staked and a few buildings erected, at the mouth of Eight-mile creek, near the head of Fire valley.

Eureka claim.

'Just beyond the head of Eight-mile creek, on a branch of Barnes creek, lies a group of claims of which the Eureka is the best known. They are situated on a dyke of white rock which cuts and alters the Nisconlith rocks. In some parts of this dyke, felspar crystals may be detected, but some of it is a fine-grained aphanitic quartz-like rock, which, however, weathers to some extent on the surface and effervesces with acid. The surrounding Nisconlith rocks are silicified and calcified to some extent. The dyke and neighbouring rocks are impregnated, especially along minute fractures, with small, usually silvery, metallic particles, which often weather bronzy, and also with some of yellow chalcopyrite. Three different assayers are reported to have found tellurides, with high gold values, in specimens from the Eureka. But the tellurides, if they occur, are not scattered uniformly throughout the rock, as in a specimen examined in this office last winter, the metallic particles contained were found to be pyrrhotite and specular iron, and no telluride was detected. A number of specimens of the most likely looking material were selected and have been passed over to Dr. Hoffmann to be examined for tellurides.

Palladora claim.

'On Olds mountain, north of Fire valley, a little above Wauchope, is the Palladora claim. In the rather basic, altered, somewhat greenish Nelson granite, is a vein of quartz and vein matter, varying in width, but averaging about four feet, running N. 85° E. (mag.) and underlying about 20° N. The quartz is bluish and holds 'spiders' of pyrite, chalcopyrite, galena, and some marcasite or arsenopyrite. It is said to assay over $30, but the average values will probably be much lower, as the amount of sulphides present varies considerably. Another parallel vein, one and one half feet wide, occurs about twenty yards north of the main vein, and a third parallel quartz vein, in places, at least, eight feet wide, occurs on the hill just north-west of the cabin. It is also mineralized, but not so heavily as the first vein. British Columbia—*Cont.*

'On the Shamrock claim, situated on Kettle river, at the base of Monashee mountain, two small parallel quartz veins have been uncovered. The quartz is heavily mineralized, especially with jamesonite, but sphalerite and pyrite also occur. Free gold occurs in the jamesonite amid the quartz, and in the cavities left by the oxidation of the sulphides, flakes of gold are quite plentiful. One specimen of the jamesonite obtained, holds a nugget of gold as large as a pea. The veins are about four inches wide. They occur in a black silicous argillite parallel to a porphyry dyke. As the claim is drift-covered and work was only starting, little can be said about the extent of mineralization upon it. A number of claims have been staked on the north side of Monashee mountain, which are said to have encouraging showings of ore. The old Monashee mine passed into new hands during the summer. Modern machinery is to be installed to give this property a fair trial. Shamrock claim. Monashee mine.

'About a mile below the new trail on the east bank of the Kettle, a prospector was doing a little placer mining. Although no mercury was being used, and all the fine gold was consequently escaping, fair wages were reported to be made. All of the drift along this part of the Kettle is said to yield colours of gold. Along the Arrow Lake divide, and from Franklin camp to Fire valley, no mineralization was observed; though such might possibly occur in the gray granite area on the plateau at the head of the east branch. Placer mining.

'From what has already been said, it will appear that, for the most part, the ore deposits of the district examined this season, have a marked similarity in their mode of occurrence and origin to those of the Trail creek and other portions of West Kootenay. Of their nature and mode of formation there can be no question. They are what are sometimes known as composite veins, or shear-zone veins, formed by mineralizing solutions traversing the country-rock, principally along fissures or zones of fissures, from which they replace with their mineral contents, particle by particle, sometimes only partially, sometimes completely, the original material of the country rock. Since the deposits are found only in districts traversed by the porphyry dykes so often referred to, and usually in the rock in the immediate vicinity, if not along the actual contact of these dykes, and since the dykes are themselves to some extent mineral-bearing, it seems altogether probable that a genetic relationship exists between the dykes Mode of occurrence of ore deposits.

British Columbia—*Cont.*

and the ore-bodies. It seems likely that the mineralizing solutions accompanied, as a later and closing phenomenon, the vulcanism which resulted in the injection of the porphyry dykes. J. F. Kemp* has suggested an igneous origin for the Trail district deposits—that these deposits were formed by the crystillization of the sulphides from the fused and cooling magma of the basic rock in which they, at Rossland, are found. But the indisputable evidences of replacement, alterations which could only be produced by heated solutions, and the fact that the same class of deposits occur in sedimentary and igneous rocks alike, are totally opposed to this theory.

'These deposits were formed just after the porphyry dykes, which, as noted above, there is good grounds for supposing to be Tertiary in age.

Ores in rocks older than Rossland granite.

'The areas where ore-bodies may be expected to occur, and hence the most favourable for prospecting, are those in which rocks older than the "Rossland" granite are cut by the porphyry dykes, and particularly such areas of older rocks as lie outside of, but somewhat adjacent to the contact of this granite. In the larger areas of older rocks included in the Rossland granite ore bodies may also occur. The smaller inclusions, though generally altered, are not heavily mineralized, since they have not afforded fissures for the mineralizing solutions, and are not large enough to have given rise to the dykes. The dykes and ore bodies extend for miles through the older rocks, from the Rossland granite areas, but it will be noted that, not many miles away from most of the camps such an area of granite is found, and it is to be remembered that areas of this granite may exist below the surface which at present have no outcroppings.

'All the rocks irrespective of kind, older than the Rossland granite, are mineralized where the geological conditions have been favourable. Deposits occur in the gray granite as well as in the greenstone and sedimentary rocks. This is the case on the North fork of the Kettle, on Olds mountain, Fire valley and elsewhere. In the Athabasca mine, Nelson, the vein has been followed during the past year from the porphyrite into the granite. Both rocks near the contact were much fractured, due to the unequal resistance of the two rocks to the stresses to which they have been subjected, and the vein as a consequence was here much broken and split up; but where followed into the solid granite it resumed its regular character, and has so far proved as valuable as when in the greenstone.

'Limestone, where it retains its bedded character, as in some parts of Burnt basin, is mineralized, but where altered and recrystallized it seems to be little mineralized, although its contact with another rock

* Ore deposits of the United States and Canada, pp. 62, 396-397.

is apt to prove a favourable point for ore deposition. The occurrence of calcite in an ore is taken to be a good local indication of gold. British Columbia—*Cont.*

'No work need be done in the porphyry dykes themselves, in the expectation of striking a large body of sulphides. While most of these dykes have a slight tenor, and might at certain points contain enough to be of value, no large ore-bodies similar to those in the adjacent rocks, occur in them. The areas of Rossland granite also seem to be barren, that is to say, no deposits similar to those now known to occur in the older rocks, have been found or are to be expected in this granite. Some minerals of economic value may, of course, eventually be found in them, but if so they will, at least in their mode of occurrence, be dissimilar to the deposits now being sought for and worked.

Porphyry dykes unproductive.

'The Grand Forks smelter, built and operated by the Granby Consolidated Mining and Smelting Company, was completed and blown in toward the close of the season. At first only one furnace was used, but now both are in operation, with a joint capacity of 600 tons per day. The ore is obtained from the Victoria, owned and operated by the Smelter Company, the Old Ironsides, Knob Hill and City of Paris mines, as regular shippers, with occasional lots from the Winnipeg, Athelston, Humming Bird and Golden Eagle. Other custom work is done when offered. The smelter management state that they are prepared to enlarge the capacity of the plant as need may require. The treatment of the low-grade Boundary ores have so far proved more successful than was anticipated. The ores have proved self fluxing. Should any flux be required, it may be conveniently obtained from the immediate neighbourhood. Very little roasting has been resorted to, only small job lots, about one-twentieth of the total ore treated, have so far been roasted. Consequently very low smelter rates can be offered. These low rates for treatment will have a stimulating effect upon the Boundary district, where the immense ore-bodies are of low grade, and until the smelting possibilities had been proved, their success remained somewhat in doubt. The British Columbia Copper Company's smelter at Greenwood is nearing completion, and a plant is also being erected by the Standard Pyritic Smelting Company, near Boundary Falls.

Grand Forks smelter.

Smelters under construction.

'On the whole, mining has continued to make substantial progress throughout West Kootenay during the past year. The mines of the Slocan, which were closed down last year on account of labour troubles, were re-opened early in the year. Almost all the old mines are shipping as usual, and the tonnage of this year will greatly exceed that of last. It should almost equal that of 1898. The Ivanhoe concentrator is almost completed, and when this is running a large addition will be made to the Slocan output. The Slocan lake properties are de-

Progress of mining in West Kootenay.

British Columbia—*Cont.*

veloping favourably. The output for the year, principally from the Arlington, Bosun and Enterprise mines should approximate 5,000 tons.

Nelson district.

'In the Nelson district, the closing down of the Fern mine and the Hall mines and smelter, has somewhat offset the progress made in other parts of the district. The smelter, under new control, is now in operation again, with sufficient custom work to keep it running steadily, and on the Silver King mine, under a new and separate management, work has again been resumed. The Ymir mine has made the most marked progress; it is now treating 200 tons a day, with an 80-stamp mill. Some properties, as the Athabasca, Granite and Yellowstone, are producing steadily, and others are making occasional shipments, so that the output of the district will show no falling off. The Rossland district is steadily increasing its output. Last year showed a marked increase in production over all preceding years. This year, despite the stoppage of shipments from the War Eagle, and the limited capacity of the smelters, the tonnage should be about one-fifth greater than that of 1899. The weekly output is now over 6,000 tons; recently a shipment of 7,000 tons was made. The values here, as in many of the districts, show a tendency to decline. This may be partly accounted for by the quantity of second grade ore which is now being shipped. The Le Roi is now stoping its vein for a width of 105 feet. The Centre Star is now shipping heavily. The Le Roi No. 2, (Josie) is also shipping, and Le Roi No. 3, (Nickel Plate) will soon commence. Altogether about eleven properties have been shipping, and several others are preparing to enter the list.

Rossland district.

Molybdenite ore.

'At the Giant mine, which is making a small daily shipment, a fine grained molybdenite occurs in considerable quantity through the ore. It is scattered through it in particles varying from almost microscopic dimensions to masses a foot in diameter. It has a valuable gold tenor and is shipped with the rest of the ore to the smelter.

Beaverton camp.

'There was considerable activity on the West fork of the Kettle river, when visited in the spring. Thirty miles from a wagon road, over a bad trail, the town of Beaverton was being built. Time did not permit an examination of the camp, but some good showings of ore were seen. The camp furnishes fine ore specimens, particularly of copper sulphides and native silver.'

Work by Mr. J. McEvoy.

Mr. J. McEvoy, during the early part of the year 1900, was engaged in working up the notes of his previous year's exploration in East Kootenay. Early in the summer he commenced a geological examination of the Crows Nest Pass coal-fields, the principal object being to determine the extent and relations of the coal deposits in that area with greater accuracy than had heretofore been done. Mr. McEvoy reports progress as follows :— British Columbia—*Cont.*

'I left Ottawa on May 9th and returned on October 9th. Mr. J. Keele accompanied me during the season and assisted materially in the work.

'The Crows Nest coal-field is situated immediately west of the summit of the Rocky mountains on the Crows Nest pass. It is all included in the province of British Columbia, excepting a small portion in the immediate vicinity of the pass, which crosses the watershed into the district of Alberta. The area of Cretaceous rocks in the vicinity is nearly 500 square miles in extent. The coal measures, originally deposited over the whole of the area, have been eroded away around the edges, where the rocks are crumpled and folded, and along some of the deeper valleys penetrating well into the area, so that their actual area is approximately 230 square miles. In shape, the area covered by the coal measures, like that of the Cretaceous basin itself, is, roughly speaking, a long pointed triangle, with its base to the south. Its greatest length is about thirty-five miles, north and south, and its greatest width about thirteen miles. These figures are of course only approximate as the work has not yet been plotted. Crows Nest Pass coal-field.

'Coal is said to have been discovered in this part of the country many years ago. Its reported existence is alluded to in the Report of Progress of the Geological Survey for 1880–82 (p. 2 B). It is again referred to in the report for 1882–84 (p. 111 C). The coal-bearing area was approximately defined and examined in a preliminary way by Dr. G. M. Dawson in 1883. It was again visited after some prospecting had been done, by Dr. A. R. C. Selwyn in 1891.*

'The Crows Nest branch of the Canadian Pacific Railway, descending Michel creek on the western slope of the mountains, crosses the northern part of the coal lands. It then follows the Elk river downward nearly along the line of the western boundary of the Cretaceous area, for a distance of about twenty-five miles. The upturned western edge of the Cretaceous rocks form a ridge or escarpment which runs parallel to the Elk river and three or four miles distant therefrom. The height of the escarpment is fairly uniform, being 3,500 to 4,000 feet above the river. About half-way up the slope the coal measures are found outcropping with dips of 30° to 40° eastward. Proximity of coal area to railway.

'A search for fossils in the limestones underlying the Cretaceous rocks, resulted in the discovery of several specimens of the genus *Productus*. These rocks have been classed as Devono-Carboniferous, and for the greater part of their extent such classification must Carboniferous rocks.

*See Annual Report, Geol. Surv. Can., (N. S.), Vol. I. (1885), Part B., and Summary Report, 1891.

British Columbia—*Cont.*

remain. The discovery of *Productus* is, however, fairly good evidence that in this part the upper members of the limestone series is definitely Carboniferous.

General attitude.

'Notwithstanding the great lapse of time between the Carboniferous and Cretaceous deposits, wherever their relation to each other could be seen they appear to be conformable. The general attitude of the Cretaceous rocks is that of a wide flat-bottomed syncline, or rather basin, for the beds are upturned at the north and south ends of the area, as well as at each side. On the south and west borders of the area, the upturning has been accomplished without much faulting of the coal measures and overlying beds, but the lower members of the series, consisting of the black shales and soft calcareous shales, have been badly crushed and folded. It is along or near the eastern edge of the area that the greatest dislocation has taken place. The greatest erosion, however, did not here follow the line of contact with the limestones, but is marked by a depression in the hills, running parallel to the contact, and about four miles inside the border. In some places here at the actual contact, the Cretaceous measures appear to have been tilted up bodily, without crushing, and it may be hoped that further work will discover a section where the thickness of the lower beds of the series may be obtained. Such a section could not be found on the western edge, on account of the crushed and folded state of the rocks previously mentioned.

'Although in general the Cretaceous rocks are said to have assumed the form of a flat-bottomed basin, there are many places where local faults have destroyed the symmetry of this arrangement. Some of these faults are of considerable dimensions and will form an important factor to be reckoned with in the problem of systematically mining the coal.

Measured section on Elk River escarpment.

'Before attempting any detailed statement of the situation of the coal measures it is perhaps desirable to have an idea of the character and thickness of the Cretaceous rocks occurring in the basin. Toward the end of the season, a section was measured on the front of the escarpment, about three miles north of Morrissey siding. A steel tape was used and slopes were measured with a hand-level. The results should be fairly reliable. It is only in the adjustment necessary where there was a local twisting of the beds, that there is room for any appreciable error. The site selected for the section was on a small spur from the escarpment, where, some years ago, Mr. Fernie had excavations made on the outcrop of the coal seams. The crest of the spur has an average slope of nearly thirty degrees, and affords the exceptional opportunity of getting an unbroken section of almost 5,000 feet. Dr. Selwyn, then Director of the Survey, published in the Summary Report for 1891 a list of the seams then measured. The section which follows is given in the natural order, beginning at the top of the escarpment and running downward.

British Columbia—*Cont.*

Section on Elk iver.

		Feet	Inches.
1	Hard conglomerate	6	0
2	Gray nodular limestone in soft brown shale	3	0
3	Hard, coarse conglomerate with layers of sandstone	38	0
4	Brown shale and brown soft nodular sandstone.	48	0
5	Hard conglomerate with layers of gritty sandstone	50	0
6	Covered	33	0
7	Gritty sandstone	16	0
8	Brown shale	35	0
9	Gritty sandstone and conglomerate	13	0
10	Bluish, thinly bedded sandstone	41	0
11	Brownish, shaly sandstone	30	0
12	Black shale	14	0
13	Gritty sandstone	22	0
14	Black shale	11	0
15	Conglomerate and gritty sandstone	25	0
16	Black shale	4	0
17	*Coal*	2	6
18	Black shale	20	0
19	Conglomerate	85	0
20	Black and brown shale with one layer carbonaceous shale	72	0
21	Hard gray sandstone	11	0
22	Conglomerate	20	0
23	Hard gray sandstone	65	0
24	Carbonaceous shale. (Some coal?)	8	0
25	Black shale	6	0
26	Brownish shale	27	0
27	Fine-grained gray sandstone	24	0
8	Brownish shale; some beds of soft sandstone	84	0
29	Bluish hard sandstone	10	0
30	Black shale	8	0
31	*Coal*	2	0
32	Brown and black shale	57	0
33	Gray sandstone	96	0
34	Black and gray shale	34	0
35	*Coal*	1	0
36	Brown shale	3	0
37	*Coal*	1	0
38	Thinly-bedded bluish sandstone	14	0
39	Hard gray sandstone	133	0
40	*Coal,* including some carbonaceous shale	5	0
41	Black and brown shale	20	0
42	Hard gray sandstone with three irregular layers of conglomerate	175	0
43	Black shale	27	0
44	Coal (upper foot impure)	4	0
45	Black shale	38	0
46	Hard gray sandstone	55	0
47	Deeply covered	100	0
48	Shale, probably including some coal	107	0
49	Carbonaceous shale	8	0
50	*Coal*	7	0
51	Carbonaceous shale and coal	2	0
52	Black shale and carbonaceous shale	33	0
53	*Coal* (impure)	3	

British Columbia—*Cont.*

		Feet.	Inches.
54	Shale and soft sandstone	6	0
55	*Coal*	5	0
56	Carbonaceous shale	4	0
57	Black shale, including some carbonaceous shale and possibly some coal	150	0
58	*Coal*	3	0
59	Black shale and carbonaceous shale	100	0
60	Carbonaceous shale and coal	20	0
61	*Coal*	10	0
62	Black and brown shale and carbonaceous shale with thin seams of coal	140	0
63	*Coal* (upper ten feet impure)	36	0
64	Brown and black shale	134	0
65	Hard sandstone	56	0
66	Black shale	4	0
67	*Coal*	1	4
68	Shale	0	5
69	Coal	0	9
70	Shale	0	10
71	*Coal*	6	0
72	Shale and shaly sandstone	208	
73	*Coal* (upper foot impure)	2	
74	Bluish shaly sandstone	2	
75	*Coal*	2	
76	Black shale	65	
77	*Coal*	4	
78	Shale	1	7
79	*Coal*	4	9
80	Shale	6	0
81	*Coal* (bottom two feet impure)	19	0
82	Bluish black shale	10	0
83	" sandstone	35	0
84	Black shale	125	0
85	*Coal*	2	6
86	Chiefly black shale, partly covered	364	0
87	*Coal*	1	4
88	Shale	1	3
89	*Coal*	46	0
90	Black shale	16	0
91	Hard gray sandstone	60	
92	Black shale	110	
93	*Coal*	46	
94	Black shale	10	
95	Hard gray sandstone	100	
96	Black and brownish shale	1,060	
	Total	4,736	3
	Total thickness of coal	216	2

Thickness of workable coal.

Of the above thickness of coal, the greater part, 198 feet, occurs in a thickness of measures of 1,847 feet. Besides the parts of the coal mentioned in the section as impure, there are some irregular layers of shaly material and nodular iron-stone in the larger seams. Making allowance for these, and deducting some of the smaller seams that could not be profitably mined, say three feet or under, it may be safely concluded that there is a total thickness of workable coal of at least 100 feet.

British Columbia—*Cont.*

Disturbed rocks at bottom of series.

'Below the base of the section the rocks are disturbed and broken, but the black shales last mentioned appear to continue for some distance farther. These are succeeded by 500 feet or more of soft gray sandy argillites, fairly calcareous and occurring in thick beds. Below the argillites comes an uncertain thickness, possibly 1,000 feet, of thin shaly limestone and calcareous shales. Although not seen in this place, a band of rather coarse grained fragmental limestone belongs to this horizon. The lowest beds of the series are not exposed here, but where seen elsewhere, consist of black shales with two or more layers of hard fine-grained dark-coloured dolomitic limestone. Their thickness has not yet been ascertained, but they appear to be several hundred feet at least.

Preservation of coal seams by harder beds above.

'Toward the top of the section, it will be noted that the beds largely consist of conglomerate and gritty sandstone. The conglomerate especially is very hard. Its pebbles are principally of black and gray chert, imbedded in a matrix so silicified that cleavage-planes cut both pebbles and matrix as if the rock were of homogeneous texture. The preservation of the coal measures is in a great degree due to the presence of these hard beds, which prevented erosion, and by their great strength saved the more yielding beds of the underlying coal measures from crushing and folding. The conglomerates and sandstones are false-bedded and of irregular thickness, and individual beds cannot be expected to be continuous over very large areas. The beds consisting chiefly of nodular limestone, near the top of the section, and another similar bed occurring a few feet higher up in the series, have been recognized in several places in the same relative position to the conglomerates, and may be regarded as a definite horizon for the correlation of the strata at widely separated points.

Rocks of series above the measured section.

'Above the top of the measured section, the overlying rocks are seen northward along the escarpment, the first succeeding bed being ten feet of soft brown shale, then the second band of nodular limestone in brown shale already mentioned, followed by 200 feet or more of alternating layers of brown shale and sandstone, in beds of six to fifty feet thickness. Above this, although partial sections were obtained here and there, the continuity is broken. There appears to be altogether a development of 4,000 to 5,000 feet of measures above the top of the section just given. In contrast to the lower part of the series, black shales are rarely found here. Brown colours prevail throughout. The principal rocks are: soft brown friable shale decomposing easily into brown sand, brown shale weathering into angular blocks, soft gray, greenish, and yellowish sandstone weathering brown and reddish, frequently unequally and nodularly hardened. There are

British Columbia—*Cont.*

some beds of harder gray sandstone and conglomerate. Dark gray friable shale forms an appreciable part of the series, and an occasional band of black shale is to be seen. Toward the top of the series there is a notable bed of conglomerate, composed of well-rounded dark, cherty quartzite pebbles up to six inches in diameter, loosely held together by a matrix of soft gray sandstone. It decomposes readily, the pebbles being found in abundance in stream-beds and strewn along the hill-sides, while the rock in place, like the outcrop of coal-seams, is only to be found in certain favourable locations.

Total thickness of series.

'The total thickness of Cretaceous rocks deposited in the area, according to the above estimates, is from 12,000 to 13,000 feet..

'It is not at all probable that a section could be found in any other part of the area that would exactly, or even closely, correspond to the one just given. A comparison of a part of this section with the beds at the mines on Coal Creek, shows that there is a great difference in thickness between the measures at the two places. The coal seams numbered 61, 63, and 71, in the section, correspond to the three seams which up to the present have been chiefly worked at the mines as shown in the following table. The distance between the two places is about seven miles.

Correlation with Coal creek.

	Near Morrissey.	On Coal Creek.
Coal	10 feet.	10 feet.
Intervening beds...........	140 "	60 "
Coal	36 "	30 "
Intervening beds...........	197 "	42 "
Coal	6 "	6 "

'It will be seen that while there is a great diminution of the intervening beds, the coal seams are fairly persistent. This may not be the case throughout the whole of the area, but whatever change may take place, is as likely to be favourable as othewise. The openings at Michel, sixteen miles north of the mines on Coal creek, expose three seams of coal, fifteen to seventeen feet in thickness, but there is not yet sufficient evidence to correlate them with the seams at Coal Creek. What there is, however, tends to show that some of the seams at least have a greater thickness here than they have to the south.

Continuity of seams.

Beds at Marten creek.

'The coal seams near Marten creek were not examined in detail, as the excavations made there, about the same time as those near Morrissey, have caved in, and re-excavation would be necessary to expose the seams. Measurements were made at this place also by Mr. Frank B. Smith, engineer for the Crow's Nest Pass Coal Co., and the results are given in Dr. A. R. C. Selwyn's Summary Report for 1891. A part of this list of seams agrees fairly well with the Morrissey section, but in other parts there is a marked difference. It appears likely that the four lowest seams there given, are a repetition of some of the upper ones, and are placed at the bottom, either by attempting to compile partial sections at two or more places, or because the excavations were continued downward across a line of fault which runs north-and-south, near the outcrop of the lower seams. The lowest of the large seams was not fully exposed when the list was published, and further work showed a much greater thickness of coal than was then estimated. Apart altogether from any success in correlating the individual seams in this section at Marten creek with those in the Morrissey section, there is abundant evidence to show that they are of the same horizon, and that there is only one set of coal measures to be found in the area.

British Columbia—*Cont.*

One set of coal measures.

'The Kootanie series of Dr. Dawson comprises the lower and middle beds of the section just given. Their age has been established as Lower Cretaceous, chiefly by the determination by Sir J. William Dawson of fossil plants contained in the beds of the coal-bearing horizon. It was remarked in this connection that the list of plants included "some forms usually regarded as Jurassic, but that the greater number have the facies of the Lower Cretaceous." * There is, however, in this section at least 3,000 feet, and probably a much greater thickness, of beds underlying the horizon from which these plants were taken. This year two specimens of Ammonites and several specimens of a Belemnite were discovered in these lower beds. They have not yet been determined, however. The rocks of the upper part of the section probably extend into the upper division of the Cretaceous representing the Dakota group or even higher members. No fossils have yet been found in these beds.

Age of coal-bearing rocks.

'Without the assistance of a map, the work not yet being compiled, it is difficult to give a clearly intelligible description of the outcrop and attitude of the coal seams, but by omitting detailed statements of distances and elevations, something further may be said. Along the front of the escarpment facing the Elk river, the coal seams begin to outcrop at elevations of 1,500 to 2,000 feet above the river. The dips are uniformly to the east at angles of 20° to 40°. Going eastward up Coal creek, these dips are seen to flatten out, until at a distance of about five miles from the Elk the beds are almost horizontal. They continue thus with slight undulations nearly to the summit between Coal creek and Marten creek, where the dips begin to be reversed. A short distance beyond, to the north-east of the summit, these dips are greatly increased and the successive beds are rapidly brought to the surface till the coal measures again appear at the crossing of Marten creek.

Attitude of beds.

Elk river.

Coal creek

* Trans. Royal Soc. Canada, vol. X., sec. IV.

British Columbia—*Cont.*

Marten creek

'Marten creek is one of the sources of the south branch of Michel creek, which occupies a wide low valley running northward to the "loop" on the railway. The erosion of this valley has carried away the coal measures from a wide strip of country. The valley follows the line of what was, at one time, probably a broken anticline caused by the uplifting of the limestone floor of the basin. Two faults resulting from this movement are to be seen running parallel to the valley, one on each side. The uplift was greatest to the north where there is a protruding hummock of the limestone near the junction of the west branch. Toward the south, evidence of this movement gradually dies out, extending only a few miles to the south-east of the mouth of Marten creek.

East of Michel creek.

'Beyond the valley of the south branch of Michel creek, the coal measures outcrop well up the mountain side in the same attitude and relative position to the stream that the beds on the front of the escarpment bear to the Elk river. The measures continue eastward forming another syncline, narrower than that first described, on the west side of the valley, and should outcrop again on the mountains near the edge of the Cretaceous area. Further information is, however, wanting at this point.

Faulting of beds north of Coal creek.

'North of Coal creek, in the area lying between the south branch of Michel creek and the Elk river, the beds do not long continue to hold the same regular form that they exhibit along Coal creek itself. A few miles north of the creek, the transition from the steep dips at the front to the horizontal position farther back is more abrupt; and, a short distance farther northward, becomes a sharp break with more or less faulting. This fault continues northward to opposite a point between Hosmer and Sparwood stations. Beyond that the beds resume a more normal attitude, such as they have near Coal creek. On the east side of the fault the rocks dip to the south at angles of 10° to 15°. The result of this is that the coal measures are brought nearer to the surface, and they are found outcropping on the side of a deep gash in the hills made by a small stream emptying into the south branch of Michel creek, below the junction of the east fork. This stream thus causes another bay in the outline, at least of the upper part, of the coal measures. Eastward from this place, the beds bend around gradually to join the measures at Marten creek, without any further serious dislocation. The fault above mentioned generally lies behind the front of the escarpment, but for a few miles northward from a point opposite Hosmer it cuts across the face of the hills some distannce below the summit. This gives a complicated appearance which is the only exception to uniformity along the entire front.

'Where Michel creek cuts through the northern part of the area, the basin is narrow, and the upper part of the coal measures has been eroded away in the valley. The bottom of the syncline is probably a short distance to the east of Michel station, and it appears to rise gradually both to the north and the south, with the lowest point of the basin, or trough, situated a little to the south of the stream.

British Columbia—*Cont.*

Attitude o beds near Michel.

'There are minor folds and irregularities in the rocks, and even with the help of the knowledge gained by the Coal Company in its operations at this place the situation is not entirely clear.

'To the north of the stream the beds continue in the form of a gradually rising syncline for a distance of about six miles. Beyond this, although Cretaceous rocks occupy the bottom of the Elk River valley for some distance, there is no sign of any coal measures for fully twenty-five miles. For several miles of this length the Cretaceous rocks are altogether wanting and the Carboniferous limestones and quartzites are exposed to view.

North of Michel creek.

On the hills to the east of the 'loop' on the railway at the forks of Michel creek, thin remnants of the Cretaceous rocks are left in patches, and parts of the two lowest coal seams still remain, but for the most part the measures have been worn away.

'The narrower syncline of coal measures on the east side of the south branch of Michel creek, continues northward beyond the interruption caused by the east branch and extends for a short distance across the main watershed into the district of Alberta. The coal measures in this extension occur in a long spur from a mountain, four or five miles southward from the Crows Nest summit on the railway. They are fairly flat-lying for the greater part, but on the west side of the spur, facing the old pack trail, a sharp fold or fault has given the rocks a dip of 60° to 70° to the north-east. Hereabouts, especially on the coal seams occurring in the steeply-dipping part of the rocks, the British American Coal Company has done a good deal of prospecting. The seams have been exposed at the surface in many places, and during the last season a tunnel was commenced with the object of tapping the seams some distance below their outcrop. The point at which the tunnel is driven is 600 feet up the hill, but the seams are exposed lower down, and can no doubt be found near the base of the hill in a convenient place for shipping the coal.

Continuation into Alberta.

British American Coal Company

'In the part of the coal lands thus far described, there is no very great area intact, and as there are several points from which the measures may be conveniently attacked, no excessive underground haulage will be necessary. The coal seams do not reach any great depth, being almost entirely above the level of the Elk river.

British Columbia—*Cont.*

Area south of Coal creek.

'The measures lying south of Coal creek occupy a practically unbroken block of country twelve miles or more in width and of somewhat greater length. Along the front by the Elk river, the beds continue to hold uniform easterly dips and behave in the same way that they do at Coal creek. Morrissey creek, ten miles south of Coal creek, makes a slight indentation in their outline and affords a good site for mining operations. Southward from Morrissey creek, the escarpment or rim of the basin begins to bend to the east and continues curving around along the southern limit of the measures by Lodge-pole creek, finally turning northward as far as the Flathead river at the south-eastern corner of the area. Here the escarpment ends. The rocks all the way around dip regularly inward. They gradually flatten out to a more or less horizontal position a few miles from the edge, without any noticeable fractures, but in so doing, in this southern part of the area, they are carried to a greater depth than they are to the north. A section eastward from Morrissey creek would show that the coal measures, after first bending to a horizontal position, rise a little in a gently swelling anticline and then slope steadily downward till they reach the lowest depth in the whole area. This point of greatest depth is only three or four miles from the eastern edge of the basin. The rocks at the surface are the highest beds of the section previously given and they still dip to the east. A low drift-covered valley lies between this point and the eastern edge, where the lowest beds of the series are upturned against the limestone mountains. It is probable that this rapid transition has been assisted by faulting. Owing to the depth of the measures in this eastern interior part, it is doubtful whether the coal can be profitably extracted. For the greater part, however, the conditions for mining are favourable enough. Coal creek, Morrisey creek and Lodge-pole creek are all suitable places to commence operations, and a part of the area can be reached from the south branch of Michel creek.

Accessibility of seams.

Crow's Nest Pass Coal company.

'The mines of the Crow's Nest Pass Coal Company at Coal creek, already referred to, were started when the Crow's Nest branch of the Canadian Pacific Railway was built. On this line, near the crossing of Coal creek, the town of Fernie has sprung up. It is a good example of rapid western growth. The mines are reached from Fernie by a spur from the main line running four and a-half miles up the creek. The good quality of the coal is now so well established that further mention in that respect is unnecessary. The output is increasing rapidly of late and is now well over 1,000 tons a day. About one-half of this is converted into coke, 360 bee-hive ovens being in constant operation at Fernie. The coke produced is of superior quality and preparations are being made to increase the number of ovens.

Coke ovens at Fernie.

'In addition the mining on Coal creek the company has recently commenced work on the seams at Michel and is already turning out coal for shipment. Material is on the ground for the construction of coke ovens and this point promises shortly to equal Fernie in importance.

British Columbia—*Cont.*

Mining at Michel.

'Although the extent of the coal lands in the area can as yet be only somewhat roughly estimated, the estimate (230 square miles) should be near enough to the truth to be used as an argument for the calculation of the total available coal supply. The thickness used in the calculation is the minimum already given of 100 feet of workable coal.

Estimate of total workable coal.

Total area of coal lands	230 square miles.		
	= 147,200 acres.		
One acre with 100 feet of coal would yield	153,480 tons of 2,240 lbs.		
50,000 acres would yield	7,674,000,000	"	"
147,200 acres would yield	22,595,200,000	"	"

MACKENZIE DISTRICT.

As explained in the Summary Report for 1899, Mr. J. M. Bell remained, in the autumn of that year, at Great Slave lake, wintering there with the object of continuing explorations in the far northern region in the summer of 1900. It was decided to authorize Mr. Bell to undertake an examination and survey of the shores of Great Bear lake, and instructions to this effect were sent in by the Hudson's Bay Company's winter packet. Mr. Bell has succeeded in carrying out the work outlined with ability and success; the only unfortunate circumstance connected with it being the desertion or loss of one of the men comprising his party, under circumstances of which he was unable to obtain any satisfactory explanation, although diligent search was made for the missing man. Mr. Bell reports as follows upon the work :—

Work by Mr. J. M. Bell.

'In June, 1899, I left Ottawa in company with Dr. Robt. Bell, for Great Slave lake, to act as his assistant in explorations to be carried on in that part of the country. As has already been related in Dr. Bell's summary report for 1899, I passed the summer making a topographical and geological exploration of the Fort Rae arm of Great Slave Slave lake, together with its north-western expansion, Lake Marian, nd in the autumn worked along the south-eastern and northern shores f Great Slave lake. Dr. Bell having found it advisable, according to your instructions, to leave me in the north, to continue operations during the autumn and winter and to carry on further work during the summer of 1900, arrangements were made with Mr. F. C. Gaudet, of the Hudson's Bay Company, at Fort Resolution, by which I was to

Winter at Fort Resolution.

Mackenzie District—*Cont.*

pass the winter with him. During the winter I made several short excursions east and west of the Slave river and made an examination of the limestone rocks exposed in that part of the country. I also kept the readings of the barometer and thermometer at Fort Resolution and obtained much useful information, by inquiries from the Indians, regarding the country east and north of Great Slave lake.

Exploration of country between Great Slave and Great Bear lakes.

'Late in March, I received your instructions to make an exploration of the country between Great Slave and Great Bear lakes, together with as much as possible of the shores of the latter, and therefore, immediately set about making preparations for the long trip to the northward. I obtained the services of two men at Fort Resolution, as from what I was informed, it seemed likely that any men engaged farther on, would be anxious to come as far south as this Post on my return journey. Having made inquiries from all reliable sources regarding the various routes to Great Bear lake, I decided that the best route thither was by the Mackenzie and Bear rivers, returning overland from Great Bear lake either by Lac la Martre, or Lac Ste. Croix, the former of which was said to be the easer of the two. By taking the route via the Mackenzie, it was supposed that owing to the early opening of navigation of that river, Great Bear lake could be reached much earlier than by going via Lac la Martre. Furthermore, no supplies whatever, could be obtained at Fort Rae, while there was a chance of getting a fair outfit at Fort Simpson. Accordingly I left Fort Resolution on April 11th, with Charles Bunn and Louis Tremblay, the two canoemen mentioned above, and one dog-team, carrying my canoe and dunnage, which was to go with us across Great Slave lake to Fort Providence. Another load with instruments, supplies, etc., had preceded us, and we met the men and dogs returning in making our traverse of the lake. The travelling on the lake was exceedingly bad, a thaw having set in which covered the ice with water, so that we could travel only at night and then with difficulty. The trip to Hay river that I had made during the winter in two days, now took us five to make, and we did not reach Fort Providence until the 23rd. I delayed there until the 28th, taking astronomical observations, to compare with those previously taken there by other observers. From Fort Providence we went to the mouth of Willow river, some sixteen miles below, where the employees of the Hudson's Bay Company's steamer *Wrigley* were working, and with them I stayed till the Mackenzie opened. I chose this halting place on account of the abundance of wild fowl and fish which could be obtained there. I was advised to go as far as Fort Simpson at least, by steamboat, on account of the difficulty of getting a landing-place, owing to the ice being piled high along the shore at this time of the year.

Date of leaving Fort Resolution.

Wait at Willow river for the Mackenzie to open.

'The ice of the Willow river broke up on the 6th of May, and the Mackenzie on the 12th, but the *Wrigley* was unable to leave before the 21st, so I passed the intervening time in making a short exploration up the Willow river. This stream is interesting as being the route followed by the Slave Indians to Mount à la Corne and Lac la Martre. Some seven miles up we encountered small rapids which are said to continue as far as Willow lake, a distance of about thirty-five miles. The *Wrigley* reached Fort Simpson on the 21st of May, and I delayed here for a week to arrange about supplies, and managed to obtain a small but sufficient quantity. We set out from Fort Simpson in our own canoe, and by travelling all night with the swift current of the Mackenzie, reached Fort Wrigley in a day and a half. Below this post I delayed for two days to make a short trip into the interior at Rocher Trompe à l'eau, so that it was the 3rd of June before we sighted Fort Norman. Here we had a long wait. The Bear river had broken only two days before our arrival, and Indians who arrived soon after the ice had gone out of the river told us that tracking on the Bear river would be impossible for at least two weeks, owing to the ice piled high along the shore, and that Great Bear lake itself was still as solid as in midwinter, so I again occupied myself by making trips into the interior and by rearranging my plans and outfit for our trip. Here I hired two extra canoemen, Charles Camsell and John Saunderson. Saunderson agreed to act as guide and interpreter around Great Bear lake. He had a good wooden canoe which he was to give me the use of during the season.

Mackenzie District—*Cont.*

Exploration of Willow river.

Leave Fort Simpson for Fort Norman.

'The party left Fort Norman on the 18th of June, being composed of myself and the four canoemen already mentioned. The trip up the Bear river was accomplished in six days. The news that Indians were still crossing the lake with dog teams was anything but encouraging intelligence to greet our arrival, and we were obliged to wait till the 4th of July before we could leave the head of the Bear river. While there we made arrangements with the Indians to meet us in McTavish bay and to furnish us with a guide who knew the lake and portage route to Fort Rae.

Fort Norman to head of Bear river.

'Leaving the embouchure, we turned to the left and followed the north-western shore of the lake. We had numerous delays from the ice, it being often necessary to portage our load over the points, and we did not reach Richardson bay till the 12th. Here I thought it better to follow an old portage route from the foot of the bay across Gros Cap to Smith bay, thus hoping to escape the ice which was still unmoved around the Gros Cap, as well as to look into the geology of the interior. Reaching Ice-bound bay, a portion of Smith bay, we were again delayed by the ice, so that it was the evening of the 24th of July, and then only by breaking our way through the ice for four

Delayed by ice.

Mackenzie District—*Cont.*

miles, that we were able to get off and make the traverse for the north shore.

Traverse made to Coppermine river.

'The time was, however, not lost, and the country was well examined. Following the north shore we reached the north-eastern extremity of the lake, the site of old Fort Confidence, on the last day of July, and thence made a traverse to the Coppermine river. We left Fort Confidence on our return journey on the 13th of August, but did not reach the rendezvous agreed upon with the Indians till the 29th, the coast-line being much longer than expected. The Indians had already gone and so we were obliged to start across country without a guide. My party was now reduced to three voyageurs and myself, Bunn having left us on the Barren Lands. It was now too late in the year to attempt to go farther around the lake and take the portage route via Lac la Martre, so we decided to try the other way by Lac Ste. Croix, which was said to be shorter, though more difficult. We were now entirely out of provisions, except such as we could obtain by hunting or fishing.

Great Bear lake to Fort Rae.

'The trip from Great Bear lake to Fort Rae was not an easy one, and we often had great difficulty in getting along. The route followed lay almost entirely through new ground, so that the names on the map showing the route will be for the most part unfamiliar. Leaving Great Bear lake we ascended a river about seventy-five yards in width at its mouth, which I have called Camsell river, and passed on through its expansions Lacs Clut and Grouard. From the latter we made a portage into a large lake, known to the Indians as Hottah lake. This lake is nearly fifty miles in length, and lies almost north-and-south. Its waters flow into MacVicar bay of Great Bear lake. From the southern extremity we portaged into Lake Stairs and were again in the waters of the Camsell river. Thence we followed the river or its expansions as far as the height of land, making numerous portages to avoid rapids, and often searching for a long time to find our way onwards. At Lake Rosamond, a beautiful clear stretch of water, the second large lake before we reached the height of land, we were lucky enough to encounter some Fort Rae Indians, and from this lake our course was an easy one. I engaged three of them to come to the Post with us to help us over the height of land portages and to guide us quickly southwards.

Portage to Hottah lake.

Engage Fort Rae Indians as guides.

'Leaving Lake Rosamond, there was again a stretch of river filled with rapids, avoided by three portages with small lakes between, which brought us into Lake Dawso-necha, which was about twenty-five miles in length. At its southern end we again entered the river, and after going some six or seven miles came into a small lake, from which we made several portages in crossing the height of land and entered the

Follow Marian river to Lake Marian.

head-waters of the Marian river. This we followed to its junction with the Petitot river, from Lac la Martre, and continued our way down the united stream to Lake Marian, which we reached on the 18th of September and got to Fort Rae on the 20th. We crossed Great Slave Lake among the islands, although it was considered rather late to attempt the crossing, and reached Fort Resolution on the 29th of September. Thence we continued our way up the Slave river to Fort Chipewyan, where we thought it best to wait till the river froze over. We were not able to leave Fort Chipewyan before the 14th of November. I left the fort with two dog-teams and two dog-drivers, having only Charles Camsell still remaining with me of my original party. I reached Edmonton on the 7th of December and Ottawa on the 12th.

Mackenzie District—*Cont.*

Crossed Great Slave lake.

Date of reaching Edmonton

'The method of survey during the summer varied according to circumstances. In the larger lakes, on the return route, and in Great Bear lake, bearings were taken with a prismatic compass. As a rule distances were measured by the speed of the canoe paddled at a regular rate in calm water, but frequently, especially around Great Bear lake, a system of rough triangulation was caried out, after having found an initial base on which subsequent triangles were built. On all the land traverses, including the long one to the Coppermine river, distances were measured by pacing. Hills were often ascended to sketch in the contour of the shore and to take long bearings. This was especially useful for lakes on the Barren Lands. Observations were taken nearly every clear day for latitude and frequently for magnetic variation. An accurate record of the weather and the readings of the thermometer for both air and water and of the barometer were kept. A number of photographs were also taken.

Method of surveys made.

Distances measured by pacing.

Record of weather kept.

'The Bear river is a fine large clear-water stream about eighty miles in length, with an average width of one hundred and fifty yards and an average current of nearly five mile per hour. It is easily navigable throughout its entire course, with one exception, namely at the rapid, where a rocky range crosses the river. Great Bear lake is roughly stellate in shape, having five huge rays or arms. Its greatest length from the head of the Bear river to the mouth of the Dease, does not greatly exceed 160 miles and its width from Cape Etta-d'ettellé to Gros Cap is approximately 55 miles, but the immense arms stretching in five different directions, greatly increase its size and give it a shore-line many hundreds of miles in length. On wide traverses I several times made soundings. Crossing Smith bay in one place, I found the depth to be 116 feet, and in another, 281 feet of cord did not find the bottom, although not two miles farther west, my other canoe-men found the botton at twenty feet. The topography of the lake varies with the country-rock. The south-

Bear river.

Description of Bear lake.

Soundings made.

Mackenzie District—*Cont.*

western portion of the lake, known as Keith bay, together with Smith bay and Dease bay to within thirty miles of Fort Confidence, are surrounded by unaltered and almost horizontal Cretaceous strata. There are few outcrops of solid rocks, but shales and sandstones are exposed along Smith bay, and the Sweet Grass hills represent a low anticlinal fold, composed of hard sandstone, which acts as the backbone of the Gros Cap peninsula Clay-shales, boulder-clays, gravels and unconsolidated sandstone are exposed at various places within the Cretaceous area and these all show a bedding which is almost horizontal. Presumably Cretaceous rocks are also exposed along the shore of MacTavish bay, east of Cape MacDonnel. On the Bear river, the Bear River Tertiary, similar to that already described by Mr. McConnell, at Fort Norman, extends some seven or eight miles up the river, and consists chiefly of unaltered and slightly consolidated sandstones in horizontal beds. Arenaceous shale and thin lignite seams are occasionally interstratified. The beds are often overlain by boulder-clay and cut sand-banks are common. Beyond the Tertiary basin, Cretaceous rocks extend to The Rapid, where a rocky range of Paleozoic strata, crosses the river. Above this, there are frequent exposures of Cretaceous rocks, with some fossils almost as far as Great Bear lake. Here they consist chiefly of dark ferruginous and arenaceous shales overlain by thin-bedded and jointed light-yellow sandstones. Talus slopes are common. The beds dip down-stream at a very slight angle. It is from a stratigraphical and lithological comparison with the rocks of Bear river, that the rocks of Great Bear lake are referred to the Cretaceous, as nowhere on the lake were fossils found. On the upper part of Bear river are horizontal gravel beds of sixty and seventy feet in thickness, overlain by Pleistocene deposits. These gravel beds are probably analogous to those beds of the Mackenzie river which Mr. McConnell there calls Saskatchewan gravels. They are exposed at several places in the Cretaceous area.

Geological features.

Cretaceous rocks.

'Ordovician or possibly Silurian rocks occur at "The Rapid" on the Bear river where the mountain range crosses it. Mount Charles, the most prominent part of these mountains, is a hill of about 1,500 feet in height, and consists of a large anticline, embracing subordinate folds. The rocks are interstratified conglomerates, quartzites and magnesian limestones; the latter of great thickness. I found thin layers of gypsum in several places, interstratified with dark-gray, shaly dolomite. Salt springs are mentioned by Sir John Franklin as occurring here, but I was unable to locate them, and my Indian guide had never heard of their existence, although some thirty miles to the north-westward he knew of salt in quantity. From the description given by Richardson, it is probable that the promontory between MacVicar

Rocks of Mount Charles.

and Keith bays is Devonian, though I think from what the Indians say, Cretaceous rocks must occur there also.

Mackenzie District—*Cont.*

'Our route to Great Slave lake from Great Bear lake, lay not far east of the Palæozoic boundary, as could be seen by the outline of the hills to the westward, and at the head-waters of the Marian river; and at Nagle lake, the limestone rocks came to the water's edge. From this vicinity, however, the strike seems to be almost south, while our course was south-east, so that we did not see Palæozoic rocks again, till we arrived at Lake Marian.

Cambrian rocks.

'From a point about thirty miles southwest of the mouth of the Dease river, eastward, exposures of solid rocks occur which are analogous to rocks seen last year on Great Slave lake, and there referred by Dr. Bell to the Animikie or Lower Cambrian. A low range of hills follows the shore of Dease bay for a considerable distance, and gradually approaches the lake-shore, till it terminates at a place called by Richardson, Limestone point, some twenty miles from Fort Confidence. The hills seem to be a series of anticlinal folds running almost parallel to Dease bay. Limestone point at its greatest height does not exceed one hundred feet. The lowest exposures are of purplish dolomite, which changes to a ferruginous slate. Above this comes gray, semi-crystalline dolomite, associated with light-gray quartzite. Rocks of like nature occur all the way to the Coppermine river, though isolated and small hills of both granite and syenite occur, which may be of different age. Along the Dease river the rocks consist chiefly of bright-red quartzite and drab and red magnesian limestones. Nearer the Coppermine, quartz-conglomerates, red and green shales, and pinkish sandstones are the prevailing country rocks. Amygdaloid is, however, found, together with some earthy volcanic rocks. In a range of hills running north-east and south-west, probably a spur of the Copper mountains, occur thick intrusive sheets of greenstone, frequently presenting steep mural precipices on either side. These hills rise to a height of about 1,000 feet. Greenstone rocks are also met with, near the mouth of the Dease river. Rocks similar to these occur for a considerable distance around the northern and north-eastern portion of MacTavish bay, and here greenstone intrusions with mural precipices, cutting through horizontal Lower Cambrian strata, are of common occurrence.

Greenstones.

'The eastern part of MacTavish bay is composed of a series of basic rocks, or greenstones, that seem to overlie the Laurentian granites, of which, however, exposures are seen at several places. The southern part of MacTavish bay and the islands there, are mostly of granite, though greenstone dykes are common. Crystalline rocks, composed chiefly of phorphyries, syenites, and granites, with numerous greenstone intrusive sheets, occur all the way from Great Bear lake to

Mackenzie District—*Cont.*

Lake Marian. Hornblende gneiss is exposed on the Marian river. Certain rocks, met with near the headwaters of the Camsell river and near Lake Marian, may be referred to the Huronian system, or possibly they may be analogous to those met with on Great Slave lake, and named by Dr. Bell, the Intermediate series.

Copper ores on Great Bear lake.

'With regard to the occurrence of copper ores in the Great Bear lake country, I may say that in the amygdaloid and associated rocks near the Coppermine, specimens of chalcopyrite and stains of copper carbonate were found, but the locality of native copper, etc., spoken of by the old explorers was not met with, as it probably lies farther south. In the greenstones, east of MacTavish bay, occur numerous interrupted stringers of calc-spar, containing chalcopyrite and the steep rocky shores which here present themselves to the lake are often stained with cobalt-bloom and copper-green. According to Indian report, native copper occurs also at the north-east end of MacTavish bay. Siderite was found in pockets, in quartz and calc-spar in Cambrian rocks on the southern shore of Dease bay. Several other minerals seem to be connected with it. Iron ore in the form of reniform hæmatite, was found, but in uncertain quantity at Rocher Rouge on Edatravers bay, in the north-eastern part of MacTavish bay. Hæmatite also occurs near the Coppermine river and at several localities on the east shore of MacTavish bay. Here the ore is associated with what seems to be a dark reddish trap, which I was unable to identify more precisely in the field. Talus slopes of the ore and country rock are common.

Glaciation.

'Evidences of glaciation, in the form of numerous glacial erratics were everywhere visible from the mouth of the Bear river, but it was not till the harder rocks of the Lower Cambrian were met with that glacial striæ were seen. The general course of the striation is a little north of astronomical west, though great local differences occur. On the barren lands near Dease river, I noticed glacial striæ in a direction N. 85° W. and fainter markings almost exactly at right angles. As Great Slave lake was approached, the course of striation seemed to be much more southward. Rows of drumlins, some of them three or four hundred feet in height, and long winding eskers were seen near the head-waters of the Dease river, and near Dismal lake, kames occur.

Old shore-lines.

'Modern ice deposits are seen on the Bear river and are being annually added to by the ice freezing to the bottom around the shallow shores of Bear lake, and in the spring the ice rises and carries away pebbles, sand, and sometimes even boulders of good size. Around Great Bear lake wonderful examples of old shore lines occur, showing the former extent of the lake. On the north-west side they exceed, in places, three hundred feet in height, and are at a distance of three to four miles back from the lake shore. This height on the north is much greater than any observed on the southern side, which might show a tilting of the lake towards the south or south-west. Besides these, broad beaches of one hundred to one hundred and fifty yards were often met with, and in places terraces of pebbles, showing old shore lines, extend for a short distance from the present shore of the lake, at various heights of from ten to one hundred feet. These are especially common in the northern part of MacTavish bay. Mackenzie District—*Cont.*

'The country abounds in game. Grizzly and black bears were frequently seen, and Polar bears on the Coppermine river. Caribou are abundant around the northern and eastern shores, and a few musk-oxen were seen. Moose are to be had in plenty from MacTavish bay southward. All the ordinary northern waterfowl were abundant, and the waters of not only Great Bear lake, but all the lakes to the south of it, teemed with splendid fish. Game.

'A careful collection of the flora of the country was made and about 150 species were obtained. I was greatly assisted by Mr. C. Camsell in the collecting of botanical specimens. The Bear river, and all the country from MacTavish bay southward, is well wooded and fine specimens of white spruce, canoe birch, and poplar of both kinds occur. On the north-western shore of the lake spruce trees, sometimes eighteen inches in diameter, were seen, at a distance of three to four miles back from the lake on the sandy hills, but near the shore the country is either very sparsely wooded or not wooded at all. On the northern shore, until near old Fort Confidence, the country is very thinly wooded with stunted spruce and willows, and these only at some distance back from the shore; and the same conditions are seen around the southern shore of Dease bay. In MacTavish bay, in the shelter of the rocks, occur some fair-sized spruces, with some stunted birch and poplar, which were observed here for the first time in going south. Banksian pine is not seen until reaching Lac Fabre but from there south, it becomes an important forest tree. The northern limit of tamarack is near the mouth of the Camsell river. Around old Fort Confidence and about twelve miles up the Dease, the country, strange to say, is well wooded with spruce. Beyond this, spruce practically disappears, though occasional clumps of stunted trees were seen. Trees of fair size were observed on the Happy river, a tributary of the Coppermine. Willows were also found at several favourable spots on the Barren Lands. Timber.

'Acknowledgments are due for assistance in carrying out the exploration, particularly to Mr. F. C. Gaudet, with whom I spent the winter, Mr. J. S. Camsell and the various officers of the Hudson's Bay Company, Messrs. Hislop and Nagle, and the missionaries, both Roman Catholic and Protestant.

ONTARIO.

Ontario.

After preparing his preliminary report for the previous season, Mr. W. McInnes spent the remainder of the winter in plotting the surveys of the summer of 1899, and in work upon the Manitou and Ignace sheets, the former of which is about ready for the engraver, and the latter in course of preparation.

Work by Mr. Wm. McInnes

Mr. McInnes' work in the field during the past season was mainly directed to the exploration and mapping of the area of sheet No. 8, Ontario, to the south-west of Port Arthur, and extending to the International boundary. Upon the progress of the work Mr. McInnes makes the following report:—

'Leaving Ottawa on May 30th, ten days were spent by permission of the Director in examining the iron ore deposits of northern Minnesota, preparatory to an examination of the same series of rocks in their extension into Canada. In pursuit of this object the mines at Tower, Ely, Biwabic and Eveleth were visited and a number of sections examined along the railways and roads in the vicinity of these towns. The few days spent here proved most instructive and the experience gained will be of good service in connection with working up the iron ores on our own side of the line.

Iron ranges of Minnesota.

'The iron ranges of Minnesota, which are so extensive and of so great value, belong to two distinct geological horizons with characteristic ore deposits in each. The Vermilion range represents the older horizon. In it occur the deep mines at Tower and Ely. The ores mined are hæmatites of the close-grained metallic description known as "hard ores," though only those at Ely are typically hard.

Continuous with Keewatin areas of Hunters Island.

'At Ely good sections were seen of the surface exposures of rock, and these were found to be quite similar in general character and mode of occurrence to our Keewatin iron-bearing belts. This belt has now been traced on the ground into actual continuity with our Keewatin areas of Hunters island. There seems to be a prospect, therefore, that some of the many known iron-bearing areas occurring in these rocks on the Canadian side may show deposits of good workable ore.

'The upper iron-bearing horizon is represented by rocks of the Mesabi range which are, without question, a part of our Animikie formation. It is, generally speaking, a flat-lying series of rocks with, however, generally undulations and minor local crumpling. On this range occur the remarkable "soft ore" deposits, some of which allow the most economic mining methods to be employed—the direct transfer of the ore from the beds to the railway cars by steam shovels. One-half or perhaps more than one-half of the Mesabi ore is thus mined. The whole region is, in the main, deeply covered by drift deposits, making

Ontario—*Cont.*

the first discovery of the ore lenses a matter of great difficulty—so difficult that, although the region has been closely prospected for years, the area of workable deposits has been widely extended through prospecting by means of test pits and the diamond drill within the last year.

Probability of similar beds in Canada.

'The position of these deposits, near the base of the Animikie, makes it a matter of probability that similar beds of ore may be found in Canada, where we have a wide area covered by these Animikie rocks. Roughly described, this area occupies a triangular space bounded by Lake Superior, the United States boundary, and a line extending from Gunflint lake north-easterly to the shores of Thunder bay.

Facilities for shipment.

'Iron ores of good quality, with a high percentage of iron, have been discovered at a number of points over this area, but up to the present time none have been proved to be in sufficient quantity for practical working. These ores consist mainly of magnetites, hæmatites, limonites and carbonates. The iron-bearing district is now well served by railways, the Canadian Pacific, the Canadian Northern, and the Port Arthur, Duluth and Western all traversing it. The haul to a lake port would not be any longer than is the case in Minnesota and often much shorter. In the case of the Vermilion range of Minnesota the haul to the shipping docks at Two Harbours is over 100 miles, and that from the Mesabi to deep water but little less. The sections exposed in the Matawin valley and on Hunters Island seem to be those most closely parallel to the Vermilion beds, and in both of these places deposits of iron ore of considerable extent have been found.

'Mr. E. J. Meyers, of Listowel, who had been assigned to my party as an assistant, joined me at Port Arthur on June 11th. After collecting canoes and outfit that had been stored over winter at Ignace station, on the Canadian Pacific railway, and engaging Indians, etc., the first train on the P. A. D. & W. railway was taken to Gunflint lake, the terminus of the Canadian part of the road.

Gunflint lake.

'A few days were then spent in an examination of the shores of Gunflint lake and the country in its neighbourhood. The eastern edge of the Saganaga granite area reaches the western end of the lake, and the granite is at no place more than about a mile back from the lake to the north, a belt of Keewatin and often a rim of Animikie lying between the granite and the shore. The immediate basin in which the lake lies and the bordering hills to the south are Animikie, and belong to the lower iron-bearing portion of that formation. These rocks as a whole lie almost horizontally, with but slight undulations. The high hills to the south show thick exposures of black slate, with a capping of trap, and with sills of trap showing here and there at different levels in the slates. Below the slates is the quartzite division

Ontario—*Cont.* made up of hard quartzites, with interbanded chert, jasper and iron ore, ferriferous dolomite, etc. To the north of Gunflint lake an iron-bearing band extends from Magnetic lake to beyond LeBlain station, lying about a mile back from the shore and trending parallel to it. As no development work has yet been done, it is impossible to say with certainty from the limited surface exposures what its extent or possibilities may be.

'The unconformity between the overlying, horizontal Animikie and the nearly vertical Keewatin is well seen in the section afforded by the cuttings along the line of the P. A. D. & W. railway.* The Keewatin is here made up of green schists, altered argillites and quartz porphyries with, at one point, a schistose band from four to five inches in thickness, coated and seamed with pyrolusite.

Gunflint river

'On June 27th, a start was made down the Gunflint river, for the purpose of further exploring the country lying to the north and east of Saganaga lake. The granite-gneiss is struck on Magnetic lake, immediately beyond the Animikie ridge dividing this lake from Gunflint. Continuing down the river, the same gneiss striking about N. 70° E., is seen down past Flat-rock portage, where there is a descent of ten feet and at Mill falls, with a descent of twenty-five feet.

'Below, at Island falls, with a descent of forty feet, the gneiss is less decidedly foliated and the prophyritic crystals of quartz, characteristic of the Saganaga granite area, show prominently on weathered surfaces. The same obscurely foliated gneiss or granite is seen all the way down the river to Saganaga lake, where it is defined pretty closely by the shore line; the granite appearing only on projecting points, with, generally a closely-cut line of intrusive contact between it and the Keewatin.

Saganaga lake

'A micrometer survey was then made of the long easterly arm of Saganaga lake and of the corresponding long westerly arm of Northern Light lake. The main Saganaga lake had been surveyed by the late W. H. Smith of this office and Northern Light lake by H. B. Proudfoot, O.L.S., for the Ontario government, so that this survey was carried only far enough to establish a good tie between them. Granites of the Saganaga area extend to the end of the Saganaga arm, and granite-gneisses of the typical Laurentian character occur all along the line of Northern Light lake.

'After tying the survey to Sewell's base line, Northern Light lake was examined to its south-eastern end. Banded biotite-granite-gneisses were found all about the lake, the strike gradually swinging from N. 40° W., at the north to S. 80° E., at the narrows, and to N. E. about the south-easterly bay. Our return to the railway was made by way of Twin lakes and a number of smaller lakes and

* Port Arthur, Duluth and Western railway.

ponds, a route involving six portages and passing over biotite-gneisses to within about 300 yards of the railway at North lake, where the horizontal beds of the Animikie come in. Returning through North lake to Gunflint, after making a number of sections over the hills and along the railway, the route down the river to Saganaga was again taken for the purpose of examining the country to the north and north-west of Northern Light lake. A micrometer survey was started at Sewell's base-line and carried up Sand river about two miles, where a branch coming in from the north-west was taken and followed up to the lake at its source about two miles and a half long. A route through a number of small lakes to Kinnimikwisas lake, was then surveyed. This lake is four and a half miles long, with very irregular and broken shore lines. Obscurely foliated biotite-granite-gneisses were found all along. Returning through Conmee and Mowe lakes the same gneisses were observed all the way. The country passed through, everywhere showed evidences of glaciation, the glacial striæ averaging about S. 20° W., in direction. Coming out by way of the outlet of Northern Light lake, this was found to empty, from the bay running westerly from its southern end, into Long Bay of Saganaga.

Ontario--*Cont.*

Routes surveyed.

'North lake, South lake, Mud lake, Rose lake and Arrow lake were then examined, and good sections of the Animikie rocks were seen in the cliffs bordering them. Soundings showed these to be the deepest lakes visited. A few of the greatest depths obtained are :

Depth of lakes.

	Feet.
Gunflint lake	208
South lake	147
Northern Light lake	123
Saganaga lake	121
North lake	114
Mowe lake	72
Rose lake	65

'The lower part of Arrow lake is evidently deep, but no soundings were made. A micrometer survey was made of Whitefish lake and a tie line run to the railway. This lake, though about six miles long by two miles wide, is exceedingly shallow and is apparently gradually filling up. Wild rice beds occupy many of the large bays, and are constantly extending farther and farther out into the main lake, which averages less than seven feet in depth. Whitefish are still caught in the lake in small quantities, but constant fishing for a great many years, without any provision for restocking, has sadly diminished the large catches of former years. Arrow lake is fished for both lake trout (*Salvelinus namaycush*) and whitefish, and the former are taken in considerable numbers. Both lakes lie entirely in the Animikie, the high hills to the south showing in places perpendicular cliffs of slate,

Whitefish lake.

Arrow lake.

Ontario--*Cont.* overlain by a capping of trap, and the hills to the north, of more moderate height, exposing the lower division of the Animikie. Bands of iron ore of good quality are found in these beds north of Whitefish, but as far as observed, they are limited in quantity. A few veins carrying silver have been found in these rocks, but none are being worked.

Sections on railways.

'The remainder of the season was spent in examining the cuttings along the Canada Northern and P. A. D. & W. railways as well as the various colonization roads that are being opened up by the Ontario government.

'A number of short excursions were made through the bush to the north of the railway. One of these gave a section northward from the 45-mile post. From the railway, the lower division of the Animikie was found to extend back for about two miles, or to a quarter of a mile beyond the Star mine, where it gives place to the underlying biotite-granite-gneiss. Continuing, the gneiss only is seen through the township of Strange and on beyond Trout brook, trending in parallel east-and-west ridges.

Outpost hills.

'About three miles beyond the north line of Strange, the farthest of the Outpost hills rises, the lower slopes being composed of gneiss, and the more steeply sloping top of Animikie quartzites, etc. A band of iron ore of good quality can be traced for some distance along the hill, but the surface exposures do not show a great quantity. A flat-lying bed of trap forms the summit. The general denudation has been so great as to leave the hill of Animikie quite isolated on the gneisses.

Agricultural land.

'The south-eastern part of the region included in the map-sheet embracing about two thirds of its area and underlain by the flat-lying beds of Animikie, is covered generally by a thick mantle of drift, through which the flat-topped hills of trap protrude. This may be considered as being generally good agricultural land, the soil varying from a heavy clay to a light sand. Along the various river valleys are broad tracts of excellent alluvial soil well suited for general farming. The valley of the Little Whitefish is a good example of this kind of land. The district generally is particularly well adapted for the growth of root crops as well as hay and clover, the latter, where it has been accidently sown along old lumber and colonization roads, growing most luxuriantly. The severity of the winter climate is the greatest draw-back, but that it is not so rigorous as to prevent the growing of reasonably hardy fruits, seems to be proved by the strong and well fruiting plum trees (*Prunus Americana,*) that grow wild throughout the district.

Timber.

'The principal forest trees are red and white pine, Banksian pine, spruce, fir and tamarack among the conifers, and poplar, elm, ash, white birch and soft maple.

'The rule obtaining with reference to the distribution of brook trout farther north, was found to hold good here also. All the streams flowing into Lake Superior, where no unsurmountable fall intervenes, teem with brook trout, while in those across the height-of-land these fish are entirely wanting. Lake trout are widely distributed, and white-fish occur wherever suitable conditions exist. Pickerel and pike are common in most of the lakes, and suckers are everywhere abundant. Ontario--*Cont.* Fish.

'Moose and caribou are plentiful and appear to be increasing in numbers, and Virginia deer are coming up from the south followed by their enemies, the timber wolves. Bears and other common fur-bearing animals are trapped during the season. Ducks of various species are plentiful wherever rice beds furnish good feeding grounds, but only a few kinds breed in the district. Grouse, including the pin-tail, are fairly plentiful. Game.

'The only mine at present being actively worked is the "West End" silver mine of Silver mountain, which is being operated by a syndicate under lease. At the time of my visit I was permitted, through the kindness of Capt. Shear, to examine the mine and mill. Rich ore was being taken chiefly from the upper levels. The very high grade ore is barrelled for shipment as it comes from the mine, and the lower grades are run through the stamps and concentrated for shipment in sacks to the smelter. Mining.

'In connection with the mill, the company have erected a trial excelsior plant, for the production of excelsior packing from poplar and other woods, that can be cut in quantity near at hand.

'Work was resumed late in the summer on the old Polson iron location, situated at the end of the P. A. D. & W. railway, just across the border, in Minnesota. A new company which has taken hold of the property, was engaged in September in freeing the old works from water with a view to thoroughly testing the location. On the Canadian side, prospecting parties have been active in Hunters island and north of Saganaga, and it is claimed by some of them that iron-ore in commercial quantities has been found. In the north-western part of the township of Marks, exploratory and preliminary testing work was being done on an iron-bearing band that has been located there.

'Mr. Meyers, owing to an accident that laid him up for a month or more, was forced to return home early in the summer. During the remaining time Mr. A. J. Carlyle of Woodstock acted as my assistant.'

Michipicoten District.

Dr. Robert Bell was engaged during the summer in Michipicoten district, north of Lake Superior, where he had previously spent the greater part of the season of 1898, and which he had visited also in previous Work by Dr. Robert Bell.

Ontario--*Cont.* years. The recent discovery of extensive deposits of iron ore have rendered the district a specially important and interesting one. Dr. Bell reports as follows on his work :—

'I left Ottawa on July 27th, accompanied by Mr. W. J. Wilson, of the Geological Survey, who was to act as my assistant, and at the close of the season we returned to this city—on November 6th. On the way up we stopped at Sault Ste. Marie long enough to hire canoemen and to send forward the canoes I had in store in that place.

Michipicoten.

'On arriving in Michipicoten bay, I found the surroundings had been considerably transformed in less than one year, in consequence of the discovery of a large body of rich iron ore at Boyer lake, about eight miles north-east of the mouth of Michipicoten river. The first cove to the north-eastward of Gros Cap had been dredged and converted into a shelter for vessels and named Michipicoten harbour. It had been made the starting point of a railway, twelve miles in length, to the iron deposit, which had become known as the Helen mine. The passenger steamers called at this harbour, and a post office had been established under the same name. Being thus the most convenient centre for our operations, we made it headquarters for the season, instead of Michipicoten post, as in 1898.

Recent developments

'The topography and geology of the area covered by sheet 143, Ontario series, which lies in this district, had been partly worked out by myself in connection with explorations of the surrounding country in 1875-76-77 and in 1881, and they were represented on the map of the basin of Moose river, published in 1882. In 1898, in consequence of the discovery of gold in that region in the previous year, topographical and geological work of a more detailed character was done there by myself. The western part of the sheet was thus fairly well completed, and it was described in my summary report for that year. On account of the discovery in 1899 of the large deposit of iron ore in this section—now worked as the Helen mine—it became desirable to make additional geological examinations in the same area. Further surveys were required in the eastern part of the district, in order to complete the whole sheet for publication. The Helen mine deposit and other discoveries of iron ore recently made in this part of the country were, therefore, investigated and their geological relations studied with the object of enabling us to indicate as nearly as possible the run or position of the iron-bearing horizon or horizons in those parts of the district where ore has not yet been actually found.

Former work in the district.

Mr. Wilson's work.

'The following topographical work, with geological notes, was done by Mr. W. J. Wilson : A paced survey of the newly opened trail from Tremblay station, on the Algoma Central railway, north-westward for about twenty-five miles, track-surveys of a canoe-route from Michipicoten river by Angigami lake and thence southward, of the whole of Windermere lake, of a route from this lake northward across the height-of-land and down a stream towards Missinaibi lake, of Mattagaming lake, of a route from Manitouwik lake north-westward to and including Jack-fish lake, besides minor investigations in other parts. He also assisted me in various ways in connection with our labours towards the accomplishment of the objects of the season's operations. I may here remark that Mr. Wilson performed the various duties devolving upon him in a very efficient and satisfactory manner. Ontario--*Cont.*

'My own topographical and geological work included a track-survey of a route from Wawa lake to the Josephine mine, and of the various connecting lakes, a traverse through the woods from Tremblay station northward for nineteen miles with offsets to Black Trout lake and Catfishing lake; geological examinations of the Helen mine and the railway track between it and Michipicoten harbour; the same of the shore of Lake Superior from Michipicoten river westward nearly to Pilot harbour, with explorations inland at Doré river and Dog river. A track-survey of a chain of lakes from Windermere lake to and including the west branch of Montreal river and the main stream downward to the southern margin of the sheet; the same of Montreal river and the lakes on its course upward from the junction of the west branch to the height-of-land, south-west of Chapleau; the same of the large lakes at the head of Kapuskasing river and of this stream from these lakes downward to a point about sixty miles north-north-eastward of Chapleau, where I tied this survey to a similar one made by myself in 1881, eastward through various lakes and streams from Missinaibi river to Trout river; a track-survey of some lakes lying west of this part of the Kapuskasing river; the same of White river from the line of the Canadian Pacific railway to Pokay lake, and thence through a chain of lakes to and including Kaybinik lake; a similar survey thence through a chain of lakes and streams westward to the head-waters of Dog river and on to Iron lake; examinations of iron deposits and their associated rocks in this region. While making the above surveys and explorations, many observations were taken for latitude. In passing over ground which had been previously examined, additional facts as to the geology and other matters were frequently noted. Dr. Bell's work.

'Mr. E. V. Clergue, manager of the Algoma Central Railway and Steamship Company, had a number of topographical and geological explorers out in the Michipicoten district during the present and the previous season, in addition to the engineers engaged in locating the railway and its branches, and from time to time he kindly placed the results of their labours at our disposal, as well as the compilations of some of their maps prepared by Mr. Lawrence. This material will be of much service in supplementing our own and other surveys Other explorers' work.

Ontario--*Cont.*

in the construction of a final geological map of the district. Among the principal data now available for this map may be mentioned the straight lines run at various dates by Messrs. Salter and Gilmour, Herrick, John Fleming, Speight and Niven ; Stewart's surveys on the right-of-way of the Canadian Pacific railway, surveys for the Algoma Central railway, Bayfield's chart of the shore of Lake Superior, and my own instrumental survey of the same shore within the limits of the sheet, topographical and geological explorations made by a number of different persons in 1899 and 1900, under the direction of Mr. Clergue, inland surveys by myself and assistants in 1898 and previous years, all supplemented by the work of Mr. Wilson and myself in 1900.

Data for map.

Work beyond limit of sheet.

'Mr. Wilson's work on Mattagaming lake, above referred to, and part of my own in 1898 on the Magpie river, lie beyond the north line of sheet 143, and are in the area that would be covered by the next sheet to the north, namely, number 156. These surveys and researches were necessary in order to complete the geology of the large Huronian basin of the Michipicoten region and they, together with my topographical and geological surveys and explorations in previous years in the rest of the region covered by this sheet, leave little to be done in that area. North of the Michipicoten Huronian basin, with the exception of the small bands of the same series occurring at Kabinakagami lake, the rocks within sheet 156, consist entirely of common Laurentian gneiss.

Confirmation of geological boundaries.

'The character and distribution of the rocks of the area covered by sheet 143 are described in my summary report for 1898. The various explorations made by Mr. Wilson and myself, as above described, in the eastern half of the sheet, brought out no new facts in regard to the general distribution of the Laurentian and Huronian systems, and they confirmed the accuracy of the geological boundaries as laid down on the map of the basin of Moose river, published in 1882. As represented on that map, only Laurentian rocks were found on the Angigami river route, around Lake Windermere, thence to the west branch and down the main Montreal river and up the same stream to its source near Chapleau, also for a long distance down the Kapuskasing river. The general position and contour of the boundary of the Huronian basin to the northward of our present sheet, as given on the above map, were also confirmed.

Western extension of Huronian basin.

'Beyond the western boundary of the sheet, the Huronian rocks were found as far as Iron lake, and they continued still further west, but this lake is considerably beyond the limits of the sheet and my explorations extended no further in that direction. Mr. Robert Murray, in charge of the Iron Lake mine, informed me that the Huronian rocks continued on beyond the Puckaswa river, where Professor Coleman found them in 1898.

'The red granite area on the shore of Lake Superior, between Doré and Dog rivers, at the western edge of the sheet, has a breadth of only about three miles on the lake front. West of the granite, the shore is occupied by green schists, having a constant north-north-westerly strike for a distance of fifteen miles, when red granite again appears. It may be inferred from the great width of this body of schist and the regularity of its strike that it continues inland in the same general direction for a considerable distance. Ontario—*Cont.* Geology of shore of Lake Superior.

'The granite first referred to, between Doré and Dog rivers, is the southern part of what is apparently a large isolated area, extending north to Kaybinik lake and thence westward for some miles, although in this part of the district the exposures of granite and green schist alternate in such a way that it is possible some of the former may belong to smaller isolated areas. The most easterly part of the boundary of this large granite area touches Black Trout lake. Isolated area of granite.

'The wide belt of coarse conglomerate, which is so conspicuous on the shore and islands on both sides of the mouth of Doré river and thence eastward to the hills in the rear of Michipicoten harbour, seems to turn north and disappear before reaching Magpie river. In the opposite direction, it is seen at Dog river, running north-westward. Some of the explorers who have worked in the Michipicoten district suppose that the iron ore belt may be looked for in connection with this great band of coarse conglomerate, but I have not seen any conglomerate east of the Magpie river that can be correlated with it or that can be regarded as a guide for locating the iron belt. Although the iron ores of the eastern part of the sheet do not appear to run near any conglomerate band, the iron belt of the western part of the district lies along the north side of a wide band of conglomerate resembling that at the mouth of Doré river. Conglomerate or breccia occurs at the outlet of Black Trout lake and again at the site of the former bridge across the Magpie river on the old tote-road from the head of Wawa lake to Grassett on the line of the Canadian Pacific railway, but at neither place has the rock the volume or general character of the Doré river band, although it may be possible that the conglomerates at these localities represent it in a modified form. Some of the rocks of the iron belt itself are broken up into breccias, as, for example, those on the south side of Moon lake and at Scott lake, but these are in no way connected with the strong band of coarse conglomerate above referred to, which is composed of water-worn stones of a different character. Both weathered and freshly broken surfaces of different kinds of schist throughout the Michipicoten Huronian basin, occasionally show scattered patches of various sizes, which differ more or less from the surrounding rock as to colour and sometimes also as to the relative proportions of their constituents. They Coarse conglomerate belt. Other conglomerates.

Ontario—*Cont.* present angular, rounded and elongated outlines in cross section. These occurrences can scarcely be regarded as constituting conglomerates.

Jaspery ore-belt.

'The first appearance of the "jaspery" ore-belt on which the Helen and Josephine mines are situated is at Moon lake, from which it is traceable north-eastward past Sayer lake to the former mine, and thence onward in the same direction, passing between Wawa and Eleanor lakes to Scott lake and Park lake. From the last mentioned lake, it is supposed to run north-east, parallel to the south-eastern boundary of the Huronian basin, nearly, or quite, to Mattagaming lake. A ferruginous rock which occurs at one place on the north-west side of this lake, between the outlet and Waboose island, may perhaps represent the continuation of this belt.

The Josephine mine.

'The Josephine mine is situated at the south-west end of Park lake, on the same ore-belt as the Helen mine and at a distance of about seven miles in a straight line to the north-east of it. The ore consists of red hæmatite interstratified with thin beds of white and gray quartz-rock or "jasper," like that found elsewhere along this iron belt. During the previous winter two bore-holes had been put down, each at an angle of 45° to the horizon, and outward, or in opposite directions, from a small island in the lake, so as to cross the strike of the iron-belt which here stands nearly vertical and runs about north-east. I could not ascertain the result of these borings. A little stripping had been done on the mixed hæmatite and quartz layers, where it is proposed to develop the Josephine mine at the south-west extremity of Park lake.

Gros Cap iron band.

'The occurrence on the south side of Gros Cap of a band of alternating thin layers of quartz and hæmatite, was referred to in my summary report for 1898, and it was more particularly described in my detailed report for 1876. A smaller ferruginous band occurs on the south side of the rocky peninsula on the north side of the mouth of the Michipicoten river.

The Helen mine.

'*The Helen Mine.*—The existence of iron ore at what is now the Helen mine, is said to have been known for two or three years to certain trappers and explorers, one of whom, Benjamin Boyer, brought it to the notice of Mr. H. F. Clergue in 1899. The latter purchased the location, and immediately proceeded to develop it as a mine. The occurrence lies at the east end of a deep pond, about a quarter of a mile long, called Boyer lake.

Character of the ore.

'The ore is a hard but somewhat porous or spongy red hæmatite, with a specific gravity of about 5. The ore-body, from which a layer of muck or peaty moss has been removed, forms a point dividing the head of the lake into two small bays. It has a lumpy surface with a dark bluish-gray colour. Small quantities of brown hæmatite (limonite) and yellow ochre appear in joints and cavities, but they do not form any appreciable portion of the mass. Ontario--*Cont.*

'The horizontal dimensions of the exposed ore are about 500 feet in every direction, and its greatest height above the lake is 100 feet. The ground rises steeply all around the head of the lake, so that the ore lies at the bottom of an amphitheatre, open on the west or lake side. A drift has been run at the level of the general surface of the ore, southward into the hill, and this penetrates similar hæmatite for 250 feet, thus giving a known breadth of about 750 feet from north to south.* During the winter of 1899-1900, by taking advantage of the ice on the lake, a number of holes were bored in the bottom along a north and south line, which passed the extremity of the point of ore at a distance of 250 feet to the westward. On this line and abreast of the point the lake had a depth of 100 feet, including ten feet of soft mud, and at 150 feet below the bottom, where the boring ceased, the drill was still in hæmatite like that on the dry land. A bore-hole from the surface of the exposed ore was sunk to a depth of 188 feet below the level of the lake without reaching the bottom of the hæmatite. The ore-mass has thus been proven to have a continuous depth of 300 feet, and as this follows the plane of the bedding, which is vertical, the probability is that the depth is very much greater. The general strike is parallel to the axis of the pond, which is about east and west. The railway approaches the mine from the west along the foot of the hill on the south side of the lake.

Measurements of the ore-body.

'The rocks rising steeply from the railway track a short distance west of the ore deposit, and about in line with its southern side, consist of dark, greenish-gray diorite, and a soft, light-gray arkose schist. On the north side the ore-mass is bounded by a considerable hickness of thin layers of hæmatite, like that of the main body, interstratified with others of quartz rock. These alternating beds are from half an inch to three or four inches in thickness, and the mass is similar to the "jasper belt" traceable some miles to the east-north-east, in the general strike of these rocks.

Associated rocks.

'The ground rises to a height of 440 feet, according to our barometer, at a distance of about 1,500 feet east of the mine. The hill is called Hæmatite mountain, and the rock on its summit consists of light bluish-gray carbonate of iron (siderite) containing 36 per cent of metallic iron, according to the analysis made in the laboratory of the Survey. Where it has been exposed to the surface influences, it becomes encrusted with two or three inches of dark brown limonite, containing 52 per cent, of metallic iron. A light, yellowish-gray siderite, holding much finely divided silica, occurs near the northern side of the mine.

Hæmatite mount in.

*Mr. E. V. Clergue informs me that the distance from the head of this drift to the extremity of the ore point is 975 feet.

Ontario--*Cont.*

Siderite.

'Boyer lake is about 1,500 feet in length. On the south side of its outlet there is a purer variety of siderite, of the same colour as the last mentioned, which also passes into dark brown limonite on the surface. The lake discharges by an artificial trench cut through a narrow ridge of rock, along a bed or vein of impure, finely granular

Iron pyrites.

light-yellow iron pyrites. A width of about six feet of the pyrites is exposed. Similar pyrites in larger quantities occurs on the south side of Sayer lake, which is about 25 feet below the level of Boyer lake. In a railway cutting on the north side of the former lake, there is a good fresh section of the unaltered rocks of the iron belt, in a zone corresponding to that of the hæmatite and quartz rock on the north side of

Fresh section of siderite and chert.

the Helen mine. They consist of thin alternating beds of siderite and chert. The former is mostly of a light yellowish colour, while the latter is of all shades of gray, from nearly white to nearly black. The alterations to which both rocks are subject everywhere in the district, may be seen at this locality, the siderite passing into limonite and hæmatite, and the chert into a fine-grained, soft freestone, or 'sugarstone.' Sayer lake discharges over a ridge of rock into Moon lake, which is 78 feet lower. Along the railway, from the outlet of Sayer lake to within 50 chains of Moon Lake station, the laminated rocks of the iron belt are well exposed in the cuttings. Here they have been

Breccia.

thoroughly broken up and brecciated. The contrast in colour of the two components, as shown on the recently exposed surfaces of the breccia, is soon increased by exposure to the weather, the siderite rapidly deepening in shade, while the chert, which is mostly light, shows out strongly as spots on the yellow and brown surfaces of the siderite.

Origin of the iron-ore.

'The great mass of hæmatite at the Helen mine appears to have resulted from the alteration of an enlarged portion of the siderite band. Although the change occurred long after the upturning of the strata of which the siderite band forms a part, it must have taken place at a somewhat remote period, or long before the pre-glacial changes which produced the existing physical features of the region. The present surface of the ore-mass shows glacial striæ running S. 2° E. Some detatched masses of the ore, derived from the bottom of the valley now filled by the lake, have been elevated by glacial action and deposited on the slope and top of the hill along the southern side of Boyer lake. As already stated the general attitude of the bedding in the vicinity of the Helen mine is vertical and the strike east and west, but immediately around the ore-mass some disturbance of the strata has taken place, and this may have been connected with the alteration of the large body of siderite.

'The boundaries of the ore-mass are not known with sufficient accuracy to enable us to make a correct estimate of the total quantity of ore which may be present at the Helen mine. But since any calculation may be better than none, the following can be given as a rough approximation, based on such facts as we have. The present exposed surface of ore measures, from north to south, about 500 feet, and the width is increased, by 250 feet in the drift, or say 750 feet in all. From east to west the exposure of ore measures also about 500 feet and this length is increased by 250 feet westward from the extremity of the point by the record of the bore-holes, so that there is a known length of 750 feet. The report of the Ontario Bureau of Mines, dated 1900, gives the horizontal dimensions of the exposed surface of the ore-body as 650 by 850 feet. This would show a superficial area of 552,500 square feet, while the dimensions above stated would make it 562,500. The ascertained depth of the ore on the general plane of the bedding is 300 feet, namely 50 feet from the surface of the deposit to the level of the lake, 100 feet for the depth of the lake, and 150 feet in the bore-hole below the bottom. The breadth is as likely to expand as to contract in going down and we may safely assume that the walls descend about perpendicularly for the limited depth of 300 feet. If the deposit be supposed to be terminated by vertical planes at right angles to the strike, at the above distance apart, instead of allowing for its extension to a considerable length to the east and west, as would naturally occur in the case of an interstratified bed such as this, the content of the mass which may be considered as proved to exist, (after allowing for the portion within the above measurements occupied by the water of the lake), would amount to about 26,000,000 tons of ore. Until the actual dimensions of the deposits are more accurately ascertained, it will be impossible to say what proportions the above measurements bear to the whole mass of ore actually present. Possible irregu-l rities in the walls of the section here given may somewhat diminish or increase the above estimated tonnage, but any variation on this account from the above figure will probably not be large.

Ontario--*Cont.*

Estimate of quantity of ore in the Helen mine.

'Such a great mass of ore, having the form of this deposit, may naturally be expected to be continued in considerable force beyond the above stated limits, both as to depth and extension on the strike. It would not be surprising if the mine should produce more than double the above quantity of ore before it becomes exhausted. Three hundred feet, the depth to which it has been tested, is much less than we might reasonably expect a deposit of this magnitude and geological character to have, considering the fact that the strata are standing vertically. The occurrence of a considerable body of siderite on Hæmatite mountain, about 1,500 feet east of the mine and another at the outlet of Boyer lake about 1,500 feet west of it, with the mine itself on the line of strike

Probable extent.

Ontario--*Cont.* between the two localities, indicates the extension of the hæmatite mass into the hill to the east and under the lake to the west.*

'*Iron ores in the Western Part of the District.*—At the McDougall and Iron Lake mines, lying westward of the north-west corner of the sheet, the ores are also red hæmatite, and they are in immediate association with a quartz-rock. At the former locality, no other rock is exposed, but the east and west strike of certain green schists and diorites not far off, would carry them past the mine at about three quarters of a mile to the north. The ore consists of a good quality of red hæmatite, of which three seams about 3, 6 and 5 feet in width, respectively, have been opened by test pits. The associated grayish quartz-rock is more or less distinctly ribboned or banded and it is disturbed in some parts of the ridge on which the mine is situated. The general strike is due west.

The McDougall mine.

'At the Iron Lake mine, seven miles to the west of the last, the quartz-rock holding the ore is also disturbed, but the general strike is S. 70° W. Various test pits had been sunk over a considerable area at this place which showed four bodies of good red hæmatite, ranging from 5 to 10 feet or more in thickness at the surface. The quartz-rock and hæmatite are associated with a silicious gray schist, and together they form what is locally called the iron belt, which has a breadth of from 10 to 20 chains and has been traced for about four miles to the west-south-west of the head of Iron lake. This belt is bounded on the north side by green schist and diorite and on the south by a wide belt of coarse conglonerate, of which the stones are mostly granite, thus ressembling the conglomerate at the mouth of Doré river.

The Iron Lake mine.

'*Gold.*—Since the date of my summary report for 1898, little progress has been made in testing the value of the gold-bearing quartz veins of the Michipicoten district discovered in 1897. The delay has been owing to a want of capital to make a thorough trial of some of the most promising discoveries. Among those who first interested themselves in this field were several enterprising men, but they failed to obtain or to lay out the money that would be required to properly test the commercial value of any of the numerous veins which were prospected to a certain extent. The Algoma Central Railway Company has now taken the matter up, with the determination to prove at least one vein. They are sinking a shaft, now sixty feet deep, at the Grace Mine location, situated not far from the foot of the Long Portage on the Michipicoten river, in a fissure vein three feet wide

Gold.

The Grace mine.

*Mr. E. V. Clergue informs me that the ore shipped from the Helen mine during the year 1900, contained an average of about 61 per cent. metallic iron and 0·08 phosphorus; also that at the point where the ore-body comes to the lake a bessemer ore is found running as low as .02 to .03 per cent in phosphorus and in sulphur from a trace to .05 per cent. The ore has a high grade in the market also on account of its low percentage of water.

of quartz showing free gold; and if the size and richness continue and should warrant the erection of machinery, it is proposed to build a stamp mill in order to give the ore a sufficient commercial test. Some work was reported to have been done during the summer of 1900 on the Diamond Jubilee gold mining location in the same vicinity. Ontario--*Cont*.

'In 1898, when my attention was more particularly directed to the gold of the district, I took samples from twenty different "prospects" I did not accept any specimens offered me, but at each locality, I broke my own specimens from the solid vein. I tried in all cases to get fair average specimens of the quartz, and for this purpose a number of samples were sometimes taken from different parts of the same vein, and these were afterward all crushed together for assay. Careful assays were made of all the above samples in the laboratory of the Geological Survey. Out of the above twenty, gold was found in seven, or a third of the whole, but only as traces in four cases. The other three showed the following results: Kamisho's mine, on a high hill behind Pointe Brûlé, one piece, weighing ten ounces, contained gold at the rate of 0.233 of an ounce to the ton of 2,000 pounds; Jubilee mine, specimens from vein at mouth of shaft, ten fragments, total weight, three pounds fourteen ounces—assays gave gold at the rate of 0.875 of an ounce to the ton of 2,000 pounds; Mackie's mine, south vein, Wawa lake, a single specimen weighing one pound five ounces, was found to contain gold at the rate of 0.175 of an ounce to the ton of 2,000 pounds.

Collection of samples.

Assays.

Amount of gold.

'It is to be remembered that although the samples tested were not 'selected,' the above assays are not to be held as determining the richness or otherwise of the whole vein in any case, but only of the particular specimen tried; still they are interesting as showing that a large proportion of the veins thus tested are, to some extent, auriferous, and that a few of them contain a promising amount of gold, as far as can be judged from a single assay.

Assays not conclusive.

'*Iron Pyrites and Copper Pyrites.*—The occurrence of a bed or vein of pyrite at the outlet of Boyer lake has been already described. Mr. Joseph Cozens, O.L.S., informed me that he had examined the deposit of this mineral on the south side of Sayer lake, and that, while it occurs there in considerable quantity, none of it that he saw was sufficiently pure to use in the manufacture of sulphuric acid. A seam of pyrite occurs on the hillside at the head of Little Stony portage, at the outlet of Mattagaming lake, but at the time of our visit, the small opening which had been made upon it was filled with débris. The pyrite here is like that at Boyer lake, and its occurrence may be an indication of the same stratigraphical horizon. Impure pyrite was said to have been found on a hill overlooking Lake Superior, a short distance south of the long sand beach at the mouth of Michipicoten river. In my summary report for 1898, reference was made to the

Iron pyrites.

Copper pyrites.

Ontario--*Cont.* existence of copper pyrites on one of Johnson's locations on Wawa lake, and also at a placed called 'Frechette's Mine,' about fourteen miles inland to the east of Gargantua harbour, from which we had obtained specimens, but could not find the vein from which they had been derived. Last year this vein was re-discovered, and I was informed it is sufficiently large and rich in copper to be worth a trial. A specimen of the gangue of the vein was among those which the assays above quoted showed to contain a trace of gold.

Surface geology.

'*Surface Geology.*—The evidences of glacial action are strongly marked in all parts of the Michipicoten district. The contours of the hills show that they have been powerfully glaciated, and the surfaces of the solid rocks are grooved and striated almost everywhere that they are exposed. Boulders are plentifully scattered over hill and valley, except on the limited areas where the finer materials of the drift have been washed out and deposited by water. Well marked moraines may be seen in many places. In some localities, immense quantities of boulders, mixed with a small amount of other drift materials, are heaped up into steep and irregular hills in the most tumultuous fashion, and the surface is apparently unchanged since the ancient glaciers left these heaps as we see them at the present day. The woods have been completely burnt off some of these moraines, and they may be studied in all their details. Some of them exhibit the peculiarities of what have been called kettle moraines; that is, they are interrupted with large and deep pits with steep sides, which are supposed to be due to great masses of ice around which the moranic material was piled, and on the melting of the ice the sides of the spaces it occupied were left as steep as the stability of the surrounding material would permit. Examples of such moraines on a large scale may be seen along the north-east side of the Canadian Pacific railway, between Wa-ba-tongwa-sheen lake and Magpie river, especially from Otter station for a few miles northward; again at the south end of Pokay lake on White river, and southward to the extremity of Wi-qué-amika lake, which lies a short distance west of Kapus-ka-sing river, below Chapleau. The general course of the glacial striæ in the interior is toward the south-west, but as we approach the western part of the district they tend more southward, being about south-south-west.

Kettle moraines.

Examples.

Course of glacial striæ.

'The heavy deposits of sand, gravel and shingle of the valley of the Michipicoten below the High falls are cut into many distinct terraces in various parts of their distribution. Above these falls, higher terraces were observed at a few places. Terraces were also seen in the valley of the Magpie, and around the lakes at the head of the Kapus-ka-sing river, south-west of Chapleau. The high terraces to the eastward of the mouth of Dog river are very distinctly seen from the lake, and they form an interesting feature in the landscape. They have been already described by different geologists. It is a fact, worthy of

Terraces.

note that, in some of the larger streams flowing into Lake Superior, the bed becomes paved with almost uniformly sized cobble-stones after descending to a certain level, while this feature is absent in other tributaries. The Black river near Schreiber, the Magpie and the Michipicoten are thus characterized.

Ontario--*Cont.*

Cobbles in river beds.

Physical Features, Soil and Timber.—In general physical character, the Michipicoten district may be said to be hilly and rocky, with the valleys pretty well filled with glacial and post-glacial deposits. The height-of-land between Lake Superior and Hudson Bay has an average altitude of about 1,000 feet, wherever it is crossed by the various canoe-routes, but between these depressions the ground rises from one hundred to three and perhaps four hundred feet higher. The washed soil of the modified drift deposits is of a poor quality. Better land is often found on the tops and sides of elevated hills and ridges where the surface has had time to decay and mellow, but it is almost always encumbered with boulders. When cleared of timber, much of the ground will no doubt prove suitable for pasturage in connection with dairy farming.

Physical features.

Soil.

'In probably the greater part of the district, the woods are still green, although large areas have unfortunately been burnt over near tote-roads, canoe-routes and along the line of the Canadian Pacific railway. The timber everywhere consists of a mixture of coniferous species with the northern deciduous kinds. Small quantities of white and red pine are met with here and there, as the limiting line of these trees passes a little to the north of the sheet, but both species may be considered scarce compared with most of the other trees of the district. South of the Michipicoten river, the rounded hills of a large area, are covered with groves of rather small hard maples; but in the rest of the district, white and black spruce, Banksian or jack pine, tamarac, white birch and aspen are the most abundant trees. They are mixed with a minor quantity of balsam fir, white cedar, rough-barked poplar or balm of Gilead, rowan or mountain ash and bird cherry, while soft maple, black ash and white elm occur locally. I have seen an occasional yellow birch in the lower Michipicoten valley and this tree becomes more common a little further south. Neither hemlock nor red oak range into this district, although they reach to a certain distance up the east shore of Lake Superior.'

Burnt woods.

Species of trees.

'Before closing this report I wish to acknowledge many courtesies received from the Messrs. Clergue, which facilitated our work during the season, as well as from Professor Willmott, Mr. Lawrence and others working under their instructions.

Acknowledgments.

In the spring, arrangements were made with Mr. W. A. Parks of Toronto University to undertake geological and surveying work in the

Work by Mr. W. A. Parks.

Ontario--*Cont.* Muskoka district of Ontario, with a view to obtaining the information necessary for the Muskoka map-sheet, No. 117 of the Ontario series. Mr. Parks was engaged in this work most of the summer, and has already covered a considerable part of the necessary ground. He reports as follows on the progress of the work :—

'After spending a week in the office of the Survey in preparing plans, procuring supplies and other work incidental to taking the field, I left on June 5th, accompanied by Mr. H. O. McKinnon, who acted as my assistant during the summer. The following day we proceeded by rail to Huntsville, where I made up the rest of my party. A day was spent here in getting supplies packed in proper form for transportation by canoe. As soon as possible I moved through Fairy lake and established the first camp at its eastern end. Huntsville was selected as the starting point because it affords ready access to a chain of lakes stretching to the eastern side of the sheet. The Muskoka map-sheet lies approximately between longitudes 78° 53′ and 80° 22′ and latitudes 44° 99′ and 45° 31′. Its western boundary is the shore-line of Georgian Bay. Like the other map-sheets of this part of Ontario, it embraces an area of forty-eight by seventy-two miles. It adjoins the similar Haliburton sheet to the east. Within this district lie the famous Muskoka lakes Muskoka, Joseph and Rosseau, as well as the Lake of Bays resorts, and numerous other places of summer recreation. The Northern division of the Grand Trunk railway crosses the sheet from south to north, entering it near Gravenhurst and leaving in the vicinity of Scotia Junction. About a third of the whole area lies to the east of the railway and it was this portion that I endeavoured to cover during the summer.

Starting point

Area of Muskoka map-sheet.

'On June 7th I was joined by Dr. A. E. Barlow who remained with the party about two weeks. It was deemed advisable to thus associate Dr. Barlow with myself that I might benefit from his experience in the adjoining Haliburton district.

Joined by Dr. Barlow.

'The chain of lakes stretching eastward from Huntsville consists of two small bodies of water, Fairy and Peninsula lakes, connected by a short canal, and a larger one known as the Lake of Bays, so called from the numerous indentations in its shore line. This latter lake was, in the early days, called Trading lake from the location of a Hudson's Bay Company's post on a narrow neck towards its eastern end. The part beyond this narrows is still known as Trading lake, at the extremity of which is the village of Dorset and this is as far as our map sheet extends.

Lakes east of Huntsville.

'The above mentioned canal affords uninterrupted navigation through Fairy and Peninsula lakes but a portage of sixty chains is necessary to reach the Lake of Bays. The latter lies 101 feet above Peninsula lake.

'The two branches of the Muskoka river, rise in Lake of Bays and Fairy lake respectively and form a confluence near Bracebridge. In the vicinity of Huntsville and on Fairy and Peninsula lakes, the rocks consist of more or less horizontal and fine grained gneisses, bent into gentle undulating folds. Petrographically they are highly siliceous and, in many places charged with pink garnets. They appear to be comparable with the sillimanite-garnet-gneiss described by Dr. Adams and referred to the Grenville series. Ontario--*Cont.* Muskoka river.

'On entering the Lake of Bays, rocks of this nature soon give place to a series of rusty gneisses, which in turn are replaced by the ordinary gray and pink gneisses of the Laurentian, and these constitute the characteristic country-rock of the whole region examined. The strike and dip is quite variable, while evidence of much folding and contortion is presented in many places. Basic and acid bands are found sometimes interlaminated, and in other cases marked off by sharp lines of contact. Veins and masses of injected pegmatite are common, as well as intrusions of various basic rocks. One very interesting example of the latter type is seen in Haystack island in the Lake of Bays. This islet is a cone-shaped mass of harzburgite (?) which, however, seems to be of earlier origin than the gneiss surrounding it. Rocks of Lake of Bays.

'Compass and micrometer observations were made to tie in islands not marked on existing plans, and in some cases to correct the shore-line. Surveys of a similar nature were conducted over most of the roads accessible from the water and canoe trips were made, where possible, into the neighbouring small lakes. This and the work of collecting specimens occupied the time until July 2nd when the camp was moved back past Huntsville to Lake Vernon, where the heavier part of the equipment was stored, preparatory to a trip up the East river which is really the upper water of the north branch of the Muskoka river. This expedition occupied us about two weeks. The river was ascended with considerable difficulty as far as the crossing of the old Sinclair road, from which point we portaged into Bella lake and remained in camp there while the shore-line was examined and surveys made of the roads to connect with those previously extended northwards from the lakes. A good deal of pine is driven down the East river every spring but it comes from the district to the north-east. The country is, however, well wooded with beech, maple, hemlock and birch, most of the pine having long since been removed. The soil is practically all sand. Farms are somewhat widely separated and I regret to say that here, as elsewhere in the region, abandoned homesteads are too much in evidence. Nature of surveys made. Expedition up East river. Timber.

'The East river is very crooked and its upper part a succession of shallow rapids.

Ontario--*Cont.*

'On July 17th I proceeded down the north branch of Muskoka river from Fairy lake. At the outlet is a fall of eight or ten feet with a dam and lock to permit small steamers to pass down to Port Sydney at the foot of Marion lake. This lake is a pretty body of water studded with islands of a rocky nature, which character is also presented by the shore, particularly on the western side.

Soil.

'Sandy soil predominates, but stratified clay underlies it in places; no boulder-clay was observed anywhere in the region. The rocks are more or less horizontal in position, but average N. 20°—40° W. in strike.

'At Port Sydney the river breaks out of Marion lake and falls about twelve feet. The canoe navigation is excellent, for although there is a heavy fall in all, the descent is confined to short distances, finding its expression in three or four high falls. This is brought about by two circumstances; first, the course of the river is against the dip, and second, the presence of large masses of pegmatite.

'A micrometer re-survey of the river was carried to Bracebridge, in the course of which halts were made for the purpose of traversing the adjacent roads for topographical and geological purposes. Bracebridge was reached on July 24th. The camp remained near this place for nearly a week while the roads to the north, south and east were surveyed. Some fair farm land is encountered in the first two directions and eastward also near Bracebridge, but towards the limits of the townships of Draper and Macaulay in that direction, particularly in concessions II and III of the latter township, the land is exceedingly rough, rocky and barren.

Existing surveys inaccurate.

'In order to ascertain the correctness of existing surveys of Muskoka lake, a traverse was run from the mouth of the river to Gravenhurst. The shore-line is not well defined on old maps and very great inaccuracies exist regarding the islands. My observations were supplemented by the experience of those residing in the region, by whom a wish was expressed for more correct plans. The gueissoid rocks on the east shore of the lake are somewhat different from those previously met with, but I must await microscopic examination before entering into details respecting these.

South-east part difficult of access.

'On August 1st we arrived at Gravenhurst and proceeded to examine the adjacent roads; two of these were surveyed to Bracebridge, and the old Muskoka road was traced south and tied to Kah-kah-she-bog-a-mog lake. Though a survey was not made farther south, as it lies beyond the sheet, I examined this road into Severn Bridge. The south-east part of the sheet, including the township of Longford and part of Oakley and Ryde, is difficult of access by water. To examine this I stored my heavier baggage and canoes at Gravenhurst and engaged a man and team. As I had been obliged to part with one of my men, the party still numbered five. Ontario--*Cont*

'We proceeded by a road running eastward from the old Muskoka road about three miles north of Gravenhurst. This was surveyed to its junction with the Black River road from Orillia, a few miles south of Houseys rapids. A stay of several days was made at this point and traverses made to the east and south, as also a complete plan of Kah-kah-she-bog-amog lake, which took several days. This lake is about six miles long, very crooked and full of islands, few of which had been located by previous surveys.

Kah-kah-she-bog-amog lake.

'From the junction of the above-mentioned road with the Black River road, the latter was surveyed to Victoria bridge. It follows the river on its northern bank and is rather rough in places. The farms however, are of a better appearance than in many other parts of the region. To the eastward, beyond the bridge, is a very desolate, burnt, rocky tract of country known as "the plains." The East River road crosses to the south side of the river at the bridge and has not been used beyond this point for some time. A few miles up it crosses the south branch at the fork, where the two upper streams unite to form the main river.

Black River road to Victoria bridge.

'While camped at Victoria bridge, the side line 5—6 Ryde, was surveyed to connect with roads previously examined to the north. We remained at the forks for a few days while a canoe expedition was made to Bear lake, and other small bodies of water up the south branch. This region is largely burnt; the fire having extended from the plains and swept the southern part of the township of Longford almost to its eastern boundary. Several varieties of gneiss were noted on this trip.

Trip to Bear lake.

'From the forks I directed Mr. McKinnon to continue the traverse of the road through the township of Longford, which he did, and reported green bush, chiefly hardwood and hemlock, all the way. In the meantime I went up the Black river by canoe, portaging into North and South Longford lakes on the way, and joined the party on the road following the town line of Longford and Oakley. On this trip the river was found to be very shallow, with a good current and sandy bottom; green hardwood timber and sandy soil prevailed all through the township. No farms are cleared in Longford, as the township is the property of the Longford Lumber Co., and is not open for settlement. From this point Mr. McKinnon continued the tra verse of the road back to Gravenhurst, while with one man, in the small bark canoe, I endeavored to ascend the river to Black lake After one day's work the stream was found to be so exceedingly shallow that I disposed of the canoe and proceeded by road through Oakley

Examine Black river.

Ontario--*Cont.* and Ridout to Dorset. There are no settlements, and the road has been used for lumbering purposes only, being now badly out of repair. Some splendid beech and maple were noted on this trip.

Join party at Gravenhurst.

'On arriving at Gravenhurst I found the party camped on Gull lake and we made a survey of that water as it appears very inaccurate on old maps. The party was now reduced to three. On August 24th, we left Gravenhurst and paddled up the lake to Bracebridge, camping that night at the South falls on the south branch of the Muskoka river. The micrometer survey of this stream was tied to the railway bridge at Bracebridge and continued to the source of the river at Baysville, at the foot of the south arm of the Lake of Bays. This stream proved very useful, as it enabled us to connect the road surveys to the north with those to the south. It is more crooked and there are more portages than on the north branch. Except for several basic and pegmatitic bands the rocks are gneiss as elsewere. Some very good farms are seen at various points in this region.

'On September 8th, we reached Huntsville and here I broke camp shipping my canoes to Gravenhurst to be ready for next season's work.

'There still remained a portion of the territory on the northern limit of the sheet. To reach this I went by rail to Emsdale and remained with Mr. McKinnon at the hotel there while we examined the roads accessible from that point, this concluding the field-work for the season.

Economic minerals.

'With regard to the economic minerals of the region examined, there does not seem to be a promising outlook, despite the fact that numerous prospects have been opened. Nearly all of these are on veins of pegmatite containing specks of both copper- and iron-pyrites. Some others are in the gneiss itself on mineralized bands. A few stringers of quartz were noticed, but both the nature of the quartz and its manner of occurrence would not indicate an auriferous deposit. Some of the pegmatites contain leaves of both white and black mica that may prove valuable, as I have encountered similar deposits of value just outside the limits of the sheet. A small deposit of crystalline limestone was seen east of the railway in the township of McMurrich.'

Petrographical work by Drs. Barlow and Adams.

In the first part of the year, or up to the beginning of May, Dr. A. E. Barlow was absent in Montreal engaged in conjunction with Dr. F. D. Adams, in detailed petrographical studies of the more important rock types represented in the area of the Haliburton map-sheet. Advantage was thus taken of the unusual facilities offered for this work by the new Petrographical Laboratory in the Chemistry and Mining Building of McGill University. It was also believed to be important that the joint report now being written by these gentlemen should have the advantage of the closest co-operation before the final results were given to the public. Ontario--*Cont.*

Duties of petrographer assumed.

This work being completed Dr. Barlow returned to Ottawa on May 1st and assumed the duties of petrographer, which position had remained vacant since the resignation of Mr. W. F. Ferrier in 1897. Some weeks were spent in the office on work incidental to this position, as well as in the compilation of the results obtained by the special examinations above referred to. In regard to the field work undertaken, Dr. Barlow reports as follows :—

Field-work by Dr. Barlow and Mr. W. A. Parks.

'I left Ottawa on June 5th for the Muskoka district, going by way of Toronto, for the purpose of examining the various plans of surveys made in this area by the Crown Lands Department of Ontario. Two days were occupied in collecting this and other information relative to the district in question, when I left for Huntsville to join Mr. W. A. Parks of Toronto University. Mr. Parks had been instructed to undertake the topographical and geological surveys necessary for the preparation of a map and report of the area covered by the Muskoka map-sheet (No. 117 Ontario series). Two weeks were spent in company with Mr. Parks, and the work then accomplished consisted of various topographical and geological surveys in the region adjoining Fairy and Peninsula lakes and Lake of Bays between Huntsville and Dorset, connection being made at the latter point with the work already completed on the Haliburton map-sheet.

Haliburton district.

'Returning to Ottawa on June 24th, some days were occupied in examining and reporting on specimens of rocks from various localities. On July 5 I again left Ottawa for Barrys Bay, to make a more detailed examination and study of certain localities in the Haliburton district. I was accompanied on this trip by Prof. H. P. Cushing of Adelbert College, Cleveland, Ohio, who is at present engaged for the New York State government in a geological survey of a portion of the Adirondack mountains, and who wished to visit this district for purposes of comparison and study. Numerous interesting geological exposures were visited, for the purpose especially of noting the various phases of alteration represented by the rocks that have been referred to the Grenville and Hastings series and the nature of their junction with the granites and gneisses usually classified as Laurentian.

Corundum.

'A visit was paid to the corundum mines situated on what has been known as the Robillard Property but which is now called the Craig mine, so named in honour of the energetic vice-president and managing director of the Canada Corundum Company, Mr. B. A. C. Craig of Toronto. This company, with a head office in Toronto, and branch offices at Bridgeport, Conn., and Combermere, Ont. is now energetically carrying on the mining and subsequent treatment of this abrasive

Ontario--*Cont.* on lots 3 and 4 in concession XVII of Raglan. A mill operated both by steam and water power has been built in a very suitable location and fitted up with the latest machinery for the crushing and separating of this mineral. During the whole of the past summer the equipping and necessary experimenting has been going on steadily and it is confidently believed that large and regular shipments of the very purest material will soon be made. The mining already done has shown conclusively that the deposit is very rich and extensive, so that there is no likelihood of the supply giving out.

Mill in operation.

ron.

'Visits were also made to some of the localities where openings had been made for iron, especially in the vicinity of Bancroft and along the line of the Irondale, Bancroft and Ottawa railway in the townships of Snowdon and Glamorgan. It would be inadvisable at this time to go into details regarding these various mines and the mode of occurrence of the iron ore, as it is better that this should be postponed until a fuller examination can be undertaken of the various specimens collected. Two openings for iron have lately been made in the vicinity of Bancroft on lots belonging to Mr. J. Cleak. One of these, situated a short distance southeast of this village, about lot 30, concession XIII. of Dungannon, shows a very pure magnetite occurring as a differentiation product of the nepheline syenite. The deposit is, as might be expected, very irregular, and it is doubtful whether any very large amount of the mineral could be secured. Large, though somewhat imperfect octahedrons occur as cleavable masses of magnetite frequently containing comparatively large individuals of apatite. The other opening is about half a mile southwest of the village, in the township of Faraday. Too little development work has, however, been done at this locality to make any definite statement as to its character or extent.

Development work.

Mode of occurrence.

Howland mine.

'Along the line of the Irondale Bancroft and Ottawa railway, perhaps the greatest amount of work has been done on what is known as the Howland mine, belonging to Mr. H. S. Howland, of Toronto, and leased to the Toronto Iron Company. The ore is a magnetite with a considerable admixture of pyrite, which latter mineral is probably so abundant as to render the ore practically useless. About 1,500 tons of ore were shipped from this mine in 1881 and 1882, chiefly to the Cambria Iron Company. Last year the mine was pumped out with the idea of carrying on further work, but so far nothing further has been done.

Imperial mine.

'A considerable amount of ore has likewise been taken from the property known as the Imperial mine, owned by Mr. S. B. Howland, of Toronto. This is on lot 33, concession V, of Snowdon, about three-quarters of a mile east of Irondale station and immediately adjoining the right of way of the Irondale, Bancroft and Ottawa railway. Most

Ontario--*Cont.*

of the mine, so-called, consisted of a basic rock, portions of which occasionally become so richly impregnated as to constitute what might be considered a low grade iron ore. In the vicinity of Furnace Falls a large expenditure has been made but evidently failed to secure such adequate returns as would justify continued operations. These properties were at first known as the Snowdon mine, but are now called the Victoria mine. There are undoubtedly considerable areas of richly impregnated basic rocks, but the large percentage of sulphur usually present seems to be the main drawback. Another very interesting locality is what has been called the Pine Lake mine or location on lot 35 in concession IV. of Glamorgan. The iron ore at this place likewise occurs in association with a basic rock which is a differentiation product of the nepheline-syenite of which there is a considerable area in the vicinity. It is said to contain about nine per cent. of titanium and is thus practically valueless.

Other mines.

Joint work with Mr. James White.

'From August 5th to August 20th, I was engaged in co-operation with Mr. James White in a transit and chain survey of the Canada Atlantic railway from Rose Point to Scotia Junction, and also of the Northern Division of the Grand Trunk railway from Scotia Junction to Atherley Junction, where connection was made with similar surveys performed in previous years. This survey was undertaken for the purpose of fixing with greater accuracy the position of the Muskoka map-sheet.

'Returning to Ottawa on August 25th, the remainder of the year has been taken up in special rock determinations.'

ONTARIO.

(*With adjacent parts of Quebec.*)

Work by Dr. R. W. Ells.

The winter of 1899-1900 was spent by Dr. R. W. Ells in compiling map-sheet No. 120, and in writing a report on the work done in connection with map-sheet No. 119. The field-work of the past season covered various localities in Quebec and Ontario from about eighty miles east of Ottawa to a similar distance west of the city. Dr. Ells' report is as follows :—

'Towards the end of May examinations were made of certain points of geological structure in the townships of Russell and Osgoode, in connection with the delimitation of the Rigaud-Russell fault and anticline. The surveys of the township of Russell were also completed.

South of the Ottawa.

'Early in June work was continued in the area south of the Ottawa river, in mapping out the faulted area, in order to determine the boundaries of several outliers of the Utica shale which had been reported as occurring in that district. The presence of several low but well defined anticlines in the underlying Trenton limestone was

Ontario and Quebec—*Cont.*

also ascertained. These anticlines separate the shallow basins of the Utica, and the latter were outlined as well as the drift-covered nature of the area permitted.

'Farther east, in the vicinity of Rigaud mountain, surveys were made to the south and west, to complete those made by the late Mr. Giroux, in 1895. In this connection, a secondary spur of granite which lies to the southeast of the main mass of Rigaud mountain, was outlined and found to be about three and a half miles in length with a breadth in the centre of the mass of about half a mile. It is separated from the main mountain by a depression which is about half a mile in width at the nearest point and extends roughly parallel to the southeast face of the mountain itself. This second ridge is crossed by the road east from Ste. Marthe village, and large areas of sand cover the surface of the country to the north and east in the direction of the Ottawa, while to the south the country is a great level expanse of clay, reaching to the St. Lawrence.

Granites south of Rigaud mountain.

'This area south of Rigaud mountain rarely shows rock exposures, but is supposed to be underlain by the Calciferous formation, since the limestones of this formation are seen on the Rivière à la Graisse at Rigaud village and on the same stream four miles west of that place where the strata dip S. 10° to 18° W. $<$5° to 7°.

Rocks of Rigaud mountain.

'The material of Rigaud mountain is largely a reddish quartz-porphry. On the eastern end, however, there is a large mass of hornblende-syenite of a reddish or purplish gray colour, in which a quarry has been opened, and from which large blocks have been taken for monumental work.

Work north of the Ottawa.

'In July, several weeks were given to the completion of the surveys in the area north of the Ottawa and west of the Gatineau river. The work in this part of the province of Quebec is now practically completed and the map is being compiled.

Survey of Ottawa river.

'Along the Ottawa river, west of Ottawa an examination was made of the south shore, in order to define the limits and possible thickness of the Calciferous, Chazy and Trenton in this direction. It was found that no measurement could be made of the Trenton, as only the lowest beds of the formation are seen in this area. The thickness of the Chazy shales, to the base of the Chazy limestones, is a little over 100 feet, on the south side of the river, but the base of the formation is not there seen.

Surveys in Raglan and Lyndoch.

'Later in the season, surveys were made in the townships of Raglan and Lyndoch in the western part of map-sheet No. 119, which is contiguous on the west to that now being prepared for publication by Drs. Barlow and Adams.

'In the latter part of July and in August, new work was taken up on what is known as the Brockville map-sheet, No. 111. The portion of this sheet in Canada is limited, embracing not more than 400 square miles, bounded on the south by the St. Lawrence river. The eastern limit of the map-sheet on this river is a short distance below the town of Prescott, where it joins map-sheet No. 120, while the western limit is near the east line of the township of Lansdowne.

Ontario and Quebec—*Cont.*

Work on the Brockville sheet.

'In September, a few days were spent in the vicinity of L'Orignal and Hawkesbury with Dr. Ami, to determine more precisely the horizons of certain limestones of Chazy, Black River and Trenton age. The last days of field work were devoted to completing details relative to the map of Ottawa and vicinity, now nearly ready for the engraver.

Utica shale basins.

'In regard to the work in the area along the south side of the Ottawa river, the principal geological features have already been stated in previous Summary Reports. The outlining of the basins of the Utica shale formation is a somewhat important feature, however, in connection with work now being carried on by boring to ascertain the presence or otherwise, of natural gas or oil in this district.

'The presence of these rocks was first indicated by Mr. James Richardson in 1853, but no attempt was made to determine their precise limits at that date. This is difficult, owing to the great development of clays and overlying sands throughout a large part of the area. From careful observation, however, it is established that at least two well defined areas of the Utica extend in a northwest direction from the great area of these rocks in the southern part of the townships of Russell, Plantagenet and Clarence.

Distribution of formations south and east of Ottawa.

'Of these the most westerly extends in a narrow belt from the vicinity of the village of Caron into the township of Cumberland which continues as far west as the fourth lot of the third range of that township and may extend farther, as rock outcrops in this direction are here concealed by a heavy mantle of clay. The upper portion of the Trenton formation is seen on the north and south sides of a depression in which the Utica shales lie. The exposed breadth of the Utica at this place is about sixty chains. Continuous outcrops of the shales are rarely seen for any distance, though the character of the soil sometimes indicates the nature of the underlying rocks, and it would seem from the presence of a well-defined area of flat country, heavily clay covered, that the Utica of this narrow basin is fairly continuous.

'East of the village of Caron, these rocks are seen in the depression west of the Nation river along what is known as the brook; and the northern limit of the main area passes near the village of Pendleton. Thence it apparently continues along the north side of the Nation

Ontario and Quebec—*Cont.*

river where it is reached by a bore hole 180 feet deep through clay, on lo six, range eleven, of South Plantagenet.

'The northern line of the Utica thence apparently bends to the north and north-west, and follows a depression which is seen a short distance east of the village of Curran, whence the Utica shales should extend in a narrow belt past Plantagenet springs. The shales themselves are seen as far north in the course of this depression as the line between concessions two and three of Plantagenet north, on lots thirteen and fourteen, where they terminate against the Trenton limestone.

South Nation river.

'Along the South Nation river, the Black River limestone is well seen at the little fall, about one mile and a half from the junction of this stream with the Ottawa. The strata here dip to the south-west, but bend abruptly to the south showing a somewhat sharp anticline. These rocks are overlain up stream by the Trenton limestones, which are well exposed at several points, notably at and above the village of Plantagenet where they have a southerly dip at angles of five to ten degrees, and where they undoubtedly pass beneath the Utica just described. It would appear that the line between the Trenton and the Utica crosses the Nation river and reaches the township of Alfred near the line between concessions nine and ten, where the black shales have been struck by a boring through the clay of 186 feet in depth, a few yards east of the western line of the township of Alfred. A heavy discharge of gas and saline water is said to have taken place when the Utica shale was reached. Saline water is still flowing from the hole, and this is valued in the neighbourhood for its medicinal properties.

Borings for gas and water.

Utica shale areas.

'The Utica shales thence cross the southern part of Alfred township and extend beneath the Caledonia flats into the township of Caledonia where they are well seen at a number of points resting on the Trenton to the south-west of Vankleek Hill.

The two areas of the Utica shale just described are separated by well defined ridges of Trenton limestone. At several points, opposing dips to the north and south at low angles are visible, indicating an anticlinal structure which is presumably continuous throughout, though lack of exposures prevents the tracing of the anticlines to any very great distance. The main area of the Utica extends southward through the southern part of the townships of Cumberland and Russell till it meets the line of the great fault along the Castor river, which is well seen in the village of Russell and for a mile east of that place.

'Throughout the area just described minerals of economic value are rare. The limestones afford good quarries at a number of points, and these have been opened for building-stone. The largest and presumably the most important of these is near Rockland, known as the Stewart quarry. It is situated on the north face of a steep escarpment of limestone, the lower part of which consists of Chazy and Black River strata while the upper portion of the quarry is in the Trenton limestone. Lime of an excellent quality is also burnt here. Ontario and Quebec—*Cont.*

'Among other quarries in the Trenton limestone may be mentioned one on lot eighteen, concession seven, of Clarence, owned by Mr. John Maclean, and situated in the upper part of the formation, the Utica being exposed on the adjacent lot. There is also a quarry near the top of the Trenton owned by Mr. Percival Whinney and situated on lot nine, concession six, of Plantagenet north. This is but a short distance from the line of the Canadian Pacific railway. Another quarry, but in the Black River limestone, is located near the church at Clarence Creek, where the beds dip north-east at angles of from ten to twenty degrees. Limestone quarries.

'A number of bore-holes have been made throughout the area between the Ottawa and the South Nation rivers within the last half-dozen years. These have in most cases been sunk only through the clay in which, however, are occasional thin layers of gravel and sand. The thickness of the clay covering is in many places remarkable, many of the holes having a depth of from 100 to 150 feet, while in one case a depth of clay of 210 feet was passed through before the underlying rock was struck. Borings in valley of Nation river

'While most of these holes were sunk in the search for water, in a number of them flows of gas were encountered. The most noted of these holes is that already referred to as on the bank of the Nation river. This was sunk by Mr. Gordon, and the Utica shale was penetrated to a depth of only three inches. The rush of gas and water is reported to have been very heavy. The gas subsequently ignited and the farm buildings were removed to prevent their destruction. The pipe was taken from the hole and the water (saline) now flows in a good-sized stream from a square opening about four feet across, the surface of the water being broken by a constant discharge of gas bubbles which can be ignited as they emerge. Similar outflows of gas and water were met with at the boring in Alfred, which is two miles and a quarter distant in a direction nearly east. Gas found.

'The presence of several important faults in the area south of the Ottawa river has already been pointed out. In addition to those noted in the report of last year, there is an apparent dislocation of the strata on the Montreal road about a mile and a half west of the crossing of Greens' creek, which throws the Utica shales to the north. Nearer Ottawa city, it is clear that the fault noted on the shore of the river at Governor's Bay is continuous with that seen near the entrance to Beech- Fault near Ottawa.

Ontario and Quebec—*Cont.*

wood cemetery, where the Chazy is brought against the Utica shales for a short distance. Minor dislocations are seen in the Utica itself, as in the drainage excavation on the old Rifle Range near the crossing of Chapel street, and also in the creek a short distance south of Billings Bridge. These minor breaks are numerous throughout the area, and prevent the exact determination of the thickness of the Trenton and Utica formations.

Iron-pyrites in Masham.

'In the area west of the Gatineau, several new mining locations were visited. Among these may be mentioned a reported large deposit of iron pyrites in Masham, lot fourteen, range five, owned by Mr. R. Kennedy. But little development work had been done when I was there, but there appears to be a rather large development of pyrite in the so-called rusty gneiss that is so frequent a feature in the rocks of the Grenville series. The pyrite does not, in so far as yet proved, seem to be sufficiently concentrated for profitable mining. The locality is about four miles from the line of the Gatineau Valley railway at North Wakefield.

Mica mines.

'The mica mines along the Gatineau are being worked with more or less regularity, but the output varies greatly from time to time, owing to the pockety character of many of the deposits. Among new locations noted during the past season were several in the township of Cawood and in Alleyn near by. Of these the most important was on lot ten, range one, Alleyn, owned by Mr. Ellard. The country-rocks at the mine are grayish gneiss and some limestone, cut by a dyke of green pyroxene. The mica vein appears to have a thickness of two to three feet, and at the time of my visit, in July, had reached a depth in the excavation of forty feet. The crystals of mica were of good size and colour and nearly 200 tons of mica were in the sheds. From twelve to fourteen men were employed. The mine is about seven miles from Kazabazua station on the Gatineau Valley railway.

'At the other mines near Dunford lake, but little work was being done. A dyke of pyroxene was noted here also and some large mica crystals had been obtained, but in the lower part of workings the crystals were much crushed.

Granitic rocks in Brockville district.

'In the area comprised in the Brockville sheet, some important geological features were noted. The eastern portion of the district is occupied by rocks of Calciferous and Potsdam age, while the western part of the area shows great masses of reddish granite, gneiss and crystalline limestone, with large outcrops of glassy white quartzite.

'The granitic rocks form most of the islands in the River St. Lawrence, known as the Thousand Islands. The granites are clearly of more recent date than the limestones and quartzites, with which they are associated. They present the same character as most of the rocks seen along the north side of the Ottawa, except that the granites are more extensively developed in the St. Lawrence district. The quartzite is like that seen in the Ottawa river section, opposite Montebello, where this rock is clearly an interstratified member of a series between the grayish and reddish gneiss and the crystalline limestone with rusty gneiss inclusions. They are also identical in character with parts of the Hastings series to the west, much of the limestone seen about Charleston lake and in the township of Lansdowne having the same banded or striped aspect with that of the Arnprior and Renfrew marbles.

Ontario and Quebec—*Cont.*

Crystalline limestone and quartzite.

'Overlying these crystalline rocks are the Potsdam sandstones. The basal beds of this formation frequently consist of conglomerates, in which the greater part of the pebbles are derived from the quartzites just described. The conglomerates pass upward into the regular sandstone, which, in turn, graduates upward into the limestone of the Calciferous formation.

Potsdam sandstones.

'While fossils are seen at several points in the limestones of the Calciferous formation, none were found in the sandstones of the Potsdam proper, except those known as Scolithus markings. The fossils referred to in the earlier reports as being obtained from beds of Potsdam age, were found in what are known as the transition beds between the sandstone and the limestone. They are here frequently silicified and can sometimes be readily extracted, the best being obtained from weathered surfaces of a siliceous limestone which represents the base of the Calciferous formation.

Fossils.

'This area north of the St. Lawrence was one of the first explored by the officers of the Geological Survey. In 1851, Mr. A. Murray spent a considerable portion of the summer in the examination of the district between the Rideau and the St. Lawrence, the results of which are found in the report of the Geological Survey for 1851-52. In this report the characters of the several formations of granites, limestones and Silurian rocks are well given.

Former work by Alex. Murray.

'The outline of the crystalline area north of the St. Lawrence above Brockville is very irregular. The rocks consist largely of granites, mostly red in colour, generally massive, but occasionally foliated. In places, small areas of grayish and reddish gneiss occur, and there are frequently large exposures of quartzite, more especially along that part of the river in the southern portion of the township of Escott and of Lansdowne adjacent on the west. The quartzite is also seen on several of the islands in the river, notably above the village of Rockport, where it is sometimes associated with grayish gneiss, but more frequently involved with masses of reddish granite.

Rocks of crystalline area.

Ontario and Quebec—*Cont.*

'The beautiful sheet of water known as Charleston lake is situated in the northern part of the townships of Escott and Lansdowne, and is a great place of summer resort. It is crossed by the western line of the Brockville map-sheet, and is very irregular in outline with long arm-like bays and many islands. On the east side, a bold hill known as Blue mountain, rises to an elevation of 360 feet above the lake shore. Its rocks are of various kinds. Red granite predominates, but there are several well defined bands of crystalline limestone and associated rusty gneiss. Areas of the glassy quartzite are seen on several of the islands. These are frequently overlain by the basal or conglomerate beds of the Potsdam sandstone formation, the latter sometimes being inclined at quite a high angle. Masses of granite cut the gneiss, limestone and quartzite. The limestone is frequently serpentinous, with small threads of chrysotile. The rock is often much broken up and the disturbing action of the granites is very apparent.

Charleston lake.

Rocks chiefly granite.

'A long tongue of the red granite extends eastward from Charleston lake through the township of Yonge and forms a ridge to the north of McIntosh's mill and Graham lake, occupying parts of concessions five and six. In the eastern part of this ridge the granite is associated with considerable masses of quartzite, the latter being broken up and penetrated in all directions by the granite. The quartzite furnishes pebbles to the lowest member of the Potsdam, which surrounds the old ridge on all sides. This granite is mostly of the massive variety, though sometimes a foliated structure is visible, and occasionally masses of the grayish gneiss appear to be caught in the granite mass.

Palæozoic areas well-defined.

'Of the two Palæozoic formations represented in this area, viz., the Potsdam sandstone and the Calciferous limestone, the boundaries have been well defined. In some places this has been somewhat difficult, owing to the varying thickness of the transition beds. The line between the two formations has a somewhat sinuous character, being affected by the inequalities of the surface, since throughout most of the area the strata are in a nearly horizontal position. A small outcrop of the granite and gneiss, surrounded by the Calciferous, is seen on the road between lots six and seven, range seven of Elizabethtown. This is the most easterly outcrop of these rocks yet recognized.

'The Potsdam often lies in small detached basins upon the crystalline rocks, but in the area west of Brockville it sometimes takes the form of long tongue-like troughs which occupy depressions in the underlying granite and quartzite. One of the most marked of these extends south-west from Escott into the township of Lansdowne, with a length of about ten miles and a breadth ranging from a mile to only twenty chains. Near the village of Lansdowne this outcrop is concealed by overlying clay and sands.

'The line between the Potsdam and Calciferous on the St. Lawrence, is seen near the village of Maitland, which is about five miles east of Brockville. The contact of the Potsdam with the crystalline rocks, quartzite and granite, is in the city of Brockville itself, the former showing along the shore in its eastern part, while the quartzite is seen in the ridge on which the town is built. The islands in the vicinity are also of crystalline rocks apparently. Above this place the granites extend for about four miles along the shore, and occupy the islands in the river for that distance. Then the Potsdam sandstone comes in along the shore and forms an overlying mass which extends upwards for nearly six miles, and thence westward along the line between the first concession and the Shore Range in the direction of Mallorytown for two miles further.

Ontario and Quebec—*Cont.*

Contact of Potsdam with crystalline rocks.

'The Calciferous formation, which is essentially a dolomitic limestone throughout, except in its upper part, which becomes somewhat shaly, occupies the greater part of the townships of Augusta, Elizabethtown, the north-west part of Yonge, almost the whole of Kitley, and a portion of Bastard. The surface in this district frequently shows large areas of bare rock and many of the roads are in consequence hard and rough. No estimate was made of the thickness of the formations, but it is the western extension of the great Calciferous area which appears in the townships of Gloucester and Nepean, south of the Ottawa.

Thickness of Calciferous not estimated.

'Glacial striæ were observed at several points. The direction varied only ten degrees throughout the district, ranging from S. 15° to 25° W. (ast.) No marine shells were noted in the clays or gravels of this area, though these are continued westward without apparent break from the localities north of Prescott, where these fossils are so abundant.

Glacial striæ.

'Economic minerals are rarely found in workable quantity in the area comprised in the Brockville sheet. The iron-pyrites mine on lot nineteen of the second range of Elzabethtown, was the most important in the district during the time of its working. Unfortunately the deposit apparently became exhausted some years ago, and the extensive plant for the manufacture of acids and superphosphate has been destroyed. The process of manufacture of these substances and also the mineral contents of the vein have been fully described in the Report of the Geological Survey for 1874-75, by Dr. Harrington. Attention was directed to these deposits in 1862 by Mr. T. Macfarlane with reference to the presence of cobalt in the pyrites. Recently, new deposits have been found on the adjoining lot, owned by Mr. Nicholas Sloan, and several shallow pits have been sunk on the mineral to test the quantity. The new location is, apparently, on the strike of that formerly worked, and the character of the mineral is similar. The

Economic minerals.

Cobalt and pyrites.

Ontario and Quebec—*Cont.*

pyrites appear to form contact deposits near the junction of the granite and the white quartzite.

'No deposits of magnetic iron of economic importance have been found in this area. Mr. Murray, in his report for 1852, mentions the presence of small strings of the ore on the seventh lot of the second concession of Escott, mixed with small specks of copper-pyrites, the whole occupying a length of about fifty yards with a maximum breadth of six to seven inches.

Red hæmatite

'Red hæmatite occurs at a number of places in the lowest beds of the Potsdam formation, and is readily recognized by the colour imparted to the soil. The most important deposit of this ore seen was near the village of Delta, in the township of Bastard, on lot twenty-three, concession ten. A small excavation was made on the deposit, which is in the basal beds of the Potsdam sandstone, resting upon crystalline limestones and gneiss, which show in the immediate vicinity. The ores of this locality were mined nearly one hundred years ago, and smelted in a blast furnace at what was then known as Furnace Falls, now Lyndhurst, but the quantity obtainable was not sufficient to supply the demands of the smelter, and the works have long been closed.

Bog-iron ore.

'A bed of bog-iron ore was also noted by Mr. Murray on the twenty-first lot of the seventh concession of Bastard, which had a reported thickness of two feet in one place, but the extent of the deposit was not ascertained.

Galena.

'Galena has been mined in the township of Lansdowne. The ore occurs in connection with the crystalline limestones of the district. These form somewhat extensive bands, extending across the township to Charleston lake. They are cut by masses of red granite and also by dykes of white pegmatite. The galena veins are small and are in proximity to the dykes. The principal deposits are on lots four and six, concession eight of this township, but no mining has been attempted for some years.

Barium sulphate.

Barium sulphate is found on the twenty-fourth lot of the tenth concession of Bastard. It is of good quality and the amount appears to be considerable, as the deposit extends for at least a fourth of a mile, with a thickness of from one to two feet. This was mined to some extent about fifty years ago. The small value of the mineral is against its profitable exploitation.

Shell marl.

'A deposit of shell marl was found some years ago, in the vicinity of Farmersville, now the village of Athens, on the thirteenth lot of the eighth concession of Yonge. It is said to have a depth of fifteen feet in places, and to extend over twenty to twenty-five acres. It may be of value in connection with the manufacture of cement, but the deposit has apparently never been developed. Ontario and Quebec—*Cont.*

Quartzite.

'Among other materials may be mentioned the quartzites along the St. Lawrence and on Charleson lake, some of which appear to be sufficiently free from iron to render them suitable for glass making. Some of the granite masses also should furnish an excellent quality of building stone, since the rock is of good colour and in large massive ledges. Quarries were opened in certain beds of the Calciferous, north of the St. Lawrence, many years ago, but these have not been worked for a long time. The quartzite forms an excellent material for road metal, breaking readily and in such shape as to pack solidly on the street, while the supply is unlimited.

'Field work began on May 27th, and extended to October 1st.

QUEBEC.

Offer of report by Dr. Adams.

Dr. F. D. Adams, who has for some years been collecting and studying the records and drillings obtained from numerous bore-holes sunk in and near the city of Montreal, lately offered to put his results into the form of a report for publication by the Survey, if a geological map showing the surface distribution of the rocks in the vicinity could be provided. The Island of Montreal came under the observation of the officers of the Geological Survey many years ago, but no attempt was made to map the several formations with any minute accuracy. Arrangements were therefore made with Mr. O. E. LeRoy, under which he spent a considerable time, last summer, in a careful survey of all the outcrops within a radius of about ten miles of Montreal. This work it is hoped to continue until it may be possible to complete a good geological map of Montreal and its vicinity. This will have important bearings on the water supply from bore holes, as well as open many other practical questions. Mr. Le Roy describes the work done by him as below :—

Work by Mr. O. E. LeRoy.

Object of work.

'The object of my work, as stated in your instructions, was to revise the geology of that part of the Island of Montreal and Ile Jesu included within a ten mile radius of Mount Royal. I commenced work on August 13th, and continued it without interruption until September 22nd.

'Nearly all the outcrops of rock were examined, specimens taken, and when deemed necessary, collections of fossil were made, which were sent to the Survey for identification. The strata everywhere are almost flat-lying, the dip, with the exception of a few small areas in the vicinity of the mountain, never exceeding 5°. The whole country is so uniformly covered with drift deposits that the boundaries of the different formations must, for the most part, be approximate.

Quebec—*Cont.*

'The formations examined and outlined were as follows, in ascending series: Chazy, Trenton, Utica and St. Helens Island breccia.

Formations outlined.

'The Chazy is well exposed at Cartierville in a series of old and new quarries, and again at St. Laurent near the railway track. From these it continues eastward to Outremont, a small and very fossiliferous outcrop occurring at the corner of Wiseman and VanHorne avenues. The formation then runs north to Mile End (Parc St. Denis) where it has been quarried for many years. Its northward extension terminates on lot 481 Côte St. Michel Sud, from which point it follows a curving line to the north-west, being exposed for some distance along the railway track at Sault au Recollet. Crossing the Rivière des Prairies, it is well developed and extensively quarried just to the north of St. Martin Junction, where it occurs in the form of a rather prominent ridge.

Mount Royal surrounded by Trenton.

'The Trenton formation was first found in a small outcrop on lots 45 and 47 Côte Ste Geneviève. The rock does not re-appear until the vicinity of Mount Royal is reached, which it wholly surrounds. Northward from the mountain, it is well exposed at many points on that part of the island sloping towards the St. Lawrence river, the strata dipping at 4° to the S.E. It curves around the Chazy formation in Côte St. Michel, and is well exposed on both sides of Rivière des Prairies, below Ile Visitation extending as far north on the western shore as St. Vincent de Paul.

Sir Wm. Logan's description verified.

'The general structure of these two formations was found to agree with the description given by Sir W. Logan in the Geology of Canada (1863, p. 141), which is practically as follows: There is first a flat anticlinal arch, the axis of which runs from the north end of Mount Royal to a point a little westward of Ste. Thérèse. This anticline is traversed nearly at right angles by two others, one in each of the islands. This gives to the upper half of the Island of Montreal the form of a shallow trough.

Distribution of Utica shale

'The Utica floors the St. Lawrence river at Lachine between the breakwater and the shore, and below the Lachine Hydraulic Co.'s power house at Verdun, where it evidently extends inland for some little distance. It is also developed at Point St. Charles, below Victoria bridge, on the upper end of St. Helens island and off the wharf at Longue Pointe. Below the city the formation does not extend any distance inland, as Trenton rock was noted at Maisonneuve one-third of a mile from the river. Nor does it seem to underlie any great part of the city, for wherever borings have been made, limestone has been struck immediately below the hardpan. The Utica also appears on part of the east and north-east flanks of the mountain overlying the

Trenton limestone, and evidently in contact with the igneous rock. It is altered to a hornstone. Quebec—*Cont.*

'The St. Helens Island breccia, composed of a great variety of rock fragments cemented by a dolomitic paste, underlies the greater part of the island and all of Ile Ronde.* Its contact with the Utica is wholly concealed by drift. Considerable attention was also given to the igneous rocks of the area. The igneous mass of Mount Royal occupies an area of about one and a half square miles. A brief description of the rocks comprising it has been written by Dr. Adams. Theralite forms the greater part of the mountain. This rock is cut by the second intrusive, a nepheline-syenite, which appears as a band along the north-west flank of the former rock, having a width never exceeding 400 yards. Numerous dykes cut both the above igneous rocks as well as all the stratified rocks. They vary in direction from north and south to east and west. Intercalcated masses of trap are rather common. Besides the larger mass in Côte de la Visitation, noted by Sir William Logan in the Geology of Canada (1863 p. 144,) others of lesser importance were found at Rockfield station, Côte St. Leonard, lot 435, Rivière des Prairies village and St. Vincent de Paul in the Trenton, and at Verdun in the Utica formation.'

St. Helens Island.

Mount Royal an igneous mass.

Shefford Mountain.

Professor J. A. Dresser makes the following report on the examination of Shefford mountain, which he has been conducting and which is now approaching completion. He adds also notes on some adjacent parts of the province of Quebec which he has lately examined:—

Work by Prof. J. A. Dresser.

'The examination of the rock specimens collected from Shefford mountain in the seasons of 1897-98 and 99 has been continued during the past year and is now nearing completion. Some chemical analyses kindly undertaken by Mr. M. F. Connor, B.A.Sc., assayer, Ottawa, which will be of much service in the varietal classification as well as in the genetic consideration of the rocks, are also well advanced, so that the entire description will, it is expected, be finished at an early date.

Analysees nearly complete.

'As was stated in the Summary Report for the year 1899, Shefford mountain is an igneous mass having an area of some nine square miles, and is situated in the south-eastern part of the St. Lawrence valley near the limit of the Palæozoic strata, amongst which it has been intruded in three principal periods of irruption. The microscopic character of the rocks thus formed indicate a conspicuously alkaline composition, making the rocks all of rare types and greatly emphasizing the scientific interest to be attached to the locality. The earliest rock

Area of Shefford mountain.

*Annual Report Geol. Surv. Can., VOL. VII. (N. S.), pp. 11—12 J.

Quebec—*Cont.*

in order of intrusion, which is evidently the most basic, is an unusual variety of augite-diorite, being in part at least essexite, an intermediate type between diorite and theralite. The second and third intrusions are varieties of syenite closely analogous to certain of the rare alkaline rocks of Arkansas and southern Norway.

Large number of dykes.

'Besides these main masses there are large numbers of still later dyke rocks which are themselves of at least two different ages of intrusion. The first class consists of dark-coloured dykes generally of the lamprophyre group, which, however, frequently pass into the hypabyssal facies of their plutonic equivalents. The extremely coarse texture of many of the dykes of both series is a very noticeable feature, and is presumably an indication of the highly heated condition of the inclosing rock at the time of their formation. The dykes of the younger series, which frequently cut the others, are generally of a trachytic character. They occasionably become comparatively free from the iron-magnesia constituents, and then pass into the bostonite type.

Rocks of Brome and Shefford mountains similar.

'The peculiar characters of the rocks of Shefford mountain prove it to belong to the important series of intrusive mountains crossing the St. Lawrence valley, of which Mount Royal, at Montreal, is the best known member, and all of which, so far as known, consist of rocks of rare petrographic interest. With the adjacent mass of Brome mountain, which was stated in the Summary Report of last year to be lithologically similar to it, Shefford shares the most easterly position amongst these mountains, as far as known, which has naturally led to some investigation as to whether these are really the end of the series towards the east, or not.

Results obtained.

'The results thus far obtained seem to show that they are. A somewhat brief examination has been made along the principal highways from Shefford and Brome to Lake Memphramagog, and on the Orford mountain and on the old Missisquoi and Black River Valley railways from North Stukely southward to the Huntingdon mines, as well as a careful survey of the exposures along the Canadian Pacific railway from Shefford to Miletta have failed to show any but very dissimilar rocks to those of Shefford within the more sharply folded pre-Cambrian strata of the Sutton Mountain anticline. The serpentines, altered diabases etc., of the latter area are not rocks which suggest any genetic connection with the peculiar varieties which appear in the former locality. These field examinations, which have been made at various times, have been much facilitated by the courteous and valuable assistance of Mr. H.A. Honeyman, M.A., of Knowlton.

Acknowledgments.

'Dykes related to those of Shefford probably occur, however, for some distance to the east of that mountain. One such is a quartz-free porphyry in lot 24, range III of the township of Shefford. This was described by Dr. F. D. Adams, in the Report of the Geological Survey for the years 1880-82, and is evidently allied to the rocks of Shefford mountain, from which it is about four miles distant. Some dykes which are found in lot 1, range X of Bolton, some twenty miles east of Shefford, are now being studied with a view to ascertaining the probability of their connection with that mountain. Quebec—*Cont.*

'As however the course of the Appalachian folding is about at right angles to the direction of the Mount Royal and Shefford series of mountains, and as the folding of the former was doubtless begun before the intrusion of the latter took place, it seems probable that any further outcrops of rocks of these characters are more likely to be found along the course of the Appalachian uplift than in a line across it. A camptonite dyke which occurs at Richmond, fifty miles northwest of Shefford, but also near the western edge of the Appalachian folding, is a not unlikely indication of the occurrence of rocks of an alkaline character in the intervening distance. Intrusives along Appalachian uplift.

'There are several quarries on Shefford mountain which produce rock material of excellent quality for constructive and decorative purposes. The largest of these is that belonging to John Dorman, near Shefford Mountain post office This gives a rock of uniform hardness, texture and colour, the last being a medium shade of green. It is free from cleavage or fluidal structure, and appears in the polished column in every respect equal to the first class "granites" already established in the market. In the absence of crushing, absorption and other tests, or of the results of such tests on other Canadian "granite" for comparison, little of a more definite character can be said of it. Microscopically it is practically free from constituents that decompose readily or tend to tarnish the rock. This is also proven by the very slight discolouration shown on natural exposures. Building material. Composition of rock.

'Rocks of slightly different character, but probably not inferior quality, are found on the properties of J. Morriseau and Jas. Coupland, where quarrying to some extent has also begun. Some equally promising occurrences along the "mountain road" have not yet been opened. Owing to their favourable location and proximity to the railway these rocks can be quarried more cheaply than most of the standard granites, and bid fair to supply a large market in Central Canada at least.' Location favourable for production.

Lake St. John District.

With a view to completing the surveys necessary for the Lake St. John map-sheet, including the greater part of the shores of that lake and the adjacent country between the Mistassini and the Shipshaw, arrangements were made with Mr. G. A. Young to continue the work already accomplished in that region. Mr. Young has assisted Mr. A. P. Low in the field during several years, and is familiar with the Work by Mr. G. A. Young.

Quebec—*Cont.*

conditions in various parts of northern Quebec and Labrador. Although the result of his exploration has afforded little information of a striking character from a geological standpoint, some considerable additions have been made by him to our surveys for the sheet in question. Mr. Young writes :—

Delayed by rain.

'On June 6th, I left Ottawa for Lake St. John. During the latter part of June and all July it rained more or less every day, retarding the work considerably.

Previous work done.

'The main rivers, comprised in the Lake St. John map-sheet, had already been traversed either by Mr. A. P. Low or Dr. F. D. Adams. Dr. Adams had also covered the settled districts which all lie in the southern part of the map-sheet. The nature of that part of the country still to be gone over, was such that progress was very slow, and the results are still, in part, incomplete.

Old lake basin.

'Lying north of the settled districts, is a low level area almost completely covered by heavy deposits of clay, sand, gravel and boulders. A greater part is swampy and most of the streams are very small. This area forms the north shore of Lake St. John and at that point it is about fifteen miles wide. It extends to the eastward, gradually narrowing, and crosses the Shipshaw river as a narrow strip a few miles wide, about twenty-five miles above its mouth. This district probably, at one time, formed the bed of a large lake, including the present area of Lake St. John which was drained by a river running from about the south-east corner of the present lake to Ha Ha bay on the Saguenay. The country bordering this area to the north is very wild, the hills rising abruptly and to a considerable height. A short distance north, and to the east of the Shipshaw river, the hills rise nearly 2,500 feet above the Shipshaw which at that point must be almost 750 feet above the Saguenay river.

Rivers impassable for canoes.

'With few exceptions, the small rivers draining the country between the main rivers are impassable for canoes, being short and always very rapid. The whole country, excepting those parts that have been burnt, is covered by a dense forest, mostly spruce, which prevents the running of traverses from river to river and makes it impossible to run even a track-survey. All the valleys are covered by deposits of sand and boulders, and the heavy vegetation on the hills hides the rock except on the cliffs.

'During the winter it would be possible to make good surveys of the rivers and streams. Walking would be good through the woods, so that probably, many exposures on the faces of cliffs could be visited which is hardly possible during the summer.

Track-surveys made.

'By means of rough paths cleared by lumbermen, I was able to make track-surveys of a number of small tributary rivers of the Shipshaw. I also made similar survys of a series of small rivers and lakes which run from the Shipshaw twelve miles above its mouth, to lake Onatchiway, of another series crossing from the Shipshaw to the Peribonka, of a third series from the Peribonka to the head of Alex river, of the Alex river to its junction with the Peribonka, and parts of a small river by which we descended from the Peribonka to the Saguenay.

Quebec—*Cont.*

'The routes followed lay almost altogether within the anorthosite area which forms so great a part of this district and whose main boundaries Dr. Adams had already determined. The prevailing colour of the anorthosite is a dark purple, excepting on the eastern border where it is grey. Dr. Adams has shown that this grey colour is due to a granulation of the feldspar individuals and the loss at the same time of their schiller inclusions*. This strip varies from a width of a few miles, at a point on the Shipshaw twelve miles above its mouth, to twenty-five miles at the foot of Lake Onatchiway. The width may be even greater here, for the grey anorthosite was found to extend twelve miles east of the Shipshaw, which was the farthest accessible point, and was then beyond the boundary of the map-sheet. Probably the contact with the Laurentain was not many miles farther on, as the anorthosite was modified so as to somewhat resemble the variety of anorthosite which, in the case of the Morin anorthosite, Dr. Adams considers to be due to contact phenomena.

Anorthosite area.

Probable contact with Laurentian.

'In this case the gray anorthosite appeared to change abruptly to a brown or pink colour and held quartz. This grey area also includes two comparatively small areas of augen-gneiss which has burst up through the anorthosite. This augen-gneiss in places contains much quartz and is massive, resembling granite ; but elsewhere it is banded, the strike being the same, or nearly that of the surrounding rock.

'About sixteen miles above the mouth of the Shipshaw, the line of contact between the Laurentian and anorthosite crosses the river several times, the Laurentian being either a granite-pink hornblende-gneiss or a grey mica-gneiss. The strike of the anorthosite and gneisses varies from point to point and does not coincide in direction with the line of contact. The anorthosite at this contact appears to be intrusive.

Direction of strike and contact differ.

'The several varities of anorthosite already noted by Dr. Adams were seen ; anorthosite with no bisilicates—with a small amount—with irregular or lense shape aggregates of hypersthene or augite, these aggregates being arranged parallel so as to give an apparent strike. Sometimes the aggregates were evenly distributed, sometimes arranged

Varieties of anorthosite.

* Annual Report, Geol. Surv., Can., VOL. VIII. (N. S.) p. 109 J.

Quebec—*Cont.*

in bands. In places the hypersthene exceeded the felspar in amount. Near one contact the aggregates were composed of large flakes of biotite. The aggregates varied from a very small size to over one foot and a half in length.

Composition changes quickly.

'In the grey crushed anorthosite, minute flakes of biotite were usually seen, and in places the biotite increased in amount, apparently replacing the usual bisilicates, so that the anorthosite appeared as a grey biotite-gneiss. The characteristics of the anorthosite rocks vary rapidly from place to place. In one place within one-quarter of a mile nearly all possible variations were noticed.

'The change from the purple to grey anorthosite was, as a rule, a gradual one, and there was always a certain amount of still uncrushed dark felspar present.

'To the west, on the Alex river, in two places, diabase dykes seem to have caused considerable local metamorphism. On the same river at different points the anorthosite has a schistose structure due to a large development of biotite and augite, the felspar being finely granulated except along narrow bands. In this area there were numerous pegmatite dykes which may indicate a near approach to the contact with the Laurentian and which may explain the highly altered character of the anorthosite.

Pegmatite dykes.

'Near one of the intrusions of augen-gneiss on the eastern side, the bisilicates of the anorthosite were in lense-like aggregates. At different exposures these were seen to become more and more elongated till gradually the several lenses joined one another and gave a banded character to the rock.

Glacial striæ.

'Three different sets of glacial striae were noticed. On the Little Peribonka the striae varied from S. 10° E. to S.; on the Alex and Peribonka rivers from S. 30° E. to S. 35° E., but at one exposure this set crossed another and older set, varying between S. 60° E. and S. 65° E. On Lake Onatchiway the direction was S. 10° E., and several sets east of the Shipshaw varied between S. 30° E. and S. 35° E.'

NEW BRUNSWICK.

Work by Prof. L. W. Bailey.

In New Brunswick work has been continued by Professor L. W. Bailey on certain problems of importance in connection with the geology of that province. The investigation of the past summer has had special reference to the age of the rocks of the so-called great slate belt. His report is as follows :—

Object of work.

'These explorations, in accordance with your instructions in May last, had as their principal object the obtaining, if possible, of a final and definite settlement of the age of the great bands of slates and associated rocks which border the granite tracts of York and Carleton counties, which in earlier reports, were described and mapped as Cambro-Silurian, but were subsequently found to include strata carrying a typical Silurian fauna.

New Brunswick—*Cont.*

'The determination of this question having, in previous seasons, been found impossible through the want of sufficient surveys of the position and course of the rocks involved, more especially in tracts difficult of access, Mr. A. Cameron, previously engaged in survey work in Nova Scotia, was directed to accompany me as topographical assistant, and to make such measurements as might be required. These embraced the larger part of the roads in the parishes of Canterbury and Woodstock, together with traverses of Eel river and portions of the adjacent tracts which seemed to be of special importance. They also included, upon the eastern side of the St. John river, the district between Hartland and the north-east branch of the Beccaguimic river, the south-east branch of the same stream, the country thence to Millville, and that lying between Millville and Waterville. These surveys were subsequently plotted, enclosing the more critical areas in northern York and Carleton counties, and a map was made showing more clearly than had previously been possible the relations of the disputed groups. At the same time the included areas were subjected to a close and searching examination, all outcrops previously noticed being reviewed, new ones sought in places not previously reached, and in some instances attempts being made to follow for considerable distances the more easily recognized bands in the direction of their strike.

Topographical assistant.

'The general tendency of these observations and measurements has been to confirm the view arrived at in the previous season, but not then announced owing to the incompleteness of the data, viz., that while a Silurian age must be assigned to certain tracts, such as that in which fossils were found by Mr. Wilson, of the Geological Survey staff, six miles north of Canterbury, and that discovered by the writer in the settlement of Waterville, in the parish of Southampton, yet the great bulk of the strata in the counties under consideration is, as previously supposed, of greater antiquity, being at least Cambro-Silurian or Ordovician (the age to which they had previously been assigned), if not even older. In seeking for evidence on this question a careful re-survey was made along the line where the supposed Cambro-Silurian or older rocks are met and overlapped by the foiliferous Silurian rocks to the north, with the result that incontestible evidences of discordance is found along the whole length of that line. A new and well marked instance of this was seen near the head of Eel river, in South Richmond, Carleton county, where heavy

Results obtained.

Proof of former conclusion sought.

New Brunswick—*Cont.*

beds of bright red slates, associated with amygdaloidal diorites, have afforded large fragments to the overlying Silurian beds.

Fossiliferous slates derived from Cambrian.

'An effort was then made to determine the limits of the fossiliferous Silurian rocks previously discovered by Mr. Wilson. Fossils similar to those obtained by that gentlemen, but occurring very sparsely, were collected at several points on Eel river, and strata exhibiting similar associations were followed for six or eight miles in the direction of the St. John river. Here, however, approaching the great granite belt, they not only failed to yield fossils, but became so greatly altered as to be recognizable only with difficulty. In connection with this work the fossiliferous slates were found to be associated throughout with heavy beds of slaty conglomerates, the composition of which, though somewhat different from that of the South Richmond conglomerates, equally indicate their derivation from the supposed Cambro-Silurian and Cambrian strata. The course of these conglomerates is therefore provisionally regarded as marking, upon one side at least, the line of separation of the two systems in the parish of Canterbury. The southern side, owing to progressive metamorphism, cannot be definitely assigned.

Conclusions verified by fossils.

'So far, the conclusions reached, though in accordance with previously expressed convictions, and with the views of all previous observers (including Logan, Hind, Robb, Matthew and Ells), were based upon stratigraphical and lithological grounds only. But near the end of the season, while engaged in an effort to effect more exactly the delimitation of the groups under review, new and most important evidence, tending to confirm the views already reached, was brought to light. This consisted in the discovery, near the village of Benton, in Carleton county, of a band of very black, more or less graphitic slates, associated with gray and white quartzites, and containing a few layers charged with large numbers of graptolites of the genus *Dictyonema.* Among these were some of large size, ($2\frac{1}{2}$ x 3 inches) showing both in their outlines and in the dimensions and structure of the polypary, a very close resemblance to the form *D. sociale* or *D. flabelliforme*, Eichwald, occurring in rocks of Cambrian age on Navy island, in the harbour of St. John, as well as at Matane, in the province of Quebec. They are regarded as identical by Dr. H. M. Ami, after careful studies and comparisons, and Dr. G. F. Matthew, (by whom the Navy Island form has been figured and described) is also disposed to adopt the same view. It would seem, therefore, that although the occurrence of a single fossil species is in itself very insufficient evidence upon which to determine and represent the horizon of a great group of strata, yet, when this is taken in connection with the stratigraphy of the region, pointing as it does in the same direction, a strong presumption is established in favour of the Cambrian age of the

Palæontological and stratigraphical evidence similar.

beds yielding these forms. It may be added that, should this view be confirmed by the finding of other fossils, the indications are that some closely associated, but underlying beds of semi-volcanic character, will be found to represent here certain strata found near St. John, to which Matthew has assigned the name of Etchminian, and which are regarded by him as indicating a distinct geological system. At all events the character and relations of the "volcanics" of Carleton county covering large tracts along the upper courses of Eel river and its tributaries, accord much more nearly with the association of similar beds in the Cambrian rocks of St. John, than they do with those of this character seen in their relations to the Silurian rocks of Charlotte county and elsewhere. New Brunswick—*Cont.*

'But while we are thus in possession of at least presumptive evidence of the existence in the district under discussion of two, or rather three, distinct formations, (for both of those referred to are somewhat unlike the Cambro-Silurian of the Beccaguimic river, no trace of which could be definitely recognized elsewhere), the determination of the exact extent and location of each is by no means easy. Very similar strata are found in both; in each they have been subjected to excessive plications, so that observations of dip and strike are of little service; they are most irregularly associated with volcanic ejecta, or invaded by intrusive masses, while finally, just when exposures are most needed, the country is deeply covered with drift. It may, however, be said with some confidence, that the Silurian rocks include all those exposed along the line of the railway, and in Eel river near by, between the main bend of this stream, about five miles north of Canterbury, and the Eel River falls, three miles farther north; and that from this line the belt extends eastward through Porten and Johnson settlements to the St. John river above Sullivans creek. Upon the eastern side of the river the same belt may, in an altered form, be continuous with the fossiliferous Silurian limestones discovered last year in the settlement of Waterville, but of this no proof could be found. The limestones in question, with associated conglomerates, are quite limited in distribution, have not been found elsewhere, and are surrounded by rocks of which the aspect is much more like that of the Cambrian than that of the Silurian system, as known elsewhere. Area of Silurian rocks.

'The question referred to above constituting the main subject of my season's work, and their solution being apparently dependent mainly upon the correct understanding of the belt of slates and associated rocks north of the great granite axis, especially in the parishes of Woodstock, Canterbury, Northampton and Southampton, and the study of these, as above outlined, having occupied the larger part of my available time, no further special examinations were made of the Solution of question difficult.

New Brunswick—*Cont.*

slaty belts south of the same axis. The recognition, upon the evidence of fossil graptolites at Benton, of the probable Cambrian age of the associated rocks (slates and quartzites), certainly also lends a degree of probability to the references to the same horizon of a portion of the beds (also slates and quartzites) south of the granite; but the fact that fossiliferous slates of Devonian age are found among the strata in the Nashwaak valley (Rocky brook), thus adding another to the horizons represented in this complicated district, shows that much careful work must yet be done before the relations and boundaries of these several formations can be accurately known.

Search for minerals.

'While carrying on the above investigations, examinations of several localities which seemed to afford some promise of useful minerals were made. One of these was in the settlement of Knowlesville, in the parish of Aberdeen, Carleton county, where, upon the farm of Mr. S. R. Gayton, an opening had been made in a series of slaty rocks, in part soft or rubbly and in part much harder, with rotten layers containing much pyrites. Samples taken from this point and analysed in Philadelphia, gave returns as follows:—

	Gold.	Silver.
Soft Rock	$1 16	$0 42
Blue Rock	1 30	0 80
Hard Rock	2 40	0 22

'A second locality was in Biggar Ridge settlement, three miles east of where the road from Foreston crosses the south-west Miramichi. Here are very large beds (?) or veins, consisting mainly of white quartz, often coarsely crystalline, more or less stained with iron and manganese, and frequently showing sulphides of iron, lead and zinc, with films of malachite. Specimens selected from openings made here, and analysed in the laboratory of the Survey, gave, according to the report of Dr. Hoffmann:—

Gold..None.
Silver..At the rate of 0·583 of an ounce to the ton of 2,000 lbs.

Indications of iron ore.

'Reference may also be made to the strong indications of iron ores observed at various points in connection with the volcanic or semi-volcanic rocks so largely developed in Oak mountain and above the sources of Eel river in South Richmond. Beds approaching hæmatite in character were referred to in the report of 1884, as occurring on Oak mountain, and during last summer a thirty-foot bed of similar red hæmatitic slate was observed on the farm of Mr. Kennedy in South Richmond, the same as referred to earlier in the report. Samples from the latter analysed by Dr. Hoffmann showed only 5·71 per cent of metallic iron, equivalent to 8·15 per cent of ferric oxide, but it is not unlikely that with these are beds carrying a much higher percentage.'

New Brunswick—*Cont.*

Work by Mr. Chalmers.

Mr. R. Chalmers was engaged during the winter of 1899-1900 in compiling the information obtained in the field in 1898 and 1899, and in preparing for publication the Fredericton and Andover sheets, No. 1 N.W. and No. 2 S.W. of the New Brunswick series. A report embodying the principal facts respecting the surface geology and the soils and forests was also written to accompany these sheets.

Surface Geology.

During the past season Mr. Chalmers was instructed to continue investigations in the surface geology of north-western New Brunswick, chiefly in the area included in the Grand Falls sheet No. 2, N.W. Work was commenced here in the valleys of the St. John and Tobique rivers in Victoria and Madawaska counties, and was extended northward and eastward into the unsettled areas drained by the upper Tobique waters. Special attention was given to the alluvial deposits of the Right Hand branch of this river owing to the fact that they contain scattered particles of gold. An attempt was made to trace these to their source and ascertain as far as practicable, the limits of these auriferous beds in a region still wholly covered by forest.

Mr. Chalmers reports as follows:—

St. John and Tobique valleys.

'I left Ottawa on the 12th of June to resume work on the surface geology of New Brunswick. Mr. L. P. Silver of Kingston, Ont., accompanied me this season also for about four months. Explorations were first undertaken in the south-west part of the Grand Falls sheet, in the valleys of the St. John and Tobique where the country is settled back from the river to the third and fourth concessions. A considerable number of new roads, which have been opened up since the Geological Survey map of 1886-87 was published, had to be surveyed, which we did by prismatic compass and wheel, and the shorter ones by pacing. Settlements seem to be rapidly extending in this part of the province particularly on the north-east side of the St. John. Of these settlements those of New Denmark, Salmon River, Enninshone, Woodville, Chambord and Commeau Ridge are the most thriving and embrace tracts of excellent uplands. The soil is often a calcareous loam and river flats (intervales) skirt all the rivers. The forest consists of a heavy growth of mixed timber.

Heights at Grand Falls.

'The valleys of the principal rivers in this region, notably the St. John, Tobique and Aroostook present a number of very interesting features, and some problems in Pleistocene geology, for solution. Among these are the falls of the St. John, known as Grand falls, the most important in the province. These falls consist of a nearly perpendicular drop of about 60 feet, with a series of rapids and cascades below this in a gorge some three-quarters of a mile long; and quiet pools above and below called the upper and lower basins. The total descent

New Brunswick—*Cont.*

of the river from the upper to the lower basin is 117 feet. The falls have been caused by the filling of the ancient valley of the river by boulder-clay during the glacial period and perhaps by a transverse dislocation of the strata, resulting in a diversion of the river from its old channel to a new one eroded in solid rock. The wearing out of this channel or gorge with walls from 75 to 150 feet high, nearly vertical, is not yet completed, the excavating or cutting process being still in progress. This gorge is the most remarkable feature in connection with the falls, and is, in places, quite picturesque, having a curved or horseshoe shape from the upper and highest fall to the lower basin. Large pot-holes occur in its bottom, which arrest the attention of the observer who descends into the gorge. Two of these situated about a quarter of a mile below the upper fall, or suspension bridge were measured. They are somewhat oval-shaped at the mouth, the longest diameter being parallel to the direction of the gorge. One is 12 feet by 11 feet at the mouth, and the depth 22 feet to the top of the gravel and pebbles in its bottom. The other, which has one side of the mouth broken off, has about the same diameters as the last; but narrows from the top downwards, its depth being 27 feet to the stones and gravel in the bottom. Probably there was a depth of several feet of these materials in each. The geological formation here is Silurian limestones and slates.

Pot holes.

'The boulder-clay filling which caused these falls can still be seen occupying the pre-glacial valley of the St. John here for a distance of 865 yards, and is exposed at both the upper and lower basins. A small channel along the surface of the deposit follows the course of the pre-glacial river. This channel at the upper end is 51 feet above the level of the upper basin, but slopes slightly toward the lower basin. The September level of the upper basin is 412 feet above mean tide level in Passamaquoddy bay, and of the lower 295 feet, as levelled from the Canadian Pacific railway station at Grand falls, which is 504 feet above the same datum.

Height of Upper basin.

Terraces.

'The St. John valley at Grand falls is flanked by terraces, the highest of which, at the upper basin, are from 95 to 110 feet above the river, or 522 feet above the sea. These terraces are practically at the same height on both sides and are continuous for half a mile or more below the lower basin except where intersected by Little river and Falls brook. Their surfaces incline down river from the level of the horse-shoe shaped peninsula on which the village of Grand Falls stands, about 520 feet high, and the materials seem to become finer, or rather there are fewer coarse gravelly bands as we descend the St. John. About half a mile below the lower basin the same terrace was found to be only 475 feet above the sea, while farther down the longitudinal slope was observed to be still greater. These facts serve to show that when the St. John began to resume its course at the close of the glacial period, its waters flowed at this level for some time, forming these high-level terraces. Lower terraces much better developed than these are, however, found in this valley.

New Brunswick—*Cont.*

Drift dams.

'Drift or boulder-clay dams and, perhaps, local temporary ice dams seem to have been formed in the St. John valley in the glacial period at and below Grand falls and in different places as far down as the mouth of the Keswick river. The terraces are usually at a different level below where these dams existed to what they are above. Scarcely any remnants of these drift dams can now be seen, except on the higher slopes of the river's bank where the boulder-clay rises from beneath the fluviatile beds.

'The terraces are higher relatively to the river and much better developed below Grand falls than above. This appears to be due to the greater slope of the channel and the more rapid flow of the St. John in the former part of its course, causing the transportation and modification of a much greater quantity of the boulder-clay which originally occupied the valley. Above the falls, and as far up as Edmundston, 40 miles, the St. John has but a slight descent and a comparatively tranquil flow, hence there was less erosion of the boulder-clay, less transportation of materials, and consequently the terraces here are comparatively insignificant features. There are evidences in this part of the valley, however, that lacustrine conditions probably prevailed during that part of the Pleistocene immediately succeeding the glacial period, the lake having apparently been held in by the boulder-clay embankment at Grand falls to a height equal to that of the highest terraces at the falls, namely 520 feet above the sea. Deposits which probably represent shore-lines were observed on the east side of the St. John between Grand falls and St. Leonards at the same level. On the other hand, it is not improbable that the Pleistocene sea invaded the upper part of the St. John valley, if not from the Bay of Fundy, then from the St. Lawrence by Temiscouata lake. At the time that the highest shore-lines of this valley were formed, the sea probably found a passage into this lake basin from Trois Pistoles or Rivière du Loup, and thence could easily reach the St. John valley.

Probable shore lines.

'No fossils have yet been detected, however, in the sands or clay of the upper St. John, or Lake Temiscouata basin.

'The gradient of the river valley from Grand falls to Edmundston is but slight, and the terraces here are nearly horizontal, or have only a gentle slope down river. This would mean, if they are marine that they have a slight ascent from the north-east to south-west as in the St. Lawrence valley. Between Grand Falls and Woodstock, however, the terraces everywhere have a greater slope down river, in some

New Brunswick—*Cont.*

places the gradient being regular, in other places they descend by steps. In this part of the valley they are fluviatile.

Aroostook Falls.

'The falls of the Aroostook river, two miles east of the International boundary were also examined. Here the river descends about 75 feet, in a distance of a mile and a half in a succession of beautiful cascades. An ancient channel runs on the south side parallel to the gorge in which the river now flows. The deposition of boulder-clay has also been the means of producing these falls; but a diorite dyke which cuts the slates here in a peculiar manner appears to have caused a dislocation of the river channel at a former period.

'The Grand falls of the St. John and Aroostook falls are well situated for the utilization of the water power they afford. A syndicate of United States and Canadian capitalists has leased the Grand falls, surveyed the ground, and it is reported, has prepared plans for the erection of extensive factories, but nothing further has yet been done.

Boulder-clay.

'*Boulder-clay* :—This is probably the most abundant of the superficial deposits in the area under consideration, and seems to form an almost continuous covering of the rocks. In the river valleys it is, of course, largely concealed from view by the later stratified deposits; but above the limits of the highest terraces nearly all the drier grounds show boulder-clay, the upper surface of which is often modified by ordinary atmospheric action.

Boulders.

'Numerous boulders occur scattered over parts of the area, but they seem to belong to rocks found within the drainage basin of the St. John river. A few gneiss boulders were, however, met with in the boulder-clay at Grand Falls and Edmundston, the sources of which are unknown, and which may be derived from the great Laurentian area to the north. Similar boulders were observed at Temiscouata lake some years ago. Has the lobe of the Laurentide glacier which overrode the eastern townships of Quebec extended down the St. John valley this far?

'Decayed rock was observed in a great many places, especially on the south sides of hills and ridges where it had been protected from the scouring action of the Pleistocene ice. It is, however, on the higher and more broken grounds of the interior that the material is most abundant.

Surface geology of Tobique valley.

'The surface geology, physiography, etc., of the Tobique valley and its eastern tributaries being the principal subjects of our investigation, we commenced this work in July, and our time for nearly the whole of the rest of the season was occupied in it. Many interesting facts were collected, a few of the most important of which will be detailed in the following pages. Commencing at Plaster Rock, the terminus of the Tobique Valley railway, we first examined the valley of the main Tobique river to Nictau, where it divides into three branches. All new roads were surveyed and the altitude of the country measured with aneroids based on the profile height of Plaster Rock station. Dr. Philip Cox, of the Miramichi Natural History Association, who was making collections of fishes, reptiles and plants, etc., joined us in camp for a few weeks. With his aid the two highest peaks of the Tobique valley, namely, the Blue mountains and Bald head, Riley brook were re-measured. The summit of the former was found to be 1,725 feet above sea-level, and of the latter, 2,045 feet. As there are so many Bald mountains in the province it seems desirable to change the name of this mountain. I shall therefore call it Riley Brook mountain, or simply Riley mountain. By this name it can still be recognized by lumbermen, sportsmen and others familiar with the region more readily than by giving it an entirely new name.

New Brunswick—*Con*

Elevations.

'Several Pleistocene river expansions, or lake basins, holding lakes in post-glacial time, but now extinct, seem to have existed in the Tobique valley. The largest of these was in that part of the valley between Red rapids and Arthurette, another was at Riley brook. The flats at these places are evidently ancient lake bottoms, and now form a highly fertile soil.

'The general height of the country on both sides of the Tobique, from the Arthurette basin to the forks (Nictau), is approximately 750 to to 1,000 feet above the sea, becoming higher, however, to the east, north and west. The whole region, except along the immediate banks of the river, is wooded, and has a broken, rugged surface. This portion of the province lies within the limits of the New Brunswick Land Company, the eastern and northern boundaries of which are the county lines of Northumberland and Restigouche. It comprises one of the most valuable timber areas of New Brunswick and some excellent farming lands.

'After completing the work in the valley of the main river, arrangements were made to explore the lake region at the source of the Right Hand branch and especially the Serpentine river, where traces of alluvial gold have recently been found, and several weeks were spent in this part of the country. Our route on entering it was along a portage road starting from Tobique river, north of the Gulquac, thence to Trousers lake, one of the worst roads in the province. Several high ridges were crossed, the highest being the one east of Stewart brook, the principal summit of which is named Black peak on the Geological Survey map, but Dickenson mountain on the New Brunswick Land Company's plans. Its elevation is approximately 2,000 feet above the sea. East of this the road descends gradually towards Trousers lake. Much of the land along this route is poor and unfit for settlement, though in some places there are belts of good soil.

Search for gold.

New Brunswick—*Cont.*

The whole country is still covered with timber which renders it of great value. Just before reaching Trousers lake, we pass the north end of a mountain range trending in a nearly north and south direction, and shown on the map as having three prominent peaks. These mountains can be seen from the north-east side of the lake, and are probably the highest in the region, the elevation of the chief summit being approximately 2,250 feet above the sea. They are without a name on the Geological Survey map, and I therefore propose that they be called the Costigan mountains, after Hon. John Costigan, Trousers lake and vicinity having been a favourite hunting and trapping ground of his for many years.

Lakes on south-east branch.

'Trousers or Tobique lake is 1,350 feet above mean sea level, and its depth varies from 25 to 50 feet. Its bottom is traversed by low ridges with intervening hollows, though, on the whole, comparatively flat and silted up. The basin of the lake was originally two river valleys, that is, two valleys occupied by branches of the same river, which joined at the north end of the present lake, where a drift dam now exists.

Trousers lake.

'Crossing from Trousers to Long lake we pass through Mud lake, a small shallow sheet of water, about 1,365 feet in elevation. Long lake, the largest of the group, 1,320 feet above mean tide, is a beautiful expanse of water, and the deepest of all these lakes. The bottom seems to be quite uneven, however, the depth varying from 35 to 75 feet or more. The south end is largely silted up; but ridges of gravel and boulders occur in places throughout its bottom. This lake has also been produced by the damming up or dislocation of the upper part of the valley of River Don. At present it seems to be held in by a moraine; but there has also been another outlet to the west of the existing one, which drained it into Second or Square lake, so called by the lumbermen and hunters.

Long lake now drains into Third or Mud lake. The height of Mud lake is about 1,300 feet. It is quite shallow and apparently a resort of moose. From this lake a portage of three miles takes us to two other lakes,—they are mere sinks,—lying in a narrow valley and discharging into Portage lake. There is a high ridge to the north of these. A short portage takes us thence to Portage lake, a beautiful little lake about 1,150 feet in elevation, and from 15 to 20 feet deep, surrounded by low hiils. Beaver are abundant here; several dams and houses were seen, some with freshly cut bushes and sticks. Trout are also very plentiful in this lake. This lake is likewise being silted up, and is another drift-dammed body of water, the obstruction being at one side instead of at the end.

Portage lake.

'From Portage lake a short carry or portage takes us to Adder lake which is about 50 feet higher than Portage lake, that is, it has a height above the sea of about 1,200 feet. This pretty little lake, nestles at the western base of a mountain 1,655 feet high, which may be named Adder Lake mountain. The depth of the lake is from 16 to 18 feet and it discharges into Serpentine lake.

New Brunswick—*Cont.*

'A stream flowing into the southern end of Adder lake, drains a lake about three quarters of a mile to a mile distant, of about the same size. As the latter is without a name, I propose to call it Loggie lake, after T. G. Loggie, chief draughtsman of the Crown Lands Office, Fredericton.

Serpentine lake.

'Serpentine lake is reached from Adder lake by a short portage, the stream connecting them being choked up with drift-wood and impassible for canoes. This is another fine sheet of water, with high mountains to the east and south, and a depth varying from 25 to 60 feet or more. Its elevation above the sea is 1,165 feet. The long points extending into it are probably moraines. A mountain stands on the east side of the outlet with a height of approximately 1,800 feet above the sea. This I propose to name Serpentine mountain.

Origin of lakes.

'Serpentine lake seems to be held in also by a drift dam. Terraces 10 to 12 feet above its level occur on both sides of the outlet or foot of the lake, composed of stratified materials in the upper part and boulder-clay beneath. But while all these lakes appear thus to occupy portions of ancient river-valleys, dislocated and partially cut off from those parts below by dams of glacial drift, it is doubtful whether such dams are alone sufficient to produce them. Neither does it appear probable that glacier-ice would form drift-dams in such regular alignment across the country in a north-east and south-west direction, corresponding so closely with the strike of the geological formations. Another hypothesis has, therefore, to be introduced to aid in solving the problem of the origin of these lakes, namely, that of an uplift along the north-east and south-west line indicated, an uplift which would affect all the river valleys referred to, cutting off their upper parts and forming separate basins of these. Drift accumulations have doubtless aided in ponding the drainage waters of these basins, but as the boulder-clay would be laid down unevenly, and in loops or zigzag lines, it is scarcely possible that this alone could dam all these river valleys and produce these lake basins as we now find them. On the other hand, the uplift has probably not been so regular, or along such a direct course as it appears to have been. It is most likely that it was parallel to the general trend of the pre-Cambrian belt, though, perhaps, irregular in detail. It may have been the same uplift which separated the Nepisiguit and Tobique waters, its axis passing between the Nepisiguit and Nictor lakes. The vertical movement referred to seems, however, to have been parallel to and subsidiary to the main uplift to the south-east, represented in the central granite and pre-Cambrian ridges traversing the province in a north-east and south-west

Uplift of country.

New Brunswick—*Cont.*

direction across the headwaters of the Miramichi rivers and the Nipisiguit near Indian falls, and was probably of a later date.

'A number of the lakes described are raised from five to ten feet above their normal level by artificial dams, and at the time of our examination the shores and the borders were in a drowned condition. Rows of dead trees, some standing, others uprooted, form a border to these lakes at present, and mar their beauty. Where no artificial dam has been constructed, as at Long lake, the outlet is usually choked up with drift wood, which partially has the same effect in holding up the lakes above their normal level.

Serpentine river.

'The Serpentine river is a winding stream, with a stony, bed, and is very difficult of navigation for the canoeman or voyageur. Four or five miles below Serpentine lake, we come to a stretch of dead water about two miles in length the height of which is about 1,045 feet above the sea. Below this the river descends more rapidly. A range of mountains extends along the east side of this part of the river which is also without a name on the map. To these I shall give the name of Stillwater mountains. Their height is approximately 1,800 feet above the sea.

'At the mouth of a brook coming in from the east immediately below the dead water (McNair's brook) colours of gold and considerable quantities of black sand were washed out of the river's bank. The river gravels here contain a large percentage of quartz pebbles, and may be called quartz gravels. The source of these was not ascertained, but it is probably in the mountain range to the east, as this material is abundant in the brook just mentioned, which flows through these mountains and from the high grounds beyond.

'The portion of the Serpentine river below the dead water was examined in the autumn of 1899, and briefly described in the Summary Report of that year. From this point to its junction with Campbell river it is remarkably swift, descending in the twelve intervening miles about 450 feet. The channel is also plentifully strewn with boulders, and cascades and waterfalls occur at intervals. The most interesting and important of these is the big falls, a series of rapids and pitches in which the river descends about 28 feet. These falls are caused by a granite dyke, and no evidence of an old channel could be seen on either side. As pointed out there is probably a fault here with a down-throw to the north-west, and this movement is doubtless related to that which produced the lake basins described above.

Alluvial gold.

'*Alluvial Gold.*—Washing for alluvial gold was conducted in all the lake basins, more particularly at and near their outlets, as well as on the upper part of the Campbell, Don and Serpentine rivers; but none was obtained till we reached the foot of the dead water of the Serpentine river above referred to. Here, in washing a quartz-gravel, fine colours were found. Below this, as far down as the junction of this river with the Right Hand branch, gold was obtained in a number of places by myself, and by others previously, showing that the precious metal has been distributed along the whole lower ten or twelve miles of its valley. It occurs, however, in a very fine state of division and in an extremely scattered condition. I have been informed that in addition to the small nuggets and grains of gold obtained in 1899, others weighing from ten to fourteen grains have been discovered, and some of these were shown me. Reports are also in circulation that gold has been found in the matrix in the elevated wooded country to the east of the Serpentine river and lake, at or near the source of the Little South-west Miramichi, and specimens rich in gold have been shown me by persons who stated that they collected them in that region, but wished to keep the precise locality a secret till further exploration was made. New Brunswick—*Cont.*

'The alluvial gold of the Serpentine valley has, doubtless, its source in the rocks within the drainage basin of the valley, probably in the higher grounds referred to, east and south-east of this river, and at or near the contact of the old rocks mapped as pre-Cambrian with the granite. No gold has yet been found in the matrix, however, though various reports are in circulation to the effect that it has; but the samples tested in the three-stamp mill erected in the Serpentine valley a few years ago, as well as those assayed in the laboratory of the Geological Survey, have failed to show it. Probable source of gold.

'Although no alluvial gold was found by me in the lake basins at the source of the Right Hand branch, yet it is not improbable that it may occur there in small quantities, as was shown by Prof. H. Y. Hind, in 1864.* These lakes have their banks in such a flooded condition now by artificial dams and other obstructions that only in a few places could the rock *in situ* be seen. Besides the outlets were so blocked up with driftwood, that no fair test of the alluvial deposits in these could be made for gold. From all the information at hand, however, it would appear that the southern limits of the gold-bearing deposits of the Serpentine and Right Hand branch do not reach the lakes, but coincide approximately with the axis of the uplift that produced the lake basins, which as shown on a previous page is supposed to extend in a north-east and south-west line to the north-west of these lakes.

'In that part of the Serpentine valley in which alluvial gold occurs the valley is wide and the descent greater than in the upper part, and the deposits are shallow. Here boulders of all sizes strew the river's Mode of occurrence.

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*A Preliminary Report on the Geology of New Brunswick, 1865, pp. 223-227.

New Brunswick—*Cont.*

bed and ledges or rock in sight are not infrequent. It is usually below these ledges, in places sheltered from the great force of the current, that particles of gold are found. The river is extremely winding in this part of its course, fully justifying its name, and the scattered condition of the gold particles is largely due to its peculiar character. In a number of places old channels lie on one side or the other, which are now filled up and deserted by the stream Wherever openings have been made in these, colours of gold have likewise been found. The tributaries of the Serpentine too, from McNairs brook down, especially on the east and north sides, seem to have traces of alluvial gold in the gravels at the mouths. Much more prospecting and detailed work are necessary, however, before it can be said that a thorough examination of the region has been made in regard to the occurrence of gold in it in paying quantities.

'The probable source of the gold met with in the alluvial deposits of the Right Hand branch of the Tobique is the pre-Cambrian rocks of the central part of the province. These constitute a parallel band or outlier of the rocks forming the central axis of the Appalachian range, in which gold has been found from Georgia and Alabama to Maine and Quebec. In its mode of occurrence and distribution, the gold of northern New Brunswick appears to be similar to that of the Chaudière valley and other places in south-eastern Quebec.

'No prospecting or development work of any kind, so far as I could learn, was attempted during the season of 1900, nor have any areas of paying deposits yet been located.

Topographical features.

'*Chief topographical features.*—The lake region just described lies in the south-west part of a wide belt of highlands traversing New Brunswick from the head of the main South-west Miramichi river north-eastward to the sources of the Tête-à-gauche and Jacquet rivers flowing into the Baie des Chaleurs. This wide belt not only contains the highest land of the province, but also some of the oldest rocks consisting, as already stated, of pre-Cambrian schists and slates, with granites and other intrusive rocks. A large number of elevations in these New Brunswick highlands are 2,000 feet above the sea, or more, and several exceed 2,500 feet. The highest part of the country is near the source of the Big South branch, Nipisiquit river, and the sources of the North-west and Little South-west Miramichi rivers. These highlands are nearly all forest-covered and have of late years become a favourite hunting and sporting ground. Moose, deer, cari-

Game and fish.

bou, bears, etc., are plentiful there, and the fur-bearing animals, at one time nearly exterminated, are now, under the protection afforded them by the provincial game laws, beginning to increase in numbers again. The rivers and lakes in these highlands teem with salmon, trout, togue, etc. For a number of years the Tobique river has been under lease to the Tobique Salmon Club, and being well guarded, is now one of the best salmon rivers in New Brunswick. Besides the revenue derived from the lumber lands, which here are quite important, that accruing from the fisheries and game must, likewise be considerable. New Brunswick—*Cont.*

'In a late report the writer tentatively advanced the scheme of setting apart this large central belt as a game and forest reserve, following the example of other countries which are now reserving wilderness or waste lands for similar purposes. As regards the forests of the province it is generally conceded that the existing methods of exploiting them are destructive and must result in deforesting the wilderness lands in the near future. Hence the necessity of casting about for some method of preserving them. As the settlement of the country advances, this is, of course, impossible on areas of arable land. But there are large tracts useless for any purpose, except for growing timber, and these should be brought under control and the forest growth upon them preserved, or, if destroyed they should be reforested. The timber on forest areas might also be carefully culled and that above a certain size cut away periodically without destroying the younger and growing trees, and thus the life or existence of the forests might be indefinitely prolonged. The time is now opportune for setting apart such portions of the provincial lands as are not adapted for agricultural purposes and settlement, and placing them under such regulations as to ensure the preservation of the forests, game and fish. These are among the most valuable assets of the country, and their care and preservation are matters in which every citizen should be interested. Game and forest reserve advocated.

'The forests of the Tobique area consist of a mixed growth of trees, which may be enumerated in the order of their abundance as follows: fir, black and white spruce, black birch, large yellow birch, white birch, maple, cedar, hacmatac, pine, etc. Extensive lumbering operations are carried on here, especially in spruce and cedar. The hemlock was not observed in the country drained by the upper Tobique waters, nor indeed anywhere in the region above Three brooks. Timber.

'Though the salmon does not ascend the Right Hand branch of the Tobique to the lakes, the branches of this river form excellent breeding grounds for this fish, and in autumn the deeper pools were swarming with them. Trout are also especially abundant in all these waters. The togue is found in Long and Serpentine lakes, but has not been seen in any of the others, the reason apparently being that they are too shallow and their bottoms silt-covered or muddy. The beaver, at one time nearly exterminated in the province, is beginning to increase in number in these lakes, the fresh work of this animal having been seen at Portage lake and elsewhere indicating quite recent or present occupation.'

Nova Scotia.

Work by Mr. Hugh Fletcher.

Mr. H. Fletcher was engaged during the winter of 1899-1900 in plotting the surveys made in Cumberland county, N. S., referred to in the Summary Report for 1899, pages 162 to 168, and in making sections of the bore-holes therein described. He left Ottawa on June 7th, for field-work in Nova Scotia, and did not return to Ottawa until January 9th, 1901. On the field-work he makes the following report:—

Work by Mr. McLeod.

'I was again assisted by Mr. M. H. McLeod, who had with him for about two months early in the season, Mr. Colin McLeod, of Springhill, and in the months of September, October and November, Messrs. A. Cameron and Walter McKay, to finish surveys necessary to complete map-sheets 61, 62 and 63. They surveyed the various brooks, rivers, lakes and roads in the district of Folly lake, Wentworth, Westchester and Castlereagh, and along the Wallace, Pugwash and Philip rivers, and defined the extent and geological structure of the pre-Carboniferous, Carboniferous and Permian rocks of that region, the general outlines of which had been previously indicated by the late Mr. Scott Barlow and by Dr. R. W. Ells.

'My own time was divided between a study of the south-western corner of the Springhill coal-fields, and a further examination of the Inverness coal-fields.

Springhill.

'In the work at Springhill I was assisted by Mr. Lee Russell, B.S., of Truro, for several weeks. I have again to thank Mr. J. R. Cowans, general manager of the Cumberland Railway and Coal Company, and the gentleman mentioned on page 163 of last year's Summary Report, as well as Messrs. Jenkins Morgan, John W. Hunter, William Simmons, E. Trousdell, E. Corbett and others for assistance.

Coal seams traced.

'Seventy-eight hand-drill borings, ranging in depth from ten to fifty feet, together with several pits, have been made to define the course of the coal seams along the anticline already described as passing south-westward through this district from Clairmont toward the Upper Maccan river at Mapleton. By means of these bore-holes, the Golden seam* has been traced about 2,100 feet to a point near Trousdell's spring, from which it turns to the eastward round the anticline, but was not followed.

'The next seam to the south-westward, however, which may be called the Canning seam, was traced from the quarry in Harrison brook, about 250 feet below the bridge on the Leamington road, for more than 300 feet to the south-westward, then across the road, sharply

* Summary Report, Geol. Surv., Can., 1899, page 167.

around the anticline and for 1,400 feet to the eastward. It is overlain by a thick belt of the gray massive sandstone of the quarry, but immediately above and below it lie dark gray argillaceous shales.

Nova Scotia—*Cont.*

'The Canning seam may be that cut through in Harper's bore hole at about 322 feet from the surface.*

'The anticline here passes to the westward of the road; and the next coal group, opened on both sides of the road, about 3,350 feet from Harrison brook, or 250 feet north-east of the road to Mr. J. W. Hunter's house, is on the south side of the anticline. This may be called the Dan McLeod seam; it is associated with thick beds of dark gray argillaceous shale and was bored into also at the old Mountain road half a mile to the westward, but has not yet been traced northward to the apex of the anticline. In many respects it is like the coal at Alex. Stewart's, and may prove to be the same.

Evidence from mine workings.

'These explorations and the extension of the 2,600-foot level of No. 3 seam to a point nearly half a mile south-west of the Athol road or a mile and three quarters from the north slope, indicating that Barlow's "highest seam"† ought to cross Harrison brook—which is only two miles and ten chains from that slope—about 3,900 feet below the bridge on the Leamington road. It was looked for there; and a bed of coal and shale, six feet five inches thick, containing nearly two feet of coal, was found lying between two bands of sandstone inclosed among red strata. This coal was traced about 2,000 feet to a small fault across the old Mountain road. The associated red strata were followed 2,400 feet farther to the south-westward, then 1,000 feet around the point of the anticline; but work was discontinued before this seam had been located exactly or its relation defined to the seam of the 715 foot bore-hole, one mile and a quarter to the south-westward.

Extent of basin.

'The coal basin as thus proved has a breadth of more than four miles from the workings of the Aberdeen slope on the north-east. Its extension much arther to the south-westward may reasonably be expected, while the extension of the Aberdeen levels in the opposite direction will be awaited with interest.

Inverness coal-fields Cape Breton.

'Nearly eight weeks were spent in Cape Breton, principally in re-examining the Coal Measures of the western or Inverness coal-field between Margaree harbour and Little Judique, to the development of which an inpetus has been given by the construction of a line of railway from Port Hastings to the Broad Cove mines and the projection of another from these mines to Whycocomagh and Orangedale.

* Ibid, page 167.
† Ibid. p. 166.

Nova Scotia—*Cont.* Mabou.

'Several small cargoes of coal have been shipped from Mabou and the mines at Port Hood and Broad Cove have also been reopened. The Richmond and Inverness Railway Company has the rails laid for construction trains to within about three miles of the mine at Broad Cove, while that portion of the road from Hastings to Mabou is nearly completed.

Port Hood.

'At Port Hood mines, the slope is now down about 1,150 feet, the dip being throughout about 24° and the coal about seven feet thick. Levels have been turned away north and south and balances and cross-cuts begun. The following analyses of the coal were made recently.

	Face of slope.	Face of south level.	Face of north level.
Moisture	2·11	2·47	2·42
Volatile combustible matter	38·86	38·48	37·18
Fixed carbon	49·25	50·39	50·96
Ash	9·78	8·66	9·44
	100·00	100·00	100·00

'The manager, Mr. John Johnstone, is of opinion that the present output of one hundred tons a day can be increased to four hundred tons by the first of June, when an engine and fan are expected to be in position and shipping will begin from the company's pier. A $70,000 plant is to be erected in addition to the pier. Twenty-five miners and loaders are employed at present and this number will be increased as the mine is opened out.

Broad Cove.

'Active work on a large scale has also begun at Broad Cove mines. Not far north of McIsaac pond, two slopes have, under the superintendence of Mr. Charles Fergie, been put down between 700 and 800 feet on the so-called seven-foot seam. At 680 feet, No. 1 lift is turned off, levels are driven east and west and a water-lodgment made to continue the sinking of the slopes, which is expected to go on at the rate of 200 feet a month. Both slopes have been arched with stone at the surface. The bank-head will be built and permanently equipped this spring and hoisting engines erected. The angle of dip is 16°, the roof improves as the slope is continued and the coal is very regular.

Section of coal measures.

'In company with Mr. Hugh Campbell, manager for the company by which McIsaac pond was converted into a harbour for the shipment of coal from two large seams at the old mines on Broad Cove river, I made sections of the measures exposed along the coast and in other parts of the district, and took exact observations of the exploratory and permanent workings on the various seams. I am also indebted for valuable information to Mr. Donald McLeod and others.

Chimney Corner.

'Of late years no mining has been done at Chimney Corner, although interesting developments have deen made, as pointed out to me by Messrs. Neil P. McKay, William Y. McRae, James W. MacKenzie, C.E., and others. Nova Scotia—*Cont.*

'As already stated in the report for 1882-84, Carboniferous rocks occupy most of the western shore of Cape Breton island along the Gulf of St. Lawrence from Cheticamp to the Strait of Canso; but only small portions of this belt, lying between Chimney Corner and Little Judique, a distance of thirty-eight miles, include Coal Measures; while in only four limited districts, at Chimney Corner, Broad Cove, Mabou and Port Hood has coal been mined, these districts being separated by upheavels and protrusions of underlying barren measures, as shown on the maps which accompany the report above mentioned.

Workings under sea.

'The coal-seams all border on the shore and are not known to extend far inland. Both at Port Hood and Broad Cove the workings will be largely under the sea, and the question of the conditions under which the sea areas can be won becomes one of great importance.

Faults

'Although at some points there is a great thickness of barren strata between the coal seams and the gypsum and limestone, in other places they are brought together, evidently by faults. Exposures even on the shore are not continuous, while inland they are few; nevertheless an attempt has been made to build up a connected section of the strata for comparison in different parts of the field and with those given in the report for 1882-84.

Borings at Torbrook.

'Two drills owned by the government of Nova Scotia have been at work during the past autumn. One of these, a Davis calyx-drill, cutting a core of five inches diameter, is boring among the iron bearing rocks of the Nictaux and Torbrook district in Annapolis county. This drill, the invention of an Australian, is said to be very much cheaper to operate and more efficient than a diamond drill. The boring is effected by steel teeth and chilled shot and the makers claim that $1.17 worth of shot will do the work accomplised by $500 worth of black diamonds.

At Pottle lake

'The other, a diamond drill, has been set up at Pottle (Sawmill) lake, near North Sydney, to test the existence of a workable seam of coal reported in this vicinity. The borehole is now about 200 feet deep. The importance of such explorations, systematically conducted, cannot be too strongly insisted upon.

At Grand Lake road.

'A third drill, a calyx-drill of 1,000 feet capacity, cutting a five inch core, has been set up, by a private company, at the bridge over the South-west brook on Grand Lake road, about six miles from Sydney, to test the eastward extension of the Mullins or Carroll seam in workable form, and the western extension of the Tracy seam. As was stated in my recent report on the Sydney coal-field, the former is of workable size and good quality at Lingan basin, but has not been traced to the

Nova Scotia—*Cont.*

southward; while the latter, apparently workable from False Bay Beach to Cochran lake has not been proved to the westward.

Doctor Brook iron mines.

'Mention has already been made of the iron ores of the Arisaig district in Antigonish county; and particularly, in the Report of the Geological Survey for 1886, pages 26P, 27P and 117P, and sheet No. 33 of the Nova Scotia series of maps—of the occurrence of red hæmatite, of good quality, in large workable masses or beds, in the neighbourhood of Doctor brook. In 1893 and 1894 about 1,376 tons of ore were mined in this district by the Nova Scotia Steel Company, principally from a bed running in an easterly and westerly direction for about a mile between the main branch and the east branch of Doctor brook; it was carried over a pole-railway two miles and a half to a shipping-place at Arisaig pier. The dip of this bed is nearly vertical, but it was not followed to a greater depth than twenty-five feet. Assays of the ore, made by the company, yielded 46·62 per cent. metallic iron. (G. S. C. Report for 1897, pp. 98 and 108S).

'During the summer of 1900, further extensive developments were made on the surface both along the bed worked by the Nova Scotia Steel Company and on a belt apparently immediately south of and distinct from that bed. The openings, of which a cursory examination was made by me in company with Mr. P. S. Archibald, C. E., of Moncton, on November 21st, are outlined on a map prepared by Mr. Archibald, a copy of which is in the office of the Geological Survey. They show a most encouraging quantity of ore, in masses varying from 2 to 16 feet in width, situated on high ground capable of easy drainage to a much lower level without pumping. Samples collected from seventeen of these openings were given to Dr. Hoffmann for analysis.'

Nova Scotia Gold Fields.

Work by Mr. E. R. Faribault.

Mr. E. R. Faribault, spent the first part of the winter 1899-1900 in plotting the surveys made during the previous summer in the counties of Hants and Queens. A summary report was also written on this region, including a description of the gold districts of Renfrew, Mount Uniacke, South Uniacke, Upper Newport, Meander River and Ardoise, as well as some additional notes on recent developments made at the Dufferin mine in Halifax county.* The large-scale plans of the gold mining-districts of Renfrew and Mount Uniacke in the county of Hants, and that of Lawrencetown in the county of Halifax, were completed and prepared for publication. The plan of Lawrencetown is now published, as well as those of Renfrew and Mount Uniacke.

On February 15th, Mr. Faribault left for the Paris International

* Summary Report, Geol. Surv. Can., 1899, pp. 168 to 187.

Exhibition to superintend the installation of the Canadian mineral exhibit, and returned to Ottawa August 26th. This has been referred to at length on a preceding page. Nova Scotia—*Cont.*

From September 5th to 28th he was engaged in field-work in Nova Scotia, in making a further examination of the gold mining districts of the eastern part of the province, visiting Renfrew, Oldham, Waverley, Lake Catcha, Tangier, Mooseland, Moose River, Caribou, Beaver Dam, Dufferin Mines, Harrigan Cove, Ecum Secum, Goldenville, Wine Harbour, Cochran Hill, and Isaacs Harbour. Field-work.

In regard to this work Mr. Faribault states that many interesting notes were gathered on the recent developments made, which will throw more light on the laws governing the zones of special enrichment in the veins. He writes :—

'Important mining developments have lately been made in many districts, notably at Waverley, Caribou, Dufferin Mine, Ecum Secum, Golderville, Wine Harbour and Isaacs Harbour; while new development works were being started at Renfrew, Mooseland and Harrigan Cove. Mining developments.

'At Renfrew, extremely rich quartz was being taken out on the Jubilee vein recently found to the east of the fault on the Colonial property. A crushing of 110 tons is reported to have given 2,700 ounces of gold, valued at some $53,000.

'The East Waverely property has recently been equipped with a thoroughly good mining plant, a large compressor and a modern eighty-stamp mill provided with eight Wilfley concentrating tables, the whole driven by an excellent water-power, enabling mining operations to be conducted at a very low cost.

'The recent cross-tunnels and drifts opened up at Ecum Secum mine have developed several very interesting saddle-shape veins on a double crumpling of the main anticlinal fold, and an important true fissure vein following the axis-plane of the local synclinal fold. These developments show most conclusively and in a very striking manner that the size and richness of the veins are altogether a result of the structure of the measures, and that they are well-defined and can be located.'

CHEMISTRY AND MINERALOGY.

Reporting on the work done in these branches of the Survey's operations, Dr. Hoffmann says :—'The work carried out in the chemical laboratory during the past year has, conformably with the practice of preceding years, been almost exclusively confined to the examination and analysis of such minerals, etc., etc., as were considered likely to prove of more or less economic value and importance. Briefly summarized it embraced : Chemistry and mineralogy.

Chenistry and mineralogy —*Cont.* Analyses.

'1. Analyses of fuels, including lignites, lignitic coals, coals, and anthracite, from the following localities :—Lignite from the upper and lower workings on Cliff creek, and from the upper and lower seams on Coal creek, in the Yukon district, North-west Territory. Lignitic coal, from Lewes river, about six miles above Rink rapid, also in the Yukon district. Coal, from Dunsinane, Kings county, New Brunswick; from a seam on the Stony Indian reserve, district of Alberta, North-west Territory; and from two seams on Collins gulch, Tulameen river, Yale district, British Columbia. Anthracite, from ten miles west of Dugdale station on the White Pass and Yukon railway, Yukon district, North-west Territory.

'2. Analyses of the following iron-ores :—Magnetite, from the townships of Litchfield and Sheen, Pontiac county, province of Quebec, and from a creek entering the Tulameen at Otter flat, Yale district, British Columbia. Specular iron from Cape Rouge, Inverness county, Nova Scotia. Siderite and limonite, from Hematite mountain, Michipicoten, Ontario; and bog iron-ore, from Chipman, Queens county, New Brunswick.

'3. Analyses, partial, of samples of copper-ore from localities in Joliette county, province of Quebec.

'4. Analyses, in regard to nickel content, of pyrrhotite from the township of Mattawatchan, Renfrew county, Ontario; and from Kyuquot, on the west coast of Vancouver Island, British Columbia.

Assays for gold and silver.

'5. Assays, for gold and silver, of samples of material from various localities in the districts of Cariboo and Cassiar, British Columbia, and from numerous localities in the Klondike area, in the Yukon district, as likewise from some localities on Great Slave lake, in the Mackenzie district, and others from Carleton county, in the province of New Brunswick.

'6. Analyses of building stones, that is to say, of a limestone from the fifth bed of Mr. Robillard's quarry, Ottawa front, township of Gloucester, Carleton county, and of a dolomite from the township of Ross, Renfrew county, in the province of Ontario; also the examination, in regard to its suitability for constructive purposes, of a sandstone from Prince Edward Island, and of another from near Dorchester, Westmoreland county, New Brunswick.

'7. Analyses, partial, of graphite from the township of Blythfield, Renfrew county, and from the townships of Bedford and South Canonto, Frontenac county, in the province of Ontario; and of disseminated graphite from Glendale, River Inhabitants, Inverness county, Nova Scotia.

'8. Analyses of natural waters—with the object of ascertaining their suitability for economic or technical purposes, or possible value from a medicinal point of view—from the undermentioned localities :—In the province of New Brunswick, from three springs on the Tobique river in Victoria county; and from a spring near Plumwessep station on the Intercolonial Railway, in Kings county. In the province of Quebec, from a spring in Bay of Seven Islands, Saguenay county; from a boring near St. Grégoire, Nicolet county; from a well in St. Paul l'Ermite, L'Assomption county; and from a spring at Ste. Rose, Laval county. In the province of Ontario, from a well on the property of Mr. Cole, township of Ramsay, Lanark county; and from a well at Tilsonburg, township of Dereham, in Oxford county. In the province of British Columbia, from a spring near Discovery claim, three miles up McKee creek, east side of Atlin lake, and from another spring on the east shore of Atlin lake, ten miles south of Atlin; also from a spring on Sharp point, on the west coast of Vancouver island. Chemistry and mineralogy—*Cont.*

'9. Analyses of several minerals not previously recognized as occurring in Canada, namely, of danalite, newberyite, schorlomite, struvite, uranophane, and wood-tin,—a variety of cassiterite (tin dioxide); all of which will be referred to in detail in my forthcoming report. Examinations have also been made of many minerals from localities where they were not previously known to occur, that is to say, of—altaite (lead telluride), from Little Nigger creek, East Kootenay district, British Columbia; amazon-stone, from islands at Paint hills, James bay, Ungava district; barite or barytes, from the township of Huntley, Carleton county, Ontario; danaite (a cobaltiferous variety of mispickel), from the township of Calumet, Pontiac county, province of Quebec; epidote, from Walrus island, Paint hills, James bay, Ungava district; erythrite (a hydrous arsenate of cobalt), from Bull river, East Kootenay district, British Columbia; gmelinite, from Red mountain, West Kootenay district, British Columbia; jamesonite (sulphantimonite of lead), from Kettle river, Yale district, British Columbia; lepidolite (lithia mica), from the township of Wakefield, Ottawa county, province of Quebec; magnesite (magnesium carbonate), from Pine creek and Indian Reserve, Atlin, Cassiar district, British Columbia; marl, from the township of Stafford, Renfrew county, Ontario; molybdenite, from island No. 12, Paint hills, James Bay, Ungava district, from the township of Brougham, Renfrew county, Ontario, and from Trail creek, West Kootenay district, British Columbia; mountain leather, from the township of Economy, Colchester county, Nova Scotia; sericite, Bonanza creek, Klondyke, Yukon district, North-west Territory; silver, native, township of Lybster, district of Thunder Bay, Ontario; sphalerite or zinc-blende, from the township of Bouchette, Ottawa county, province of Quebec; and New minerals.

Chemistry and mineralogy—*Cont.*

spodumene (a metasilicate of aluminium and lithium), from Walrus island, Paint hills, James bay, Ungava district.

Miscellaneous examinations.

'10. Miscellaneous examinations, comprising the examination of numerous samples of clay, in regard to their suitability for the manufacture of bricks—ordinary building bricks or fire bricks, or pottery, from localities in the provinces of Nova Scotia, New Brunswick, Quebec, Ontario, British Columbia, and the North-west Territory; of samples of ferruginous slates, iron-sands, iron-ochres, marls, carbonaceous shales, bituminous shales, and of a great variety of other material.

'In addition to the foregoing work, six hundred and sixty-three mineral specimens, have been examined and reported on. Of these, many were brought by visitors, the greater number, however, were received by mail or express from residents in various parts of the Dominion.

'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 forty-one; and of those received, to eighty-nine.

'Messrs. R. A. A. Johnston and F. G. Wait, assistants in the laboratory, have, by their close and unremitting application to the work in hand, rendered most efficient service. The former has made many important mineral analyses, and, in addition to carrying out a somewhat lengthy series of gold and silver assays, also conducted a great variety of micellaneous examinations; whilst the latter, has made numerous analyses of natural waters, as likewise of iron ores, limestones, etc., and also carried out many miscellaneous examinations.

Collections made by Mr. Broadbent.

'In the work connected with the mineralogical section of the museum, I have been very ably assisted by Mr. R. L. Broadbent. In addition to the general museum work—embracing the labelling and cataloguing of all newly received specimens, and the maintaining of the collection generally in an orderly condition—he has, during the absence of Mr. Willimott, in Paris, made up twenty-seven collections of minerals (included in the list given beyond) for distribution to certain Canadian educational institutions, and also spent some seventeen days in the collection of material for the making up of further collections for similar use, visiting, for this purpose, the township of Ross, in the province of Ontario, and the townships of Hull, Litchfield, Buckingham, Grenville and Chatham, in the province of Quebec. Whilst thus engaged, he obtained :—

Chemistry and mineralogy—*Cont.*

	Specimens.	Weight.
Albite	....	100 pounds.
Barite	....	150 "
Fluorite, green	156	
" purple	70	
Granite	....	100 "
Graphite	....	75 "
Jasper	....	150 "
Limestone	....	150 "
" (marble)	....	115 "
Mica	....	90 "
Microcline	....	115 "
Monazite	8	
Porphyry	....	100 "
Pyrite	27	
Quartz	....	125 "
Sandstone	....	200 "
Scapolite	130	
Serpentine	140	
Syenite	....	175 "
Tourmaline	200	
Uraninite, with gummite	12	
Wollastonite	112	
Zinc-blende	....	300 "
Miscellaneous	....	50 "

Contributions to museum.

'The additions to the mineralogical and lithological section of the museum, during the past year, amounted to one hundred specimens of minerals and one hundred and seventy specimens of rocks, of which latter, thirty-one, from the Upper Stikine river, B.C. were collected by V. H. Dupont, C.E., fifty, from the south-east of Dease lake, and thirty-nine, from the Skeena river, B.C. by J. S. O'Dwyer, C.E. Of the additions in question, the following were :—

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

Barlow, Dr. A. E. :—

Magnetite from the township of Dungannon, Hastings county,

Bell, J. M., from Mackenzie district, N.W.T.—

a. Siderite, from the south shore of Dease bay, Great Bear lake.

b. Hematite, from Rocher Rouge, MacTavish bay, east side of Great Bear lake.

c. Specular iron, from Echo bay, Great Bear lake.

d. Micaceous iron-schist, from Les isles du Large, Great Slave lake.

e. Hydromagnesite, from the south shore of Dease bay, some thirty miles S.W. of Fort Confidence, Great Bear lake.

Brock, R. W. :—

Molybdenite from the Giant claim, Rossland, West Kootenay district, B.C.

Contributions to museum—*Cont.*

McConnell, R. G., from Yukon district, N.W.T. :—

a. Lignite from Rock creek, Klondike river.

b. Lignite from Cliff creek, Yukon river.

c. Anthracite from about ten miles west of Dugdale station, White pass and Yukon railway.

d. Bornite and chalcopyrite from the Arctic Chief claim, White Horse Copper Belt, White Horse, Lewes river.

e. Bornite and epidote, from the Springhill claim.

f. Magnetite from the Valerie claim.

g. Hematite (specular iron) Pueblo claim.

h. Bornite from the Copper King claim.

i. Bornite from the Anaconda claim.

j. Bornite from the Carlisle claim.

k. Bornite from the Rabbits-foot claim.

l. Auriferous gravel, from Gold hill, Bonanza creek, and Sulphur creek, Klondike Gold Fields.

McEvoy, J. :—

a. Crystals of Andradite from six miles east of Crows Nest lake, district of Alberta, N.W.T.

b. Crystals of Almandite (altered), from the same locality.

McInnes, Wm. :—

a. Native silver, argentite and sphalerite from the West End mine, Silver mountain, township of Lybster, district of Thunder bay, O.

b. Fluorite, calcite, amethystine quartz, sphalerite and pyrite, from the Star mine, township of Strange, district of Thunder bay, O.

c. Fluorite, quartz, and calcite, with pyrite, from the Gopher mine, township of Strange, district of Thunder bay, O.

d. Magnetite from three miles north of the west line of the township of Strange, district of Thunder Bay, O.

e. Magnetite from half a mile west of Whitefish station, P. A. D & W. railway, township of Strange, district of Thunder bay, O.

f. Fifty rock specimens from the Thunder Bay and Rainy River districts, O.

(*B.*) *Received as presentations* :—

Craig, B. A. C., Canada Corundum Company, Toronto, O. :—

Ten samples of dressed corundum.

Contributions to museum—*Cont.*

Currie, T. W., Topographical Surveys Branch, Ottawa, O.:—

a. Carborundum (carbide of silicon) crystallized, 2 specimens.

b. Graphite, skeleton, after carborundum, the silicate having been eliminated.

c. Silicon, skeleton, after carborundum, the carbon having been eliminated.

De Wolf, Geo., Vancouver, B.C. :—

a. Coal from Collins gulch, Tulameen river, Yale district, B.C.

b. Gypsum from the Salmon river, Grande Prairie, Yale district, B.C.

Harrison, H. H., Halifax, N.S. :—

Galena from Faribault or L'Abîme brook, Cheticamp river, Inverness county, N.S.

Harrison, J. E., Madoc, O. :—

Talc from lot 14, con. XIV., Huntingdon, Hastings county, O.

Haycock, E. B., Ottawa, O. :—

Molybdenite from lot 15, con. X., Bagot, Renfrew county, O.

Kingston, Paul, Tichborne, O. :—

Graphite from lot 22, con. II., South Cannonto, Frontenac county, O.

Kuntsen, M., Salesund, Norway, per R. L. Broadbent :—

Model of a gold nugget from claim 36, Eldorado creek, Klondike Gold Fields, Yukon district, N.W.T.

McLellan, Allan, Ottawa, O. :—

Crystal of iron-pyrites from Elizabethtown, Leeds county, O.

Moffatt, J., Parry Sound, O. :—

Muscovite from lot 2, con. II. of Ferguson, district of Parry Sound, O.

Pearson, W., Paris :—

Bornite from about eight miles W. of White Horse rapids, Lewes river, Yukon district, N.W.T.

Pushie, Joseph, Malignant Cove, Antigonish county, N. S. :—

Chalcocite from a point on the shore of Northumberland strait, Antigonish county, N. S.

Ritchie, R. Mc., Bryson, Q. :—

Pyrrhotite from Calumet island, Pontiac county, Q.

Contributions to museum.—*Cont.*

Ross, Thomas, Little Rideau, O. :—

Celestite from the Little Rideau river, Hawkesbury, Prescott county, O.

Shirly, F. S., Glen Almond, Q. :—

Phlogopite (exteriorily altered to pinite) from lot 6, range III. of Derry, Ottawa county, Q.

Smith, E., Prescott, O.

Galena (crystals) from lot 18, con. VIII., Bedford, Frontenac county, O.

Soues, F., Clinton, B.C. :—

a. Native gold and native platinum, from the Ward claim, Horsefly Gold Mining Co., Horsefly river, Cariboo district, B.C.

b. Silicoeus tuff, from Cadwallader creek, Bridge river, Lillooet district, B.C.

c. Claystone from about four miles north of Clinton, Lillooet district, B.C.

d. Tertiary sandstone from about four miles north of Clinton, Lillooet district, B.C.

e. Concretions of arenaceous claystone from about four miles north of Clinton, Lillooet district, B.C.

f. Shell of 'Pecten caurinas', found under a three-foot layer of gravel, at a point exactly opposite Day Bar, on the Fraser river, and about eight miles north of Lillooet, B.C.

Thompson, W., Portage du Fort, Q. :—

Magnetite (group of crystals), from the township of Ross, Renfrew County, O.

Winans, Bush, Glen Almond, Q., per R. L. Broadbent :—

Fluorite and quartz (crystals) from the township of Derry, Ottawa county, Q.

Educational collections supplied.

'Collections of minerals occurring in Canada, have also been made up and sent to various educational institutions, of which the following is a list :—

1. Dorchester High School, Dorchester, N.B......	Consisting of	100	specimens.
2. Natural History and Antiquarian Society of P.E. Island, Charlottetown, P.E.I...............	"	100	"
3. County Academy, Liverpool, N.S..............	"	100	"
4. High School, Picton, O......................	"	100	"
5. High School, Vankleek Hill, O................	"	100	"
6. High School, Dunnville, O....................	"	100	"
7. Collegiate Institute, Orillia, O..............	"	100	"
8. High School, Mahone Bay, N.S..................	"	100	"

9.	Manitoba College of Pharmacy, Winnipeg, Man.	Consisting of	100	specimens	Educational collections—*Cont.*
10.	Public School, Cody's Station, N.B	"	75	"	
11.	Public School, Port Perry, N.S	"	75	"	
12.	Collegiate Institute, Clinton, O	"	75	"	
13.	Public School, Arragance Ridge, N.B..........	"	75	"	
14.	Public School, Inkerman, O..................	"	75	"	
15.	St. Louis de Gonzague Academy, Montreal, Q..	"	75	"	
16.	Public School, Thornetown, N.B...............	"	75	"	
17.	St. Roche Convent, Quebec, Q	"	75	"	
18.	College de Longueuil, Longueuil, Q............	"	75	"	
19.	Public School, Kempt Shore, N.S.............	"	75	"	
20.	High School, Bradford, O......................	"	100	"	
21.	Public School, Caraquet, N.B..................	"	75	"	
22.	Superior School, Maryville, N.B...............	"	100	"	
23.	Convent of the Sacred Heart, Halifax, N.S.....	"	75	"	
24.	Balaclava Street School, St. Thomas, O.........	"	75	"	
25.	Wellington Street School, St. Thomas, O	"	75	"	
26.	High School, Port Perry, O....................	"	100	"	
27.	High School, Sackville, N.B....................	"	100	"	
28.	High School, Dutton, O	"	100	"	
29.	Christian Brothers School, Laprairie, Q.........	"	75	"	
30.	Superior School, Port Elgin, N.B	"	100	"	
31.	Superior School, Hartland, N.B.................	"	100	"	
32.	Westmount Academy, Westmount, Q	"	100	"	
33.	Notre Dame Convent, Charlottetown, P.E.I....	"	75	"	
34.	St. Dunstan's College, Charlottetown, P.E.I....	"	100	"	
35.	Noel Graded School, Noel, Hants Co., N.S	"	75	"	
36.	Windsor Academy, Windsor, N.S.......	"	100	"	
37.	Lacombe Public School, Lacombe, Alta., N.W.T.	"	75	"	
38.	Convent of L'Assomption, L'Assomption, Q	"	75	"	
39.	Hotel Dieu School, Upper St. Bazile, Madawaska, Q.	"	75	"	
40.	Public School, Parleeville, N.B.......	"	75	"	
41.	Sisters of Congregration of Notre Dame, New Glasgow, N.S..................	"	75	"	
42.	Leonardsville Public School, Deer Island, N.B..	"	75	"	
43.	Public School, Weymouth Bridge, N.S.........	"	75	"	
44.	Grafton Advanced School, Grafton, N.B	"	75	"	
45.	Public School, Trenton, Pictou Co., N.S........	"	75	"	
46.	Borden Street School, Toronto, O	"	75	"	
47.	Public School, Summerville, N.S...............	"	75	"	
48.	Victoria School, St. John, N.B.................	"	75	"	
49.	Public School, Bear River, N.S	"	75	"	

'Three collections of fifty specimens each have also been prepared and forwarded to the Canadian Government Agency in Glasgow.

'Of the foregoing, the first twenty-five were made up by Mr. C. W. Willimott, and the remainder by Mr. Broadbent.

As explained on a previous page, the greater part of Mr. Willimott's time during the first half of the year was taken up in connection with preparations for the Paris Exhibition, and in the unpacking and installation of specimens in Paris.

MINERAL STATISTICS AND MINES.

Mineral statistics.

Of the work of this section Mr. E. D. Ingall reports as follows :—

'The regular functions of the section have been performed by the staff during the year.

'Our information regarding the economic mineral deposits of the country has been added to, including data as to discovery and development, as well as the statistics of the annual realization of the Dominion's income from these sources. This information has been added to our permanent records for purposes of reference and much of it is also embodied in the report of the section constituting part S of the Annual Report of the Survey.

'The preliminary summary statistical statement of the mineral output of Canada was ready February 27th, 1900, the fuller data not being available until much later in the year, the full report could not be completed till November 29th, 1900.

'Apart from the completion of the annual report much information was, as in the past, given in answer to inquiries. The collecting of data for this purpose constitutes a considerable factor in the work of the section. A very considerable amount of extra work also devolved upon the staff in connection with the issuing by the department of a descriptive catalogue of the mineral exhibit sent to the Paris exhibition.

Visits to mines.

'During the summer Mr. Denis and myself visited the magnetite deposits in the vicinity of Ottawa and in the district between Kingston and Pembroke, and made magnetic observations with the dip needle and dial compass at several points, bringing up to date also our knowledge of operations in those districts.'

PALÆONTOLOGY AND ZOOLOGY.

The following is Dr. J. F. Whiteaves' report upon work accomplished by himself or under his direction :—

Work by Dr. J. F. Whiteaves.

'The fourth part of the first volume of *Mesozoic Fossils* was published in November, 1900. It consists of forty-six large octavo pages of letter press, illustrated by two woodcuts in the text and by seven full-page plates.

'A description of an apparently new species of *Unio*, from the Wellington collieries at Nanaimo, B.C., that had been forwarded for examination by the authorities of the Provincial Museum at Victoria, has been written and communicated to the *Ottawa Naturalist.*

'In the *Geological Magazine* for September and October, 1900, five new species of long-tailed decapod crustacea, from the Cretaceous rocks of Comox, Hornby island (B. C.), and Alberta, have been described and figured by Dr. Henry Woodward, and an additional species, from Comox, and Hornby island, that had been previously described by the writer, but not figured, is fully illustrated. The types of each of these species are in the museum of the Survey. Palæontology and zoology—*Cont.*

'At various times during the year, seven small collections of fossils, mostly from the Corniferous limestone of Ontario, have been sent to the department for identification. The species contained in these collections have been determined, as far as practicable, and labelled, and the collections returned. Information about numerous single specimens of fossils has also been given, either by letter or verbally.

Catalogue of marine invertebrata.

'Considerable progress has been made with the manuscript of the Catalogue of the Marine Invertebrata of Eastern Canada, which was commenced in the fall of 1899. About 345 foolscap pages of this catalogue have now been written, though some of these will yet require a little revision. Of these, 45 pages are devoted to the Protozoa, Sponges and Cœlenterata, 15 to the Echinodermata, 45 to the Annelida, 29 to the Polyzoa, 136 to the Mollusca, 65 to the Crustacea, and 10 to the Tracheata. The introduction, which is intended to consist of a brief synopsis of the progress of zoological explorations by the dredge or otherwise, in the Gulf of St. Lawrence and Maritime provinces, from 1852 to the present date,—and the part specially referring to the Tunicata, have yet to be written. The manuscript that has been written so far has necessitated a large number of verifications of references, and some correspondence with naturalists in the United States and Europe. In this connection it may be mentioned that Professor Verrill, of Yale University, who has recently been making a study of the difficult molluscan genus *Bela*, has kindly named all the Canadian species of that genus, whether from the Atlantic or the Pacific.

Zoological collections.

'The publication of the first part of Professor Macoun's Catalogue of Canadian Birds has directed attention to some deficiencies in the Survey's zoological collection. During the past year efforts have been made to supply these deficiencies, and incomplete sets of the eggs of about thirty species have been gradually replaced by full and complete ones. Among the latter are a full set each of the eggs of Wilson's Snipe and the Long-billed Curlew, from Assiniboia; of the Prairie Hen, from Manitoba; of the Sharp-tailed Grouse, from Alberta; of the Turkey Vulture, from Assiniboia; of the American Goshawk, from Alberta; of the Screech Owl, from Toronto; and Short-eared Owl from Assiniboia; of the Rufous Hummingbird, from Banff; and Lark Sparrow, from Toronto. Fine photographs of the nesting places of several species of Canadian birds have also been acquired, in exchange for similar prints from our own negatives. A collection of recent land and fresh-water shells from Washington, Ontario, and three species of

Palæontology and zoology—*Cont.*

Unionidæ from the neighbourhood of St. John, N.B., that had been sent for identification, have been named and returned to the senders.

Work by Dr. H. M. Ami.

'Dr. H. M. Ami says that the "greater part of his time during the past year has been devoted to office and museum work. Two weeks in July were spent in an examination of the Silurian formations in Antigonish county, Nova Scotia, and their inclosed faunas. A few days in August were employed in examining certain limestone quarries in Eastern Ontario with a view to determining the precise geological horizon and formation to which they belong. Considerable time was also spent in determining species of fossils from various horizons in the Palæozoic, as well as in making a revision of those from the Pleistocene, of the Ottawa valley."

"Some progress has been made in the preparation of a catalogue of Canadian fossils, and systematic tables of the succession of various geological formations are now being prepared as a basis for such a catalogue. A card catalogue of the geological formations and fossils of Canada and references thereto is greatly needed, and the commencement of such a catalogue has been made."

Specimens sent out for examination.

"With a view to obtaining all the information possible, from a palæontological standpoint, upon important geological questions as to the age and correlation of certain Palæozoic sediments in Nova Scotia, several collections were prepared by Dr. Ami during the past year, and submitted to the following gentlemen:—to Dr Henry Woodward, F.R.S., Keeper of the Department of Geology at the British Museum, London,—a series of protolimuloid and other Crustaceans from the marine Carboniferous limestones of Kentville creek, and from Harrington river, Cumberland county, N.S.; to Dr. Wheelton Hind, F.R.S., of Roxeth House, Stoke-upon-Trent, England—various genera and species related to *Anthracomya* and *Naiadites* from numerous localities and horizons in Colchester, Pictou and Cumberland counties, also from Cape Breton; to Mr. Robert Kidston, F.R.S., of Stirling, Scotland—a series of Lycopodiaceous plants from the Carboniferous of Nova Scotia; to Messrs. Charles Schuchert and G. H. Girty, of the United States National Museum, Washington, D.C. — a series of marine invertebrates from numerous localities and horizons in the Carboniferous, also a small collection of fossils from the Torbrook sandstone formation of Annapolis county, N.S. From these gentlemen reports have been received giving important notes upon the age to which the various floras and faunas represented are to be assigned. The department is greatly indebted to these gentlemen for their valuable assistance."

Determination of fossils.

"Preliminary determinations of fossils from various localities comprised within the Three Rivers map-sheet, Quebec, by the writer contains classified lists of the fossils determined from numerous collections made by officers of the Geological Survey from the counties of Joliette, Berthier and Maskinongé, on the north side of the St. Lawrence.

Palæontology and zoology—*Cont.*

" Preliminary notes were prepared for Prof. L. W. Bailey on various collections of fossils from Carleton and York counties, New Brunswick, with a view of ascertaining the geological horizon indicated. The collections included Silurian strata (with *Monograptus* in abundance) from above Campbell's mill, Beccaguimic river, in Carleton county, N.B.; Silurian strata somewhat higher in the series and holding fragments of crinoids, etc., from Waterville in Southampton parish, York county, N.B.; and Lower Ordovician impure limestones from above Shaw's mill, Beccaguimic river, N.B.; on two collections of *Dictyonema* from near Benton village, Eel river. The latter at first seemed to indicate an horizon similar to the slates of the Kentville formation in Kings county, Nova Scotia, where *Dictyonema Websteri*, Dawson, is the characteristic fossil, in the altered slates of that formation referred to the Silurian system. Better material from the second collection enabled the affinities of the species to be much better understood, and when compared with specimens of *Dictyonema flabelliforme*, Eichwald, from the Upper Cambrian slate of Matane, Que., of Barachois, in Cape Breton, and of Navy island near St. John, N.B., as well as with the figures and descriptions of this species according to Carl Wiman, there was scarcely any doubt left as to the identity of Eel river specimens with the Upper Cambrian species.

" Additional notes on a small but important collection of specimens from a black carboniferous altered shale from Springfield brook, five miles from Fredericton, N B., collected by Mr. W. H. T. Reed, were prepared and transmitted to Prof. Bailey, to be incorporated in his report upon the geology of that portion of New Brunswick.

" Some time was also spent in a critical study of Mr. T. C. Weston's collections of Ordovician fossils from Quebec city, obtained in 1890, and a list was prepared of the species therein recognized. In response to special inquiries or requests for information, a number of short reports or memoranda have also been prepared from time to time during the year, but these it is unnecessary to specify in detail.

Study of the Arisaig fauna.

" Having received instruction to describe and illustrate the fauna of the Silurian formation at Arisaig, Nova Scotia, the writer has begun his task by arranging the collections of Arisaig fossils already in the possession of the Geological Survey Department into natural formational divisions, ascribing certain faunas and strata to certain formations. Through the kindness of Profs. Whitfield and Bickmore, of the American Museum of Natural History, New York, where many of the original types of Nova Scotia species are deposited, the trustees of

Palæontology and zoology—*Cont.*

that museum have generously consented to allow these types to be re-examined and if necessary refigured so as to ensure greater accuracy and critical comparison with the species represented in various other collections in the Ottawa museum to be examined. These latter include the series of Arisaig fossils now in the museum of the Geological Survey of Canada, the Weston collection of 1886, and other collections by the writer, made for the most part during the past summer when the strata were found to be divisible into four series in descending order, as follows :—

Proposed subdivisions of the section.

"*The Stonehouse formation,* consisting of red shales, holding a highly pelecypodous fauna, mudstones and interstratified bands of limestone.

"*The Moydart formation,* consisting for the most part of light or greenish-white compact fine-grained silicious limestone and shales holding cephalopoda, brachiopoda, vermes and trilobita, with occasional crinoidea and pelecypoda.

"*The McAdam formation,* consisting of very dark-gray or almost black, carbonaceous and at times slightly calcareous, shales and mudstones, carrying a lamellibranchiata fauna. It also contains brachiopoda in thin lenticular sheets of limestone interstratified between the shales.

'*The Arisaig formation* consisting of light yellowish or buff weathering arenaceo-magnesian limestones, shales, etc., interstratified with bands of shale, etc. Corals, brachiopoda, bryozoa, trilobites and gasteropoda are prevalent types in this formation.

"These formations are based upon palæontological as well as lithological characteristics and appear to be less arbitrary than the divisions A, B, B′, C, and C′, D, of former writers.

"The "red stratum" is not a good dividing line, as the strata both above and below it are of the same origin and hold similar types of organisms.

Limestones in eastern Ontario.

"In company with Dr. R. W. Ells, a number of the limestone quarries of eastern Ontario, were visited including those in the vicinity of L'Orignal, Hawkesbury, Vankleek Hill and Little Rideau, Butler's quarry, Murray's quarry, Huneau's quarry, Milner's quarry, Ross's quarry. At these we made a careful study of the formational characters of the various limestones examined so as to be able to correlate, separate or identify the different horizons represented. Some of the limestones examined belonged to the Trenton, others to the Birdseye and Black River, and others to the Chazy formation, whilst others formed transition strata between the last mentioned and the Calciferous formation.

"Considerable time was spent in sorting, classifying and naming various collections of Pleistocene fossils from the marine clays, sands, gravels and calcareous concretions obtained during the past few years by the staff and local collectors in the Ottawa valley. The clays were found to abound in foraminifera and several additions to the fauna of the marine Pleistocene deposits of this region were noted and placed on record. Messrs. Walker and Mortimer Odell, G. L. Burland and Harold Nelson, have contributed several interesting forms new to the Ottawa Pleistocene list.

Palæontology and zoology—*Cont.*

Pleistocene fossils.

"Preliminary notes upon a number of collections of fossils by E. Le Roy, of McGill University, were prepared with a view of ascertaining the various geological formations and horizons represented in said collections. These were named as far as mode of preservation and condition of specimens allowed, and included an interesting series from Upper St. Hubert, Côte St. Michel, Outremont, the Annex and other localities around the city of Montreal.

"During the past year the following papers were written :—

Publications.

"On some Trenton (Ordovician) fossils from the light-gray limestones of Cumberland, Ontario, published in the *Ottawa Naturalist*, for January, 1900.

"On the subdivisions of the Carboniferous system in Eastern Canada, published in the *Transactions of the Nova Scotia Institute of Science*, for June, 1900.

"Notes bearing on the Devono-Carboniferous problem in Nova Scotia and New Brunswick.

"The Fossil Floras of the Pottsville formation published in the *Ottawa Naturalist*, for October, 1900.

"On the occurrence of a species of *Whittleseya* in the Riversdale formation (Eo-Carboniferous) of the Harrington river, Nova Scotia, published in the *Ottawa Naturalist* for August, 1900.

"Synopsis of the Geology of Canada, with special reference to the nomenclature of the various formations, read before the May meeting of the Royal Society of Canada, and now in the press.

"Progress of geological work in Canada during the year 1899, *Can. Record of Science*, for July, 1900.

"Bibliography of Sir J. William Dawson for the *American Geologist*, July, 1900, pp. 1-47.

"Brief reviews were prepared for the *Annales de Géographie*, of Paris, France, for *Bibliographia Geologica* of Brussels, Belgium, also for the *Geologische Centralblatt*, of Berlin, Germany, and

Palæontology and zoology—*Cont.*

abstracts of the various publications bearing upon the geology and geography of British North America during the year 1899 and 1900.

Examination of drillings.

" A number of drillings from various localities submitted to the department from time to time have been examined and information as to the formation represented in these bore-holes has been given to those interested. Suites of specimens of this kind have been examined from Stratford, Hepworth, Palmerston, Mt. Forest, Walkerton, Rockliffe Rifle Range and Gloucester, in Ontario, and from St. Paul l'Hermite, Turkish Baths artesian well, etc., in Quebec.

" Entries were also kept and records made of the ethnological and archæological collections obtained during the year."

Work by Mr. L. M. Lambe.

'Mr. L. M. Lambe reports that in the early part of the year, the report on recent marine sponges, referred to in last year's Summary as fairly under way, was finished. This report, descriptive of monaxonid, tetractinellid and calcareous sponges from our north-eastern waters, has been published in the Transactions of the Royal Society of Canada for this year, under the title *Sponges from the Coasts of North-eastern Canada and Greenland*, and consists of nineteen pages of text illustrated by six plates of figures. These sponges were placed in in Mr. Lambe's hands by Professor D'Arcy Thompson, of University College, Dundee, Scotland, who has since presented to this department an almost complete duplicate set of the species described or mentioned in the report, an addition to the already large and representative collection of Canadian sponges in the museum, that is of considerable scientific interest.

Publications

'At later dates the following papers on recent sponges were published in the Ottawa Naturalist :—"*Description of a new species of Calcareous Sponge from Vancouver Island, B.C.*" "*Notes on Hudson Bay Sponges.*" "*A Catalogue of the recent Marine Sponges of Canada and Alaska.*"

Investigation of Cretaceous vertebrates.

'Having received instructions in April last to prepare a report on the vertebrate remains from the Cretaceous rocks of the Red Deer river, Alberta, collected by me during the summers of 1897 and 1898, my time has since been almost entirely devoted to a study of these remains, but more particularly to those of the Dinosaurs. A preliminary report on these collections, in which Chelonia and Crocodilia are represented, as well as Dinosauria, has already appeared in the Summary Report for 1898. The difficulty of arriving at a proper understanding of the generic and specific relationships of many of the bones to each other, and of their affinities, is enhanced by the very scattered state in which they were found. Fair progress has, however, been made in the elucidation of many of the above questions, a result attained with the co-operation of Professor Henry F. Osborn, of the American Museum of Natural History, New York, who has consented to exercise a general supervision over this work as it proceeds. Considerable time has necessarily been spent in putting together and strengthening some of the larger specimens, that were in the condition in which they were brought in from the field, to allow of their being moved or handled for the purpose of study or illustration. A number of India-ink, shaded drawings, to be reproduced in the plates supplementing the report, have already been made.

Palæontology and zoology—*Cont.*

'In connection with this work a week was spent by Mr. Lambe, in June last, in the department of Vertebrate Palæontology of the American Museum of Natural History in New York, where Professor Osborn afforded him every facility to study the collections and to familiarize himself with the methods employed there. Mr. Lambe also at this time paid short visits to Princeton and Yale universities, where, by the kindness of Professors W. B. Scott and C. E. Beecher, respectively, he saw much interesting vertebrate material.

'Some time has been devoted by Mr. Lambe to the final revision of his second report on fossil corals, which is now in the press. This report forms the second part of the fourth volume of *Contributions to Canadian Palæontology*; it concludes "A revision of the genera and species of Canadian Palæozoic Corals," and is descriptive of "The Madreporaria Aporosa and the Madreporaria Rugosa," the first part, published last year, having for its scope, a description of the "Madreporaria Perforata and the Alcyonaria."

'A number of fossil corals, from the Trenton rocks of Baffin Land, were named for Mr. Charles Schuchert, of the United States National Museum, Washington, D.C., who in return presented this Department with some of the duplicate specimens and a co-type of a new species. described by him.

'During the past summer Dr. G. F. Matthew continued his exploration of the Cambrian areas of Cape Breton, but was able to devote only a few weeks to this work.

Work by Dr. G. F. Matthew in Cape Breton.

'Owing to this he gave himself chiefly to the study of the Etcheminian or Lower Cambrian, and the collection of its fossils. The purpose of this study was to note the succession of the species which occur in this group of beds, so that this knowledge may be available for determining the age of parallel beds elsewhere.

'He found a more complete succession of groups of strata in this series than was observed last year, and that the volcanic beds beneath are essentially a part of the series and contain similar fossils.

Groups determined.

'The slates and sandstones above the volcanic beds are divisible into three groups—the lower chiefly gray shales or slates, the middle chiefly

Contributions to museum—*Cont.*—

red with some gray, the upper chiefly gray with some reddish beds. The middle or red group, which is usually more firmly cemented and of coarser materials than the rest, is often liberally charged with diffused red oxide of iron. This has been seen to form layers rich in iron, or even thin seams of hæmatite, which have in several places been exploited for iron ore. This red member is present whenever the Etcheminian series has been found.

'While it can be shown that continuous changes took place in the Etcheminian faunas, there was such an incursion of new species at the base of the upper slates that these practically contain a new fauna, different from that which fills the layers of the lower and middle groups.

'As the fauna found last summer in shales in the volcanic rocks below the Etcheminian sediments does not differ more from that in the lower Etcheminian shales than this differs from the fauna in the upper shales, these volcanics may not be separated from the sedimentary system above.

Predominant elements of fauna.

Brachiopods and ostracods form the predominant element in the Etcheminian fauna. *Lingulella*, *Obolus* and *Leptobolus* are the three most noticeable genera of brachiopods in this fauna, though *Acrotreta* and a new genus, *Acrothyra*, are common. The latter is specially characteristic of the Etcheminian beds, and *Acrothele* has been found only in the upper fauna. There are two peculiar genera of ostracods in the Cape Breton Etcheminian.

Evidence of currents.

'Evidence was obtained of the existence of a north-east current over one district where the Etcheminian beds are found, for a great part of Etcheminian time, but the observations made were not sufficiently extensive to determine whether this current was a tidal one, or a marine current setting continuously in the direction indicated.

'Great differences were observed in the thickness of the Etcheminian rocks in different areas, hence the determination of the proper chronological succession in this group is important.

'Some problems of this investigation are still unsolved, *e. g.*, the placing of some faunal bands and the examination of the eastern and southern sides of the Mira basin.'

The following is a list of specimens collected by or received from officers of the staff during the year 1900:—

Dr. G. M. Dawson:—

Wing of fossil insect, "probably one of the planipennian neuroptera," according to Dr. S. H. Scudder, from the Kootanie group of Cretaceous rocks of the Crows Nest Pass.

Contributions to museum—*Cont.*

Dr. G. M. Dawson and James McEvoy :—

Eighteen specimens of fossil plants from the coal-bearing rocks of the Kootanie series at Michel Station, B.C., on the Crow's Nest branch of the Canadian Pacific railway.

Professor L. W. Bailey :—

About fifty specimens of black, indurated, fossiliferous slate, holding fragments of *Dictyonema flabelliforme*, Eichwald, from near Benton, Eel river, N.B.

About twenty specimens of black graptolitic (*Monograptus*) shales from the Silurian of York county, above Campbell's mill ; and about ten specimens of dark-gray and black impure limestone, from above Shaw's mill, both on the Beccaguimic River, N.B.

Ten specimens from a light-gray altered crinoidal limestone, probably of Silurian age, from Waterville, York Co., N.B.

R. G. McConnell :—

Portion of skull of extinct bison, possibly *B. laticornis*, Leidy, found in a layer of 'muck' about fifteen feet below the surface of the ground on claim No. 17, Gold Run creek, Klondike district, Yukon.

Dr. H. M. Ami :—

About 750 Silurian fossils from the Arisaig coast, Antigonish Co., N.S.

Twenty-five fossils from the Lower Devonian rocks at McAras brook, Antigonish Co., N.S. These are found to be remarkably similar to the Cornstone fossils of Herefordshire, England.

Collections of fossils from the Calciferous, Chazy, Trenton, Utica and Pleistocene formations of the Ottawa valley, including specimens from several limestone quarries in the neighbourhood of L'Orignal and Little Rideau, eastern Ontario.

James McEvoy :—

Twenty-six fossils from the Carboniferous rocks near Elk river, East Kootenay; and twenty from the Kootanie series near Fernie, B.C.

The additions to the palæontological, zoological and ethnological collections from other sources during 1900, are as follows :—

By presentation :—

(A.—*Palæontology*).

U. S. National Museum, Washington, D C. ; per Hon. C D. Walcott :—

Contributions to museum—*Cont.*

Eight specimens of *Laotira cambria*, and five of *Brooksella alternata*, Walcott (two species of fossil Medusæ), from the Middle Cambrian of Alabama.

Eight specimens of *Beltina Danai*, Walcott, from the Algonkian of Montana.

U.S. National Museum, Washington, D.C.; per Charles Schuchert:—

One specimen of *Plasmopora Lambi*, Schuchert, from the Trenton limestone at the head of Frobisher bay, Baffin Land; and three specimens of *Protarea vetusta*, from the Cincinnati group (Hudson River) of Oxford, Ohio.

Colonel C. C. Grant, Hamilton, Ont:—

Forty-eight fossils, mostly sponges; from the Niagara formation near Hamilton.

Sixteen small parcels of fossils from the Niagara formation at Hamilton and Grimsby, and from the Cambro-Silurian (Hudson River) drift of Ontario.

J. A. Gray, Dorchester, N.B.:—

Fossil plant from the centre of a large boulder that was broken up on the ridge near the penitentiary quarry at Dorchester.

Dr. A. P. Coleman, Toronto:—

Two fossil corals from Brazeau, Alberta.

F. Soues, Clinton, B.C.:—

Six specimens of a small fossil bivalve shell (*Sphærium*) from Ward claim, one of the deep gravel beds on the Horsefly river, Caribou district, B.C.

H. S. Poole, Stellarton, N. S.:—

Specimen of *Stigmaria ficoides*, with the internal structure unusually well preserved, from the third seam, Albion mines, Stellarton.

W. J. Wilson, Otttawa:—

Leaf of willow or poplar, found in a calcareous nodule at Besserer's grove, near Ottawa, in 1899.

T. C. Weston, Ottawa:—

Contributions to museum—*cont.*

Fine specimen of a graptolite (*Tetragraptus approximatus*, Nicholson), from Point Lévis, P.Q.; and small piece of limestone holding crinoidal fragments, from near Dufferin Terrace, Quebec.

(B.—*Zoology*).

Professor D'Arcy W. Thompson, Dundee, Scotland:—

Seventeen specimens of fifteen species of rare sponges, from the Gulf of St. Lawrence, Davis Strait, East Greenland, etc.

Professor G. T. Kennedy, Windsor, N.S.:—

Twelve specimens of four species of marine shells dredged in Minas Basin; and one specimen of a recent brachiopod (*Terebratulina septentrionalis*) taken on a trawl line at Tiverton, Digby Co., N.S.

A. L. Garneau, Ottawa:—

Female, nest and set of twelve eggs of the Carolina Rail, the latter taken June 18, 1900, from the Mutchmor driving-track.

Captain W. Thorburn, Pine Lake, Alberta:—

Set of fourteen eggs of the Sharp-tailed Grouse (*Pediocœtes phasianellus*) and set of five eggs of the Bank Swallow (*Clivicola riparia*) from Knee Hill creek, Alberta.

G. G. Pearce, Toronto:—

Stuffed specimenof a nearly pure white Snowy Owl (*Nyctea nivea*) said to have been shot in Manitoba.

Walter Raine, Toronto:—

Egg of Puffin (*Fratercula arctica*).from the Gannet islands, Labrador.

Set of four eggs of the Lark Sparrow (*Chondestes*) from Ontario, and a full set each of the eggs of 20 other species of North American birds.

Dr. C. Morse, Ottawa:—

Specimen of a sponge (*Chalina oculata*) from Black point, Liverpool harbour, N.S.

Master C. S. Morse, Ottawa:—

Specimen of the same sponge, from a ledge at Beach Meadows, Queens county, N.S.

Harold F. Tufts, Wolfville, N.S.—

Set of six eggs of the Tree Swallow (*Tachycineta bicolor*) from Wolfville.

Rev. G. W. Taylor, Nanaimo, B.C.:—

Two hexactinellid sponges (*Rhabdocalyptus Dawsoni* and *Aphrocallistes Whiteavesianus*) from Gabriola island, B.C., and two calcareous sponges (*Sycon protectum* and *Leucandra Taylori*) from Nanaimo, B.C.

S. W. Kain, St. John, N.B.:—

Three species of recent Unionidæ from New Brunswick.

J. W. Tyrrell, Hamilton, Ont. :—

One set each of the eggs of the Red-throated Diver, Long-tailed Duck, Spotted Sandpiper, Rock Ptarmigan, Rough-legged Buzzard, Horned Lark, American Magpie, and of two undetermined species of birds; from Artillery lake, N.E. of Great Slave lake.

(C.—*Archæology and Ethnology.*)

W. J. Rickie, Manotick :—

Rapier and stone implements, from near Manotick, Ont.

F. Dunn, Barry's Bay, Ont.:—

Two stone skin-scrapers, from Welshmans island, Barry's bay, Renfrew county; per Dr. A. E. Barlow.

A. Boyer, Ottawa :—

Jade adze, from the Tahltan summit, Teslin trail, B.C.

W. J. Wintemberg, Washington, Ont.:—

Stone chisel, three arrow heads, bone awl and six fragments of pottery, from Waterloo and Oxford counties, Ont.

F. Soues, Clinton, B.C. :—

Perforated shell (a valve of *Pecten carrinus*) found three feet below the surface, opposite Day bar, on the Fraser river; per Dr. G. C. Hoffmann.

By exchange :— Contributions to museum—*Cont*

Ornamented pipe-bowl and sixty-three fine arrow and spear heads of various shapes, from the Brant River reservation, Ontario; from F. Burnett, Nelson, B.C.; per R. W. Brock.

By purchase :—

Sets of the eggs of eleven species of Canadian birds; from Walter Raine, Toronto.

Four large carved house-posts from Old Nawhitti, Hope island, B.C., and other objects illustrative of the manners and customs of the Kwakiool Indians; per Dr. C. F. Newcombe, Victoria, B.C.

Stone pestles, chisels or scrapers, arrow- and spear-heads and bone implements from Hammond midden, B.C.; spear points, pestles, slate knives, scrapers, polishing and grinding stones, jade implements and ornaments, from Boundary bay midden, B.C., and a wooden implement from Chilliwack, B.C.—in all, sixty specimens; from C. Hill-Tout, Vancouver, B.C.

Earthenware pot, stone-pipe and other objects of Indian manufacture, from Bancroft, Ont.; from W. Mulcahey.

NATURAL HISTORY.

Report of the naturalist.

Professor John Macoun reports as follows on the work done by him and under his immediate direction during the past year :—

'Since the close of my last progress report, the work of the office has gone on as usual. During the year just closing I have had no assistance in the office, as Mr. James M. Macoun, in January and February was engaged on work for the Paris Exhibition, and since March has been in Paris in connection with the same work. While there he represented this Department at the meetings of the International Congress of Botanists and took part in several of the discussions. He also availed himself of his residence in Paris to visit all the principal herbaria and was enabled to see nearly all the botanical specimens collected in Canada by early French botanists. He returned in time to resume his regular duties at the opening of the new year.

Catalogue of birds.

'Besides the routine work of the office, I was enabled to publish the first part of my Catalogue of Canadian Birds, including the water birds, gallinaceous birds and pigeons, containing 218 pages. This work has been well received by ornithologists, both in Europe and

Natural History—*Cont.*

America. This catalogue occupied my time up to June, when at your request I entered upon a Natural History examination of Algonquin Park, a reservation lately set apart in northern Ontario for the conservation of water and the preservation of game and fur-bearing animals.

Field work.

'Mr. William Spreadborough, who had been my field assistant for so many years, was engaged, and from May 25th until August 24th was employed in collecting specimens and making observations. Early in June I went into the field myself, and closed work on August 25th. The results of this examination will appear in another part of this summary.

'On my return from the field I found much correspondence awaiting me, and this with the naming of plants and the examination and determination of my own collections and the ticketing of plants of former years, has had to be attended to. Besides the 900 species of my own collecting, I have named collections from Prince Edward Island, New Brunswick, Quebec, Ontario, Rocky mountains and British Columbia, making in the aggregate fully 2,500 species.

'As you are aware, my most important work at present is the second part of the Bird Catalogue. This is well under way, and will likely reach the printer in spring. My knowledge of our fresh water fishes has increased so much that I would propose to take the cataloguing of these up after concluding the Bird Catalogue. Part VII. of the Catalogue of Canadian Plants, which is to include the lichens, liverworts and characae, is almost written, and will be ready for the printers in March.

Skins in museum.

'In this connection I may mention that we have at present, besides the birds and mammals mounted and in the cases, over 2,000 skins in cabinets, representing all the small mammals hitherto found in the Dominion, and all the smaller species of birds. I have recorded nearly 100 reptiles as occurring in the Dominion, and of these I have now named and preserved in alcohol almost eighty species. Nearly 100 species of fresh water fish were also preserved in alcohol and most of them named.

'Besides my own collections of plants made in Algonquin Park, we have received a fine collection from Banff, Alta., made by Mr. J. N. Sanson, and another by Mr. Gwillim, at Atlin, British Columbia. In the latter are a few species that are extremely interesting, as they, with those of last year, show that there is a group of species at Atlin we are still imperfectly acquainted with.

'From places external to Canada we have received several important additions to the herbarium by donation or exchange, among which are the following :— Natural History—*Cont.*

'Kew Herbarium, London, England. Presented by the director. A large box of plants, chiefly grasses, numbering over 500 species.

'United States National Museum. Presented by the botanist. Collections from Greenland, Baffin Land, and from South Dakota and other states of the Union, not less than 1,000 species. Specimens received.

'New York Botanical Garden. Presented by Mr. Britton. 741 species of plants, chiefly from the United States Yellowstone National Park.

'Natal Botanic Garden, South Africa. Presented by the director. 251 native species in exchange for Canadian specimens.

'Louisiana Plants. Carleton R. Ball. A set of 235 species given in exchange for Canadian plants.

'The following pages refer particularly to my work in the Algonquin Park :—

'Algonquin Park is an extensive tract of country about forty miles by thirty-six in the southern part of the Nipissing district. The Parry Sound railway enters it near the south-eastern corner and passes through it in a north-westerly direction, leaving it a few miles east of Scotia Junction, where this railway crosses the branch of the Grand Trunk, which passes from Bracebridge to North Bay on Lake Nipissing. Its southern boundary is the Haliburton district and northerly it extends nearly to the Canadian Pacific railway as it passes west between Mattawa and North Bay. It may be characterized, in a general sense, by saying it is a land of lake and forest. A close examination of a large part of it would show that at least one third was lake and the remainder mostly fine old forest. Although elevated, it is in no sense mountainous, and, indeed, large portions cannot even be described as hilly. Between the lakes there is usually a gentle roll in the country, but the land seldom rises one hundred feet above local water levels. It is thus well adapted for a park reservation, and its value will become more apparent as the country to the south and east becomes more deforested than it is at present. Five considerable rivers have their sources in it, and descend in all directions except to the north-west, where the Amable du Fond has its source. This river drains the north-western part easterly and then flows northward to the Ottawa. Natural features of Algonquin Park.

'The Petawawa is the chief river within the park. Rising in the township of Butt, about the centre of the western side it unwaters a large series of lakes and lake-expansions and without muc hfall The Petewawa river.

Natural History—*Cont.*

gathers all their overflow in White Trout lake, a beautiful sheet of water about four miles long and three wide in the broadest part. This lake is in the centre of the park and is a reservoir of clear cold water that when well stocked with game fish will be a resort for fishermen and of very easy access. Leaving this lake the river flows easterly, passing through Red Pine lake, Burnt lake, Perley lake and Catfish lake, and descends into Cedar lake by a series of falls and rapids. Cedar lake is another reservoir, and besides the Petewawa, receives the Nipissing from the west and other small rivers from the north. Cedar lake is easily reached, being situated only twenty-five miles from Deux Rivières on the Canadian Pacific railway, and in time must be a great rendezvous for fishermen, as the canoe-routes ramifying from it as a centre extend to every part of the park. The lake itself is eight miles long, and with Cauchon lake, which is a river-like elongation at the western end it is not less than nine and a quarter miles long. Leaving Cedar lake the Petawawa descends to Trout lake and there leaves the park, entering the Ottawa river at Pembroke. The Muskoka river, by its various branches, drains the south-western side, and Canoe and Smoke lakes are the reservoirs into which the smaller streams and lakes discharge. The Madawaska rises in Source lake in the township of Peck, and in Cache lake finds its first reservoir, passing thence to Rocky lake and soon after leaves the park. Great Opeongo lake is the source of the Opeongo river, a branch of the Madawaska, and is itself the largest body of water within the park.

Lakes of Algonquin Park.

'It may be said that there are hundreds of lakes scattered through the park in every direction, and these with their connecting portages constitute both the summer and winter lines of communication. Many of these lakes are mere depressions below the general level and are not reservoirs except in a limited sense. All, however, contain pure water and with a few exceptions have rocky or sandy margins and good beaches at low water. This can be said of Great Opeongo lake, Cedar lake, Catfish lake (at present), Burnt lake, White Trout lake, Island lake, and many others. On the other hand, the beauty of Canoe lake is destroyed by the Lumber Company putting up a dam and keeping the water backed up permanently. Cache lake, where the park head-quarters are, and White's lake to the west of it, have also been permanently injured by the water being allowed to remain too long in the spring. The damming up of Cache lake is a real detriment and injury to the park, as the trees have been killed all around its shores and the former swamps have become stagnant marshes filled with dead trees. To this lake all sportsmen and summer visitors resort because it is easy of access by the Parry Sound railway. Here also is the residence of the superintendent, and so far as known at present the best lake for trout. During June and early July of the present year (1900) the water was so stagnant that many of the minnows were found to be affected by a fungous growth. The water improved as the lake was allowed to approach its original level at a later date in the summer, but, unfortunately, and for no known reason, it is never allowed a free outflow. An outbreak of fever may be looked for at any time at Canoe lake and Cache lake, owing to the stagnant water. Island lake has a fine beach in many places, with rocky shores in others, and many lovely islands. The water is pure, there are no marshes nor dead trees, and the same remarks might be made of all those lakes characterized as reservoirs.

Natural History—*Cont.*

'The forest within the park is still largely in a state of nature, except that the white pine has been cut out more or less completely everywhere. There are still quantities of uncut timber, however, on many limits, and many years will elapse before all of it can be removed. On Burnt lake, Perley lake and Catfish lake, young forests are growing up, and in the woods along these lakes the problem of re-foresting on nature's own plan is in progress. Around Catfish lake a young forest of pine, the trees ranging from six to fifteen inches in diameter and from fifty to one hundred feet high, has grown up, and the remains of an older growth show that poplar and white birch have been as plentiful fifty years ago as they are now along Perley lake, where the forest was evidently swept off less than twenty years ago. Any one looking at the forest along Perley lake would think that pine had ceased to grow there. Yet on the portages it was found that pine is in abundance everywhere, ranging from ten to fifteen years old, but much less in height than the poplar and birch. In the course of thirty years more, the pine will overtop the poplar and birch and other low growing trees, and smother them completely out as has occurred at Catfish lake, or will constitute a mixed forest of deciduous trees and conifers as is found everywhere in the old forest.

Character of the forest.

'One burning of the forest never destroys the whole of the pine seeds, but if two or three burnings take place there is no hope of pine or conifers of any kind re-covering the soil. It is repeated fires in the same locality that makes replanting necessary. At present each government ranger is a fire guardian as well, and besides this each lumberman keeps a certain number of fire rangers on his limits, so that the park is amply guarded from extensive fires.

Effect of forest fires.

'The bulk of the old forest consists of black and yellow birch (*Betula lenta* and B. *lutea*), though sugar maple is quite common on the more elevated and drier hills. Beech, ironwood and a little black oak are found mixed with the maple, and through the whole forest is found balsam fir and white spruce, but in no case were they found in groves. There are few swamps or bogs, and cedar, tamarack and black spruce are infrequent except close to lakes and rivers. Elm and black ash are occasionally met with, but they are comparatively

Principal trees.

Natural History—*Cont.*

rare. Canoe birch is still found in remote situations capable of producing bark for canoes which are manufactured by the rangers.

Value of the park.

'The value of the forest as a covering for the soil and as a retainer of moisture cannot be overestimated. As a pulp producing region it is of little value, but its birch forests will yet be worth more than the pine.

'Perhaps after the conservation of the water in the soil, the next most useful effect of the park reservation is the protection of the larger mammals. Moose and the common or Virginian deer have already learned the value of protection, and hence they are found in greater numbers near the line of railway than in the remoter parts where man seldom comes. The reason for the common deer approaching the haunts of men is the safety to their young in the absence of wolves. This is seen by travellers and sportsmen who penetrate into the interior. For one deer seen in the heart of the park, half a dozen may be seen close to the railway.

Mammals.

'During July, both moose and deer are very easily approached and seem to take little heed of any one in a canoe. At this time they wade out into the lakes and ponds to feed on pond lily leaves which float on the surface, as well as on river weed (*Potamogeton*) which floats below the surface and has succulent roots. On one occasion in Otter Slide brook, we ran across a large bull moose that had waded out until he was up to his shoulders in the water. When we came upon him his head was all under water except the tips of his horns, and we paused while he began to raise his head from the water. We could not proceed as he blocked the way, but a slight noise made him shake the water from his eyes and ears, and it was amusing to see the expression of his eyes as he became alert. Still gazing upon us he walked rapidly to the shore, turned to have another look and disappeared in the forest.

'Beaver are multiplying fast and are building dams in new localities and backing up the water in many places. Within a short time they have built a dam over six feet high on the stream discharging into Cache lake. By doing this they changed a marsh into a lake and now the centre of the marsh has become a floating island with deep water around it. In a few years these animals, if properly protected, will become a large source of revenue, as their numbers will have to be kept within proper limits.

'Mink, fisher and martin are in more or less abundance and will also increase as time passes and wolves and foxes become fewer. Specimens were obtained of the smaller mammals and a detailed list of these will be found in the complete report when it is written.

'Mr. William Spreadborough, who acted as my assistant from the latter part of May, was instructed to make a careful examination of the birds breeding in the park. This was attended to all summer, with the result that eighty-six species are known to breed in the area. This list includes only our own work and does not pretend to be absolutely complete. Enough was learned, however, to throw much light on the breeding habits of many small birds that are usually believed to go much farther north at the breeding season.

Natural History—*Con.*

Birds.

'Game birds, with the exception of the Black Duck and the Ruffed Grouse (Partridge) and Canada Grouse are absent in the summer. Two of the river ducks (*Mergus Americanus*) and (*Lophodytes cucullatus* are common in the rivers, and all the lakes have colonies of Loons and the larger lakes of the Herring Gull.

Wild rice.

'A useful enterprise was undertaken last year in having the river entering Cache lake seeded with wild rice. Owing to the backing up of the water in Cache lake this plant could not throw up its flowering stalks until late in August when it was too late (possibly) to ripen. When I first saw the plant on July 31st, I could not make out what it was. I asked Mr. Spreadborough to return to the place later, which he did on August 21st, and obtained a small panicle which settled the question. I then learned that the seed had been scattered in October, 1899. By seeding the innumerable places throughout the reservation suitable for the growth of this plant, in a few years water-fowl and waders during the fall migration will come in multitudes to feed while many species of our best ducks will remain to breed. The absence of food is at present the cause of the scarcity of ducks.

Fishes.

'Mr. Spreadborough assiduously collected the smaller fishes in the various lakes so that we might be able to speak with some assurance regarding the future food supply for game fishes when these shall be planted in the lakes. He made a special trap, copied in part from those used by the Indians of British Columbia, and the results were excellent. Often it would not be in the water half an hour before it would be full of various species of small fish, with the young of some of the larger ones. A few small black bass were caught in Cache lake which had doubtless grown from the small fry placed in Source lake a short time ago.

'A remarkable sameness was observed, in all the lakes, amongst the smaller fishes. The forms found in one lake or pond being more or less abundant in the next. There was, however, one remarkable exception. We had been told at Cache lake that there was a large chub in White Trout lake that was often eighteen inches long. When we reached the lower part of Otter Slide creek just before it enters the lake, and when the men were making the portage, I caught a

Natural History—*Con.*

number of these which proved to be Dace or Roach (*Semotilus bullaris*) and a species seemingly little known in Ontario, but found in the St. Lawrence at Lachine. Later we found it in the rapids in the Petawawa wherever we fished.

Food fishes.

'Owing to limited stay at various points, we did no lake fishing except in Cache lake, and Cranberry lake about one and a half miles from it. In these lakes two species of trout were common. One of them, however, was much more plentiful than the other. This species seems to have many names, but in reality is the Great Lake Trout (*Salmo namaycush*) which is found in all the large lakes lying to the northward from the Atlantic westward into the Rocky Mountains. The flesh of this fish taken in Cache lake was hard and firm the whole summer through, even in the hottest weather. The other species which was undoubtedly a brook trout (*Salvalinus fontinalis*) was found in both the lakes and their discharges, but especially in the latter. The lake form may differ in colouring from those taken in the rivers, but all have the vermiform markings which distinguish the Canadian brook trout from the char or trout of England. This fish was found in all the rivers, but July is not a suitable month for fly fishing, and hence our success in taking fish was rather poor. Owing to the comparatively short brooks that connect the larger lakes and rivers, brook trout are not plentiful except in the rivers as the Petawawa and the Madawaska. In Cache lake not more than five per cent of those caught are brook trout and in Cranberry lake about ten per cent.

'Of the coarser fish, there are several species, including two suckers, two catfish, perch, sunfish, eels and burbot, (*Lota maculosa*) and doubtless others. We saw no jack-fish, nor did we hear of any, and the same may be said of whitefish, which seem to be entirely absent. Twenty species of fishes were noted in all.

Reptiles.

'In addition to the common frogs and toads found in most parts of Ontario, two species of salamanders and a newt were found. Snakes were rarely noted, only the dark coloured form, (*Eutœnia sirtalis ordinata*) being collected.

Insects.

'A collection of the butterflies of the district showed nothing new or very interesting. Most of the forms, like the weeds along the railway, are evidently of recent introduction. The beetles were rare, or seldom observed, so that a large collection was not made. The species have yet to be determined.

Plants.

'A careful examination, as far as time would permit, was made into the whole flora of the park, the total number of species collected numbering 862. These were made up of 540 flowering plants and ferns, and 314 cryptogams, including mosses, liverworts, lichens and a few leaf fungi. The trees, shrubs and herbaceous plants were simply those of the northern Ontario forest and produced few novelties.

Natural History—*Con.*

'The climatic conditions under which our forests develop themselves in a state of nature were shown in the park just as I had observed them in Nova Scotia and Quebec. Certain trees require a saturated atmosphere and hence prefer the lower levels, where coolness and moisture are to be found in such northern districts. The sugar maple, on the other hand, as we leave the lower plain of the St. Lawrence going north, begins to ascend the hills, and this it does until, when we reach its northern limit it is found on the highest hills facing the south. On account of the appearance of the forest, I thought the altitude given for the park was too high and after investigation found it was under 1,500 feet, instead of 2,000, as generally believed.

Effect of climatic conditions.

'The effects of the passage of the railway and the cutting of lumber roads through the park, were well illustrated by the introduction of species of plants that are found as weeds in the open spaces and around dwellings. These have been followed by a few species of birds and a number of butterflies, so that every year greater changes will be observed, and when the lakes have been stocked with food fishes, the denizens of both land and water will change so much that in twenty years hence the present conditions will not be recognizable.

'A scientific aspect of the examination was the discovery of a few plants which I predicted many years ago would yet be found on the Ottawa. One of these, the three toothed cinquefoil *(Potentilla tridentata)*, was found on a rocky point on Cache lake, thus connecting the Lower St. Lawrence botanically with Lake Superior. The cryptogamic flora, as might have been anticipated, produced the most novelties and a number of mosses new to science or to Canada, were detected.

'In forest regions where cultivation has not made inroads there are two series of plants. The first is the spring flora, the second is that of July and August. Distinct from the forest flora is the aquatic flora which reaches its fullest development in July. On account of these changes of habitat and time of development, the inexperienced collector only gets one series of plants, and these being chiefly river bottom plants are not the characteristic species of the country examined but only of the lowlands generally. The characteristic plants of a region are its forest flora. These exemplify the climatic conditions and constitute a very true index of the climate.

Character of flora.

'In conclusion, I wish to thank Mr. J. W. Bartlett, superintendent of Algonquin Park ; Mr. T. O'Leary, chief ranger, and Mr. J. Simpson, O. L. S. engineer, for their assistance and attention while I was engaged in the examination of the park.'

Natural History—*Cont.*

Dr. James Fletcher, F.R.S.C., Entomologist and Botanist to the Experimental Farm, as honorary curator of the entomological collections in the museum of this Department, furnishes the following report:—

'I have the honour to report that the entomological collections are in good condition. The only additions which have been made during the past two years, by members of the staff of the Geological Survey, have been collected by Professor John Macoun and Dr. Robert Bell. Prof. Macoun's collections were (1) on Sable island in the summer of 1899. This collection was interesting on account of the locality, but the species of insects were practically the same as would be found on the mainland. Two interesting additions, however, were made to the collection, *Ommatostola lintneri*, Grt., and an Argynnis of the Aphrodite group, possibly referable to that species, but showing remarkable variations in marks and coloration. (2) A general collection made by Prof. Macoun in the Algonquin Park in the summer of 1900. This collection was chiefly of diurnal lepidoptera and contained 18 species of these insects. I was rather surprised to find that all of these species were the same as occur at Ottawa, the rarest being *Argynnis Triclaris* and *Colias Interior*. There were a few dragon-flies and moths, but nothing of any special rarity.

'Dr. Bell's collection was made at Great Slave lake in July and August, 1899, and consisted of three species of butterflies and four of moths. These were all of interest on account of the locality, although none of them were rare, the only addition to the collection was *Plusia U-aureum.*

'I would again ask you to urge upon the members of the staff, the value to the Museum of collections of insects, however small these may be, when exact dates and localities are given, and if each party would bring back only half a dozen specimens, valuable additions would doubtless be made to the collection. Prof. Macoun has contributed several important facts to our knowledge of the entomological fauna of Canada. One of the new species discovered by him at Nipigon some years ago, *Chionobas Macounii*, is one of the most interesting butterflies we have in the Dominion. It belongs to a distinctly Pacific Coast type of a genus which occurs all over the world, but differs from all known species by the total absence of the conspicuous sexual band in the males of this genus.

'Owing to the remarkable discoveries which have lately been made demonstrating the agency of mosquitoes belonging to the genus *Anopheles* in the dissemination of malaria, yellow fever and other diseases. I have thought it well to place in the museum a small collection of mosquitoes. These I trust will be of interest and will be added to from time to time as occasion occurs.' Natural History—*Con.*

Maps.

Report of Geographer.

Mr. C. O. Senécal, geographer and chief draughtsman, reports as follows on the mapping-work of the past year :—

'The assignment of the work has been as in previous years, the staff remaining practically unchanged. The ordinary routine work of laying down projections, correcting and revising engravers' proofs of maps, preparing memoranda on various subjects related to map-work, etc., has been attended to. Some time has been spent on a new edition of the List of Publications and in sending out instruments for repairs.

'During the year, Mr. L. N. Richard was mainly occupied with the compilation of the northern portion of the map of Hudson Strait and Ungava Bay, making afterwards a tracing of the same for the engraver. Additions to the map of Ottawa city and vicinity were made by him from surveys carried out during the past summer. He also revised and traced for the engraver, the Haliburton sheet, No. 118 of the Ontario series, and reduced latitude observations for the map of Lake Nipigon.

'Mr. W. J. Wilson has completed the compilation of the Manitou sheet, No. 4 Western Ontario; revised the Grenville sheet, No. 121 Ontario and Quebec, and reduced Mr. A. P. Low's survey of the east coast of Hudson bay to a scale of twenty-five miles to one inch. On July 27th, he was detached to accompany Dr. R. Bell in the field, and returned on November 6th. He has since been engaged in the revision of the map of Ottawa city and vicinity, and in plotting his own field-work.

'A preliminary map of the Klondike gold-fields was compiled by Mr. J. F. E. Johnston, who again accompanied Mr. R. G. McConnell in the field during the past season.

'Mr. J. Keele has completed the compilation of the Haliburton sheet, No. 118 of the Ontario series, and the map of the district near Bancroft, Ontario, and left for the field to assist Mr. J. McEvoy in the Crows Nest coal-fields. Since his return he has been engaged in the compilation of sheets 119 and 122, Ontario and Quebec.

'Mr. O. E. Prud'homme, besides attending to the usual distribution of maps held for sale, has drawn the following maps for the engraver, viz.: —Lawrencetown sheet, No. 53, Nova Scotia ; plans of gold districts of Lawrencetown, Renfrew and Mount Uniacke, Nova Scotia, and part of the Grenville sheet, No. 121, Ontario and Quebec. He has been employed on several compilations, and has also spent some time in tra-

Maps.

cing railway plans at the Department of Railways and Canals, for office use.

'Mr. H. Lefebvre has been employed on the compilation of the Lake Nipigon map. Additions to the Nottaway River map, from recent provincial surveys, were made by him and a tracing of the same prepared for the engraver. He has also drawn for zinc-etching reproduction a series of diagrams showing the mineral production of Canada, and attended to the cataloguing of maps and plans, etc.

'Mr. W. H. Boyd, had been a short time on general draughting work, when he was sent as assistant to Mr. J. C. Gwillim, in the Atlin gold-fields. He returned to this office on October 22nd, and has since prepared township plans and road surveys for the compilation of sheet Nos. 119 and 122, Ontario and Quebec. He is now engaged in plotting his field-work.

'The engraving of the western sheet of the Dominion map, has been completed,and transferred and corrected. The geologically coloured copy, which was prepared under the immediate supervision of the Director, was forwarded to the Queen's Printer on August 27th. The engraving of the eastern sheet is approaching completion.

'A preliminary geological and topographical map of Atlin gold-fields has also been drawn for reproduction by photo-lithography, and a series of index-maps showing the areas covered by various map-sheets, is in course of preparation.

'In January, I was appointed a member of the Geographic Board of Canada with Dr. R. Bell and Mr. D. B. Dowling, to represent the Geological Survey. Eleven meetings were attended and six lists of nearly 1,500 place-names covering maps in course of preparation, have been submitted and discussed. The action of the Board being restricted to names of features having greater geographical importance, names of minor features, as well as a large number of duplicated or otherwise objectionable names, were not passed upon. In this respect, it has not been deemed advisable to abide entirely by the decisions of the Board, and omit all such names from our maps, on account of necessary references in geological reports.

'During the past year, twelve new maps and plans have been published; there are at present, eighteen maps in the engraver's hands or in press, and about fifty other maps and plans at various stages of progress.

'Sheets 42 to 48, and 56 to 58,—ten sheets of the Nova Scotia series which have been engraved—are still held over, pending the final decision on certain geological points occuring in the area covered by them.

'An enumeration of the maps published during the year, or in course of preparation, is appended herewith:—

	Maps published.	Area in square miles
677	Relief map of Canada and the United States—Scale 250 miles to 1 inch.	
688	Yukon—Map of Klondike Gold-fields, (Preliminary edition.)—Scale 2 miles to 1 inch	1,432
676	British Columbia and Alberta—Yellowhead Pass route from Edmonton to Tête-Jaune Cache—Scale 8 miles to 1 inch.	
626	Ontario—Map showing the occurrences of iron ore and other minerals in portions of the counties of Frontenac, Lanark, Leeds and Renfrew—Scale 2 miles to 1 inch	1,700
681	Ontario—Sketch-map of oil-areas in Lambton county—Scale 4 miles to 1 inch.	
682	Ontario—Sketch-map of gas-field in Essex county—Scale 4 miles to 1 inch.	
683	Ontario—Sketch-map of gas-field in Welland county—Scale 4 miles to 1 inch.	
699	Ungava and Franklin—Map of Hudson Strait and Ungava Bay—Scale 25 miles to 1 inch.	
696	New Brunswick—Sheet No. 2, S.W.—Surface Geology—Scale 4 miles to 1 inch	3,456
697	New Brunswick—Sheet No. 1. N.W.—Surface Geology—Scale 4 miles to 1 inch	3,456
666	Nova Scotia—Lawrencetown Gold District—Scale 500 feet to 1 inch.	
701	" " —Renfrew Gold District—Scale 500 feet to 1 inch.	

Maps, engraving or in press.

	Dominion of Canada, 2 sheets, each 28 inches by 34 inches. Scale 50 miles to 1 inch	3,500,000
663	British Columbia—West Kootenay sheet—Scale 4 miles to 1 inch	6,40
711	British Columbia—Map of Atlin Gold-fields—(Preliminary edition)—Scale 6 miles to 1 inch	4,920
605	Ontario—Sheet No. 126—Manitoulin Island sheet—Scale 4 miles to 1 inch	3,456
630	Ontario—Sheet No. 129—Missisagi sheet—Scale 4 miles to 1 inch	3,456
708	Ontario—Sheet No. 118—Haliburton sheet—Scale 4 miles to 1 inch	3,456
702	Quebec—Basin of Nottaway river—Scale 10 miles to 1 inch	56,800
593	Nova Scotia—Sheet No. 42—Trafalgar sheet—Scale 1 mile to 1 inch.	216
598	" " 43—Stellarton " — " "	216
600	" " 44—New Glasgow sheet—Scale 1 mile to 1 in.	216
608	" " 45—Tony River " " "	216
609	" " 46—Pictou " " "	216
610	" " 47—Westville " " "	216
633	" " 48—Eastville " " "	216
635	" " 56—Shubenacadie " " "	216
636	" " 57—Truro " " "	216
637	" " 58—Earltown " " "	216
709	" Mount Uniacke Gold District—Scale 250 feet to 1 inch.	

Maps, compilation complete.

720	Western Ontario—Sheet No. 4—Manitou sheet—Scale 4 miles to 1 inch	3,456
	Ontario—District near Bancroft--Scale 2 miles to 1 inch	
	Ontario and Quebec—Sheet 121—Grenville sheet—Scale 4 miles to 1 in.	4,051
714	" " City of Ottawa and vicinity—Scale 1 mile to 1 inch	450
.700	Nova Scotia—Sheet No. 53—Lawrencetown sheet—Scale 1 mile to 1 in.	216
	" Waverly Gold District—Scale 250 feet to 1 inch......	

Maps in progress.

663	British Columbia—West Kootenay sheet (partly engraved)—Scale 4 miles to 1 inch...........	400
	British Columbia—East Kootenay sheet—Scale 4 miles to 1 inch....	6,400
	" " Okanagan sheet—Scale 4 miles to 1 inch..........	6,400
	" " Map of Rocky Mountains—Scales 4 miles to 1 inch	
	" Map of Crows Nest Coal-fields—Scale 2 miles to 1 inch	
	Keewatin and Saskatchewan—Grass River map—Scale 8 miles to 1 inch	
	Ontario—Lake Nipigon map—Scale 4 miles to 1 inch	
	" Nipigon River map—Scale 2 miles to 1 inch...............	
	" Sheet No. 113—Peterborough sheet—Scale 4 miles to 1 inch	3,456
	" " 119—Perth sheet—Scale 4 miles to 1 inch.... .	3,456
	" " 120—Ottawa sheet—Scale 4 miies to 1 inch......	3,456
	Ontario and Quebec — Sheet No. 122—Pembroke sheet—Scale 4 miles to 1 inch...........	3,456
	Ungava—Map of East Coast of Hudson Bay—Scale 25 miles to 1 inch	
	New Brunswick—Sheet No. 2, N. W.—Surface Geology—Scale 4 miles 1 inch.........	3,456
	New Brunswick--Sheet No. 17, N. E.—Surface Geology—Scale 4 miles to 1 inch........	3,456
	Nova Scotia—Sheets Nos. 59 to 65, 76, 82, 100 and 101—Scale 1 mile to 1 inch.....	2,376
	Nova Scotia—Sheets Nos. 54, 55, 66 to 69, 73—Scale 1 mile to 1 inch.	1,512
	" " Catcha Gold District—Scale 250 feet to 1 inch.........	
	" " Montague Gold District—Scale 250 feet to 1 inch......	
	" " South Uniacke Gold District—Scale 250 feet to 1 inch.	
	" " Tangier Gold District—Scale 250 feet to 1 inch.	
	4 Index maps—British Columbia; Ontario and Quebec; Quebec and New Brunswick; Nova Scotia,—Scale 50 miles to 1 inch.	

LIBRARY.

Dr. Thorburn, librarian, reports that during the year ended December 31, 1900, there were distributed 17,555 copies of the various publications of the Survey, comprising Annual Reports, special reports and maps; of these 11,755 were distributed in Canada, the remainder, 5,800, in other countries. There were received as exchanges during the year, 2,515 volumes. There were also sold 3,415 of the Survey publications, including reports and maps, for which $543.10 was received.

The number of letters relating to the library sent out, was 1,017, besides 1,545 acknowledgments for publications received by the Survey from exchanges and persons to whom our publications had been sent.

The number of letters relating to the library received, was 1,569; besides 648 acknowledgments for publications sent out.

The number of volumes purchased was 111, and the periodicals subscribed for 34.

The number of volumes bound during the year, was 102. There are now in the library about 13,500 volumes, besides a large number of pamphlets on various scientific subjects.

Visitors to Museum.

The number of visitors to the museum again shows an increase, having been, during the past year, 36,091.

Staff, Appropriations, Expenditure and Correspondence.

The strength of the staff at present employed is fifty-two.

The funds available for the work and the expenditure of the department during the fiscal year ending June 30, 1900, were :—

——	Grant.	Expend'ure.
	$ cts.	$ cts.
Civil-list appropriation	53,300 00	
Geological Survey appropriation	60,000 00	
Boring appropriation	5,483 98	
Civil-list salaries		50,650 00
Exploration and survey		27,288 54
Wages of temporary employees		15,115 37
Boring operations		2,174 47
Printing and lithography		15,796 35
Purchase of books and instruments		1,023 51
" chemical apparatus		6 65
" specimens		2,798 53
Stationery, mapping materials and Queen's printer		1,434 99
Incidental and other expenses		3,047 45
Advances to explorers on account of 1900-01		9,537 80
		128,873 66
Deduct, paid in 1898-99 on account of 1899-1900. $16,067 79		
Less, transferred to casual revenue 18 60		
		16,049 19
		112,824 47
Unexpended balance civil-list appropriation		2,650 00
" " boring "		3,309 51
	118,783 98	118,783 98

The correspondence of the department shows a total of 10,290 letters sent, and 8,500 received.

I have the honour to be, sir,

Your obedient servant,

GEORGE M. DAWSON,

Deputy Head and Director

Richmond Gulf.

GEOLOGICAL SURVEY OF CANADA
ROBERT BELL, M.D., Sc.D., LL.D., F.R.S.

REPORT

ON AN

EXPLORATION

OF THE

EAST COAST OF HUDSON BAY

FROM

CAPE WOLSTENHOLME TO THE SOUTH END OF JAMES BAY

BY

A. P. LOW, B.Sc.

OTTAWA
PRINTED BY S. E. DAWSON, PRINTER TO THE KING'S MOST
EXCELLENT MAJESTY
1902

13—D

No. 778

Robert Bell, L.L.D., D. Sc., M.D., F.R.S.
Acting Director Geological Survey Department.

Sir,—I herewith beg to submit my report on an exploration of the east coast of Hudson Bay. In so doing, I beg to acknowledge the kindness and assistance received from Mr. C. C. Chipman, Commissioner of the Hudson's Bay Company, and from the following gentlemen in that company's service: Messrs. W. K. Broughton, D. McTavish, D. Gillies, Miles Spencer, A. Nicholson, J. A. Wilson and Capt. Alex. Gray, all of whom materially aided in the success of the exploration.

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

A. P. LOW.

REPORT

ON AN

EXPLORATION OF THE EAST COAST OF HUDSON BAY

FROM

CAPE WOLSTENHOLM TO THE SOUTH END OF JAMES BAY

This report is based upon the information obtained by an exploration of the east coast of Hudson bay, extending from Cape Wolstenholme at the entrance of Hudson strait, southward to the Rupert river in the southern part of James bay. The work of exploration extended over the summers of 1898 and 1899; and during the intervening winter two exploration trips were made inland, the first into the barren interior, in N. lat. 57°; and the other on the northern branches of the Great Whale river. The information so obtained was supplemented by that collected from the northern Eskimos, who annually visit the trading post at Great Whale river, to exchange the products of the hunt for powder, shot and other necessaries. A number of sketch-maps and much information concerning the character of the north-western portion of the Labrador peninsula were obtained from these people, so that what was blank on previous maps may now be at least roughly filled in. Area explored.

A log-survey of the entire coast was made by my assistant, Mr. G. A. Young, B. Sc., who also carried out a micrometer survey of the coast between Richmond gulf and the mouth of Big river. These surveys have been plotted and appear in the maps accompanying this report. Mr. Young also kept a continuous set of meteorological observations and made a large collection of the plants found in this region, which although containing comparatively few new species, is valuable in extending the range of many already known. Surveys by Mr. G. A. Young.

Rough surveys and observations must have been made long ago from the ships trading to Hudson bay, for the earliest charts of the bay give indications of all the principal features of the east coast. W. Coates, who was captain of one of the ships of the Hudson's Earlier investigations.

Bay Company between 1727 and 1751, left sailing notes in which he describes Richmond gulf and other places along the east coast. About 1860, Mr. Anderson, who was in charge of Great Whale river post, made a canoe trip northward from that place to Mosquito bay, to examine the porpoise fisheries in the northern rivers. He made an excellent track-survey of this portion of the coast, and a manuscript copy of his map is now in the possession of the Hudson's Bay Company at Great Whale river.

Exploration by Dr. Bell.

During the summer of 1877, Dr. Bell made an exploration of the east coast of Hudson bay, as far north as Portland promontory, and the results obtained were published in the annual report of the Geological Survey for 1877-78,* together with a map of the coast from Great Whale river to Portland promontory on a scale of four miles to one inch.†

During the summers of 1887 and 1888, the writer was engaged examining the islands of James bay and some of the rivers flowing into the east side of Hudson bay.‡

Division of area.

The east coast of Hudson bay may, for descriptive purposes, be divided into three portions, namely, the northern part extending from Cape Wolstenholme to Portland promontory, the middle section lying between Portland promontory and Cape Jones, and the southern portion from Cape Jones to the south end of James bay.

Portions of coast dangerous for navigation.

The northern and southern sections are very similar in character, the shores being formed of low rounded hills of gneiss or granite, rising very little above the wide drift-covered valleys; and inland, presenting a slightly rising plain broken by long, rocky ridges, hardly worthy of the designation of hills. The shores are rocky at points, while the bays are fringed by sand or boulder beaches. The water for a considerable distance from land is shallow, and the bottom very uneven, with rocky ledges and sharp ridges of boulders, which, when they rise above the surface, form the wide fringe of small islands characteristic of these portions of the coast. From the above description, it will be seen that the greater parts of both the northern and southern sections of the coast are dangerous to approach with ships drawing any considerable depth of water, especially in the present unsurveyed state of the waters. The central portion, however differs from the coast to the north and south of it, being bold, with hills often rising directly from the water to altitudes of a thousand feet and upwards.

* Report of Progress, Geol. Surv. Can., 1877-78, part C.

† In 1875 Dr. Bell made an examination of parts of the southern and eastern shores of James Bay. See Report of Progress for 1875, pp. 322-5 and pp. 341-2.

‡ Annual Report Geol. Surv. Can., Vol. III (N.S.), Part II.

Chains of islands, lying from half a mile to five miles from the coast with deep water between, extend along more than half this section, and afford excellent shelter for the largest ships, as well as a safely protected channel for small craft.

About Cape Wolstenholme the land rises abruptly with steep cliffs facing the sea to elevations of a thousand feet and upwards, being a continuation of the high land forming the south shore of Hudson strait. From Cape Wolstenholme the general trend of the coast is about south-west for thirty miles to Nuvuk. Along this stretch of coast the shores are generally rocky and indented by many small bays with numerous rocky islands lying between the mainland and the large, high Digges island. On leaving the cape the general elevation of the land sinks rapidly, so that at Nuvuk the highest hills have an elevation of not more than 500 feet, and the general level along the coast is much less. From Nuvuk to Kovik the coast runs nearly due south, and the distance is sixty miles. This portion is characterized by flat shores, rising slowly into barren plains of drift, from which protrude low, rounded ridges of granite. The shore in many places is fringed by long, low islands of drift, with very shallow water between. This is a favourite summer feeding ground for the barren ground cariboo, which roam over it in small bands. From Kovik the general trend of the coast is south for twenty-five miles, and then south-west for thirty-five miles to Cape Smith. The coast and country along the first of these courses is very similar to that last described, but along the second course a high range of snow-capped hills, which form the highlands of Cape Smith and the neighbouring islands, approaches the coast at an acute angle with a gradually narrowing, low drift plain between the sea and the hills. This range of hills comes out at Cape Smith, and from there runs far inland in a direction about east north-east, forming the north shore of Mosquito bay. The hills are formed of dark green diabase thrown up into a number of sharp, narrow, parallel ridges with a small river connecting chains of small lakes in each valley. The hills vary from 500 feet to upwards of 1,000 feet in altitude, and the higher summits are partly covered with snow. Rising as they do from the nearly flat country on both sides they form a prominent feature of the country.

Cape Wolstenholme.

Feeding ground of cariboo.

Mosquito bay, as is usual with all unsurveyed inlets, has been shown altogether too large on previous maps. The distance from the point of the mainland at Smith island to its head is only twenty-eight miles, and being divided by a long, narrow point into two bays, varying from one to three miles wide, its total breadth is much less than

Mosquito bay.

is given on the charts. Some of the older charts show a water connection between this bay and Hopes Advance bay on the west coast of Ungava bay, but it is now known that several hundred miles of land lie between them. Southward from Mosquito bay the coast-line is greatly broken by large, irregular bays, with generally rocky shores, never very high, and backed by a rocky country, formed of long, rounded hills seldom exceeding an elevation of three hundred feet. A wide fringe of islands extends along the coast; these are usually rocky, but many are formed of boulders and finer drift material. The water for a considerable distance from the mainland is shallow, and the murky nature of the bottom renders an approach dangerous for any craft. This character of coast extends from Mosquito bay to Portland promontory, or from latitude 58° 45′ to lat. 60° 45′.

Portland promontory to Cape Jones.

Between Portland promontory and Cape Jones the coast forms a long flat segment of a circle with the convexity to the eastward. This portion is characterized by bold granite hills rising quickly from the coast, and in part flanked by trap-covered sedimentary rocks, which also form chains of islands running parallel to the coast. The first of these chains is the Hopewell group, which lie close to the mainland and extend south-east for fifty miles from Portland promontory. They are formed from tilted sedimentary rocks capped with a considerable thickness of trap. The rocks dip gently seaward and present abrupt cliffs along their inner sides. The channel between them and the mainland varies in breadth from a few yards to upwards of a mile. At Hopewell Narrows, about the middle of the chain, the channel is less than twenty yards wide,* and is only covered with about three feet of water at high tide, thus rendering a passage for large craft impossible; everywhere else there is a sufficient depth of water.

From the Hopewell islands to the mouth of Langland river, the distance is fifty-eight miles and the general direction S.S.E. This portion of the coast is very bold, with high granite hills rising directly from the shore. A few small islands of granite and trap occur close to shore, and these, in conjunction with small bays, afford excellent shelter for small boats.

Sound formed by Nastapoka islands.

The mouth of Langland river practically marks the northern end of the sound which is formed by the Nastapoka chain of islands extending southward nearly one hundred miles to Little Whale river. These islands are similar to those of the Hopewell chain, but are without the capping of trap. The mainland is occupied by high granite hills, which to the southward of Nastapoka river, are flanked by tilted

* Report of Progress, Geol. Sur. Can., 1877, p. 33, part C.

sedimentary rocks capped with trap. The sound varies from a quarter of a mile to three miles in breadth, with deep water in the channel everywhere.

From Little Whale river to the northern opening of Manitounuk sound, the coast runs south-west for twenty-eight miles. The trap rocks rise directly from the water, forming a ridge from 600 to 1,000 feet high, and there are no harbours for even small sailing boats. Manitounuk sound from its northern opening to Great Whale river is about thirty miles long and it varies in breadth from half a mile to three miles. The northern or boat opening is very narrow and only available for small sailing boats. The second opening is eight miles farther south and has a good channel with deep water. The Manitounuk islands resemble those of the Hopewell chain, being formed of stratified sandstones and limestones capped with trap, with steep cliffs facing the sound and gentle slopes to seaward. The mainland is less rugged than to the northward, rising a mile or so from the coast into rounded hills of granite that vary from 500 to 1,000 feet in elevation. The margin between the hills and the water is occupied by sandy plains from which rise at intervals ridges of tilted limestone. These limestone ridges also form chains of small islands along the mainland. Another portion of the ridge forms a peninsula about ten miles north of Great Whale river, with an excellent harbour on its north side. Manitounuk sound.

The distance from the mouth of Great Whale river to Cape Jones is eighty-five miles and the general direction about south-west. The coast along this section is remarkably straight without any bays or prominent points. The granite hills only come out to the shore in a few places, usually being from half a mile to three miles inland with sandy, terraced drift occupying the interval between them and the shore. A broken ridge of tilted up limestone rests upon the shore for about ten miles, commencing about 15 miles south-west of Great Whale river. Behind this ridge are a number of excellent boat harbours. This portion of the coast is very free from islands until Long island is reached, and in consequence is easily approached by vessels of all sizes. Long island is twenty-four miles in length and varies from half a mile to three miles in breadth. Its north-east end is thirty-five miles from Cape Jones, and it lies parallel to and about four miles from the mainland. On its inner side it frequently presents low cliffs of limestone and sandstone, while a second low ridge running down the middle of the island is formed of carbonate of iron capped by trap. Between the south-west part of the island and Cape Jones, the sound is occupied by a large number of low islands formed of lime- Great whale river to Cape Jones. Islands of limestone.

stone. From Cape Jones all the the way southward to the mouth of the East Main river, a distance of upwards of 175 miles, the character of the coast is very similar to that already described between Mosquito bay and Portland promontory. The mainland is formed of low rounded hills and ridges of gneiss and granite rising slightly above swampy valleys of clay and sand. With few exceptions the hills never exceed 200 feet in elevation, and the general level of the country is under fifty feet. The coast line is very uneven being broken into many large bays, while the entire shore is fringed with islands of rock or drift extending several miles out from the mainland. The water between the islands is generally shallow and the bottom uneven, so that it is dangerous to approach this uncharted coast with deep draught vessels.

Wastikun island.

Wastikun, a cone shaped island, lies about five miles north of the mouth of Big river; and as it has an elevation of two hundred and fifty feet, it is a prominent land-mark and is used as such for vessels approaching that river. The Paint Hills islands are also higher than any land in their neighbourhood and having deep water about them are safe to approach from seaward. Cape Hope island, which lies about fifteen miles north of the East Main river, is also high and is seen a long distance off.

Sherricks mount.

The coast to the southward of the East Main river is even lower than that to the northward, and the rocks only come out on shore in a few places. Islands are less numerous, and towards the mouth of Rupert bay are largely formed of drift. Sherricks mount, which marks the eastern entrance to Rupert bay, is a peninsula with a cone-shaped hill about 700 feet high, and it forms the most striking land-mark of James bay. To the southward of the East Main river the whole bottom of James' bay has been silted up with sand and mud brought down by the large rivers flowing into its southern part, and in consequence, wide flats extend far out from shore, increasing in width as Rupert bay is approached, so that in that bay the only navigable parts are in the channels cut out by the currents of the rivers flowing into it, and even these rarely have a depth exceeding ten feet.

NOTES ON THE NORTHERN INTERIOR.

The interior country south of a line drawn from Richmond gulf to the mouth of the Koksoak river has been described in former reports*

* Annual Report, Geol. Surv. Can., 1887-88, Vol. III (N.S.,) part II. J.
ibid " 1895, Vol. VIII. (N.S.,) L.
ibid " 1896, Vol. IX. (N.S.,) L.

on the Labrador peninsula, and the present notes will be confined to the region situated north of this line. My personal knowledge of this region is confined to a trip of about one hundred miles made in winter from the coast of Hudson bay inland along the 57th parallel of latitude to Kasiagaluk, or Lake Minto; also to short excursions up the lower stretches of the Sorehead, Povungnetuk and Kogaluk rivers. This knowledge is supplemented by information derived from many of the Eskimos, who roam over this interior region; and who having been greatly underrated by Mr. Gillies and the Rev. Mr. Walton in supplying the information asked for, took infinite pains in making sketch maps of the areas personally known to them. By means of these sketches much of the map previously a blank is now filled with great lakes and their connecting watercourses. The north-western interior of the Labrador peninsula lying between Hudson and Ungava bays is not, as was formerly supposed, a high mountainous region. The northern part fronting on Hudson strait is the most rugged, the land there generally presenting abrupt cliffs to the sea, and rising quickly inland to elevations varying from 1,000 to 2,000 feet. This high plateau extends southward to a line drawn roughly east north-east from Cape Smith and coming out on the east coast in the neighbourhood of Cape Hopes Advance at the western entrance to Ungava bay. Along the Hudson bay coast, the land does not rise as abruptly as that fronting on Hudson strait, and one travels several miles inland before elevations of 1,000 feet or more are reached. The whole of the region is formed of long glaciated ridges of granite or gneissic hills, flanked to the southward with the high steep ridges of trap which are a continuation of the Cape Smith area of those rocks. The valleys between the ridges are dotted with lakes, none of which are very large, and these are connected by a network of small streams which seldom attain the size of rivers, as the watershed of this region is not far inland. The largest stream flowing into Hudson bay is the Kovik (brook), the mouth of which is situated near latitude 61° 30′. At a small rapid above its mouth, it has an average breadth of one hundred yards and an average depth of nine inches. The Illukotat, Kingwa and Korak are smaller streams emptying into the bay in the vicinity of Cape Smith. The whole of this northern hilly region is devoid of trees and in most places only bare rocks are seen strewn over with blocks and boulders of granite. The finer drift material is confined to the valleys. Although in a sense very barren and desolate, this region is not wholly so, as wherever any soil is found it supports a growth of arctic plants and the rocky surfaces are often hidden by lichens. Snow lies perpetually in patches in the higher valleys and the contrast between

Excursions inland made in winter.

North-western interior not mountainous.

Area devoid of trees.

it and the beautiful flowers that spring up in the immediate neighbourhood is very pleasing. The vegetation is chiefly saxifrages and other flowering plants growing close to the ground, together with the various white or gray lichens (reindeer mosses), sedges and grasses, all of which provide food for the large bands of barren ground caribou that frequent these regions during the summer months.

The area lying south of that just described and along the Hudson bay coast extending southward to Portland promontory and on the Ungava bay coast to Hopes Advance bay is described by the Eskimos as a moderately high plain largely drift covered, with low rocky ridges rising above the general level of the drift. The general altitude of this region is probably below 500 feet and long stretches inland from both coasts are considerably lower. This is a region of large rivers and great lakes. The Povungnituk and Kogaluk are the largest streams emptying into Hudson bay, which also receives the waters of the Sorehead, Koktak and Nauberakvik. The mouth of the Povungnituk river is near latitude 60° and it empties into a strait five miles in length which carries six fathoms of water up to the first rapid at its head. Above this it is separated into three channels by large islands; its volume must be nearly equal to that of the Ottawa river. This stream drains a large area of country to the east and north-east of its mouth, its headwaters extending to within one hundred miles of the coast of Hudson strait near Stupart bay. It is to the headwaters of this river that the Eskimo go annually to kill the barren ground caribou as they migrate southward in September; this they do by spearing them in the water while crossing the narrows of long lakes, or feeding places in the rivers. The Kogaluk is even larger than the last mentioned river and drains a number of large lakes to the eastward of its mouth, which is near latitude 59° 30′. Its headwaters interlock with those of Payne river flowing into Ungava bay and the summit is so low that very little difficulty is encountered in crossing this portion of the peninsula by following the waterways. Payne river is the most important stream emptying into Ungava bay and takes its rise in Tasukrak or Payne lake, one of the largest lakes of the peninsula, being about a hundred miles long.

Povungnituk and Kogaluk rivers.

The southern portion of the area under consideration extends along the Hudson bay coast from Portland promontory to Little Whale river, and along the east coast from Hopes Advance bay to the mouth of the Koksoak river. This area, although not high, is much more rugged than the central district and slopes up gradually to the southward where the watershed attains an elevation of about 800 feet. The entire

Extent and description of southern area.

region may be described as a rocky plateau greatly broken by rounded granite hills and ridges. The land rises abruptly along the western coast and for upwards of thirty miles inland is almost wholly driftless, nothing being seen but the naked rock, partly covered with arctic vegetation. The central area is less rugged and has more drift in its valleys, while the eastern part is less rugged than the western area. The valleys between the ridges are filled by lakes, often of great size, the largest of which is Kasiagaluk or Lake Minto, which is upwards of 100 miles long and empties into the Leaf river which flows eastward into Ungava bay.

Forest Areas.

The southern portion of this region is partly wooded, the northern tree limit, leaving the coast of Hudson bay near the north end of Richmond gulf,* curves northward and crosses the route to Lake Minto about 20 miles inland, thence bending eastward and southward recrosses the Leaf river about 100 miles inland and comes out on Ungava bay near the mouth of the Koksoak river. The trees near the northern limit are all short and straggling; they grow only in the protected valleys and their struggle for existence is manifest by the number of dead tops and branches found everywhere. Black spruce and larch, or tamarac, are the last survivors of the forests to the south and the latter tree grows to about twice the size of the spruce. The white spruce reaches nearly as far north as the black spruce, and the balsam poplar comes next in order, followed quickly by the balsam fir, all of which trees are found on the islands of Richmond gulf. The banksian pine grows as far north as the Great Whale river, which is also the limit of the white birch and aspen. Timber.

As before stated, the northern tree limit on the coast of Hudson bay is towards the north end of Richmond gulf. Thence southward trees grow in protected gullies on the mainland to Mantounuck sound where the country is fairly well wooded with small black and white spruce and birch; small trees of the same species also growing on the inner sides of the Manitounuck islands. Southward of Great Whale river the coast is wooded to beyond the northern end of Long island, where the limit passes inland leaving the islands and Cape Jones barren. The trees again come out to the coast about twenty five miles south of Cape Jones and continue from there southward. The islands off the coast between Cape Jones and Big river, with the exception of a few southern ones close inshore, are all barren. To the Northern tree limit on Hudson bay coast.

* See Report of Progress, Geol. Surv. Can., 1877, p. 25c.

southward of Big river the trees gradually extend outwards on the islands so that at Cape Hope all of them are wooded. Merchantable timber is found in the valleys of all the rivers northward to the East Main river and pulpwood to the Big river, beyond which, although much of the country is well wooded the trees are small and the branches continue to the ground, causing the stems to be full of knots and consequently of little value.

Climate.

Climate.

With a difference of 800 miles of latitude, it follows that the climate of the northern and southern portions of the east coast will show marked differences. The southern portion may be classed as cold temperate, while the northern part is truly arctic. The temperate climate may be taken to extend to Cape Jones or to be limited to the shores of James bay. While to the northward it is subarctic or arctic and unfit for agricultural purposes of any kind, at Rupert House in the southern part of James bay excellent root crops are grown annually. Oats have also been successfully grown there and no doubt the hardier varieties of wheat would also ripen.* Rupert House is situated practically upon the sea-shore and consequently directly influenced by the cold ice-laden waters of James bay which must considerably lower the temperature in early summer. Such being the case there can be little doubt that better crops could be raised a short distance farther inland, away from the direct influence of the sea.

Large area inland suitable for farming.

There is no doubt that the large area of country situated to the south and south-east of James bay and underlain by good clay soil capped with sandy loam would with proper drainage make excellent farming land capable of raising any crop grown in the North-west territories. At the mouth of East Main river, roots are grown to perfection and abundant crops of wild hay are gathered yearly to feed the large herd of cattle kept there. At Fort George, at the mouth of Big river, good crops of potatoes and other roots are grown annually, and cattle are also kept. This is the present northern limit of agriculture as nothing is grown at Great Whale river where sandy soil aids the climate to prevent the successful cultivation of any crop. In an appendix is given the meteorological observations kept during the time of the exploration.

Fisheries.

Fisheries.

The fisheries of Hudson bay will probably prove to be its greatest natural resource, as along the east coast the sea is found well stocked

* In 1896 and 1897 wheat ripened at Waswanipi, in lat. 1° 45′, or 122 miles south of Rupert's House, from seed sent by Dr. Robert Bell to the officer in charge of that post.

everywhere with food fishes. In James bay a net set at random along shore or about the islands always caught fish. These are usually sea-run brook trout and whitefish identical with the Lake Superior whitefish* and being sea-run are, like the trout, much improved in flavour. These trout and whitefish vary in weight from one to six pounds and are the best of food fish. Similar fish are found abundantly along the entire coast to Cape Wolstenholme. The Arctic trout or Hearne salmon* is found along the northern coast as far south as Seal river, which is situated a few miles south of Cape Jones. This is a beautiful fish with well flavoured, dark pink flesh and it varies in weight from one to fifteen pounds, the average being about five pounds. These fish are salted at Fort Chimo on Ungava bay and fetch nearly the same price in London as salted salmon from the same locality. They are very plentiful about the mouths of the northern rivers and along the coast, while the Eskimos report them abundant at the Belcher and other islands lying off the east coast. There is no doubt that this fish equals or surpasses in colour and flavour the salmon of British Columbia. Cod are known to exist in Hudson bay,* being taken at Cape Smith and at Comb Hills in James bay by members of the expedition. The Eskimos also catch them in Nastapoka sound and at the Belcher islands; at a number of places in James bay they are also taken by the Indians.

Hearne salmon plentiful.

The specimens of cod taken by us were not very large but the men who caught them were Nova Scotia fishermen and said that they were true cod and identical with those taken on the Grand Banks. Food for these fish is abundant in Hudson bay and there is no reason why extensive fisheries in this Canadian inland sea should not exist. The undoubted presence of cod in Hudson bay deserves investigation, as a very valuable and exclusively Canadian fishery may be found there. The presence of cod points to that of halibut in the deeper waters of the bay.

Existence of cod fish in Hudson bay confirmed.

The only other salt-water food fishes in Hudson bay are a couple of species of sculpin which are eaten extensively by the Eskimo. Sturgeon are caught in the lower parts of the southern rivers to the East Main river and lake trout occur in the mouths and lower reaches of the northern rivers. The Atlantic salmon does not appear to enter Hudson bay, as no record could be obtained of its doing so from the Eskimos. Its range in the arctic waters of Hudson strait seems to limit it to the rivers on the west side of Ungava bay. A curious coincidence in connection with this range of the salmon is that the ouananiche or land-locked salmon has never been found in the waters

* See Report of Progress, Geol. Surv. Can., 1877, p. 28 c.

of rivers flowing westward into Hudson bay although common in the rivers of the northern, southern and eastern watersheds of Labrador.

Detailed Description of Explorations.

Details of exploration.

Early in May, 1898, I received instructions to prepare for an exploration of the east coast of Hudson bay southward from Cape Wolstonholme. For this work the small yacht built in 1897 and used on an exploration of Ungava bay was available, it having been stored at Nachvak, the most northern post of the Hudson's Bay Co., on the Atlantic coast of Labrador. After finishing the summer's work I was instructed to pass the winter with my party at the Hudson's Bay Co.'s post at the mouth of Great Whale river, and in the spring months to explore the inland part of the northern portion of the Labrador peninsula of which little or nothing definite was known. During the summer of 1899 the exploration of the islands was to be continued and if time allowed the latter part of the season was to be devoted to the examination of the Huronian rocks which occur in the vicinity of Paint hills and Cape Hope on the east coast of James Bay. The yacht at the end of the season was to be stored for future use at Moose Factory and the party to return home in canoes up the Moose river to the Canadian Pacific Railway at Missinaibi. In pursuance of the above instructions arrangements were made with the Hudson's Bay Co. for the transport of the party and necessary supplies in their schooner from Quebec to Rigolet where the SS. *Erik* would be met and the voyage to Cape Wolstenholme continued in her, picking up the yacht at Nachvak. At the same time transport by canoes from Missinaibi to Moose Factory was arranged for a portion of the winter's supplies which could not be purchased at Moose Factory, from which place they were to be shipped with provisions purchased there to Great Whale river in the Company's schooner. Mr. C. C. Chipman, the Chief Commissioner of the Hudson's Bay Co., kindly sent me a circular letter to the officers in charge of the various posts at which we were likely to call, containing instructions to afford us all possible aid and information and providing for our wintering in the Company's buildings at Great Whale river.

Arrangements for transport of party from Quebec to Rigolet.

Mr. G. A. Young appointed assistant.

Mr. G. A. Young, B. Sc., who had been with me during the preceding two years, and who was well qualified to undertake the duties that would devolve upon him, was again appointed as assistant. The remainder of the party was made up of James Lantz, sailor and carpenter ; James Schupe, sailor and cook, and Henry Ford, sailor and

Eskimo interpreter. Lantz had the year previous been with Dr. Bell in a similar yacht on the north side of Hudson strait, and Ford was employed as interpreter on the *Diana.* I may here state that they all discharged their various duties in a satisfactory manner.

Having learned that the schooner would sail from Quebec on or about the 25th of June, I left Ottawa on the 20th for Quebec, where I was joined by Messrs. Young, Lantz and Schupe. Here the final supplies and outfit were purchased, and we were all ready to go on board at the time appointed, but owing to delays caused by the non-arrival of part of the cargo belonging to the Hudson's Bay Co., we did not leave Quebec until the 30th. The schooner was loaded above the bulwarks, and as the cooking and cabin accommodation were scant the trip of over two weeks to Rigolet was not pleasant, and was rendered more disagreeable by bad weather and fog which also caused considerable delay. Rigolet was reached on the 15th of July, and we there found the *Erik* awaiting us. The *Erik* left on the 19th, and, after calling at Davis inlet, reached Nachvak on the 23rd, where we found the yacht in good order, having been carefully looked after during the winter by Mr. Guy, the gentleman in charge of that post. Embark on SS. *Erik* at Rigolet.

On the 26th of July we steamed out of Nachvak bay and were off Cape Chidley that night, having passed but little field ice and few icebergs. To the southward of Nachvak only a very few detached fields of ice were encountered, and along the whole Atlantic coast there was a remarkably small quantity of ice. This was probably due to the prevalence during the early summer of strong west and south-west winds which drove the northern pack away from the coast, as extensive fields of heavy ice were passed through by the *Erik* about one hundred miles off the coast when on her way to Rigolet from England.

Entering Hudson strait, some loose ice was met with off the Button islands. The next day we passed through stringers of loose ice, the heaviest being about ten miles south of Resolution island, with the appearance of wider streams to the southward. On the morning of the 28th, we were abreast of Frobisher glacier on Baffinland, and steamed along about ten miles from the coast, gradually approaching the land towards Icy cove, where we again sheered off for the Upper Savage islands and Big island. Little field ice and few bergs were encountered until about ten miles beyond Icy cove, where a few scattered pans were seen; after which open water continued to nearly abreast of the Upper Savage islands, when a thick pack was met with extending to the southward with open water five miles out from the Enter Hudson strait.

islands. The open strip gradually narrowed as Ash inlet on Big island was approached, and the ship lay to for the night in the ice about five miles to the east of that place. The next morning we soon cleared from the pack, but more fields were seen to the southward about fifteen miles to the westward of Douglas harbour. These gradually widened and blocked the strait to within twenty-five miles of Charles island, when open water was again reached. During the night and next day more or less open water was passed, the ice in no place being tight or heavy enough to block the passage of an ocean steamer, and in the evening we were close to Cape Wolstenholme, where it had been decided to land our party. During the passage from Nachvak we were all busily employed partly sheathing the yacht with strips of maple to protect her from the ice, and in making necessary alterations inside and overhauling the gear.

Leave the *Erik* near Cape Wolstenholme.

Early on the 31st we steamed into Erik cove, situated just east of Cape Wolstenholme. The *Erik* anchored near the head of the cove, and we were busy all day unpacking our outfit and stowing it aboard the yacht, and in getting the sails bent. Everything being aboard, the *Erik* left us at 7 p.m. for Churchill, and we sailed to the head of the cove, anchoring near the mouth of a little river which flows in from a deep valley extending to the southward. On the 1st of August, while the men were engaged on the yacht, Young and I ascended the hills to the westward of the anchorage and killed two barren ground caribou; later we examined the rocks along the west side of the cove and ascertained the barometric heights of the terraces facing the open strait. Besides the two caribou shot, several small bands of these animals were seen wandering over the hills. Deer Creek cove, in which we anchored, lies immediately east of Cape Wolstenholme. It is about three miles long, two miles broad at its mouth and only slightly over half a mile wide at its head, where a small river enters on the west side. This stream for three miles wanders in a narrow channel from wall to wall of the extension of the valley, having cut down some thirty feet below the level of the sandy plain which fills the bottom of the valley. Beyond, the grade increases as the valley narrows, and the stream changes to a rapid mountain torrent. The cove and valley are walled in by steep cliffs that rise abruptly from 600 to 1,000 feet, and then more gradually into rounded hills, with altitudes ranging from 1,000 to 1,500 feet above the sea. The cliffs are largely composed of schists and gneisses, greatly rotted and standing on edge, and are thus very uneven. Great patches of snow filled all the gulleys and spread over the valleys between the upper hills. Many of these patches were formed of old snow, showing that they never

Patches of perpetual snow.

entirely melt during the few hot days of the short summer in this region. No trees grow anywhere, and the Arctic willows never exceed two or three inches in height, but notwithstanding this absence of forest, the Arctic shrubs and flowering plants covered with brilliant bloom, which carpet every spot where the least soil is found, give a pleasing sense of life which contrasts forcibly with the barren and frozen aspect of the rocky cliffs and the snow fields. In the main and smaller side valleys, the sand that flanks the cliffs is cut into many terraces which rise as a series of narrow steps to a height of over 800 feet, and as many as twenty-eight were noted in one series. These mark the successive shore lines of the land produced during its rise since the close of the glacial period. The rotten state of the cliffs would at first lead to the belief that they had been unglaciated, but an examination of the undecayed surfaces near the water and on the hills above show that such was not the case, the stream of the glacier having striated the summits of the highest points.

Absence of forest.

Starting next morning we only reached Cape Wolstenholme at noon, and anchored in the evening in a small cove four miles to the westward of it. The cape is a bold headland with jagged cliffs rising abruptly over 1,000 feet from the water, and formed of perpendicular bands of gneiss and schist. The irregular weathering of these rocks has given the coast a serrated appearance, and great cliffs extend from the water to the summits. These broken cliffs are the nesting place of tens of thousands of Brunneck's guillemot or murre. The noise caused by the birds leaving their nests when frightened by the discharge of a gun is terrific, and sounds as if the face of the cliff were falling. Wherever there was a shelf sufficiently wide for an egg to rest, there would be a row of birds packed tightly together and each straddling a single egg. The birds were exceedingly tame, and almost allowed themselves to be taken by hand before they would leave their egg. The eggs were very nearly hatched, and a few young birds were seen on some of the ledges. A large number of gulls, ravens and gyrfalcons were seen flying about the cliffs, and at the base we found the body of an Arctic fox, a victim of poaching.

Brunneck's guillemot.

Cape Wolstenholme terminates in a sharp narrow point about 200 feet high which stretches out about 200 yards from the main cliff. Past it, the tide sets with a very strong current. The east point of the eastern or smaller Digges island lies about two miles north of the cape. This island is a little over two miles long, and is formed of high deep cliffs like the mainland. It is also a favourite nesting place of the guillemots. It may be here stated that these birds do not breed to the westward of Digges, and are only rarely seen along the east coast of Hudson bay. The larger island is about twelve miles long and is also rocky but not so precipitous; near its western end is Port Laperrière, where the station for observation of the climate was placed by the government in 1885-86. A quantity of loose ice was encountered in the channel between the islands and the mainland. In the evening we were visited by two Eskimos in kyaks, who informed us that they were encamped on the mainland several miles to the westward. One of them was engaged as pilot to a river, about a week's travel to the southward. Our anchorage was in a small cove sheltered by a bold rocky island, and the next day being calm, the morning was spent washing for gold in the stream which empties into the cove, but without any promising results. In the afternoon, accompanied by several Eskimos, we climbed the cliff and tramped a distance inland over rounded hills of bare rock rising gradually inland to a general level of about 150 feet and partly covered with blocks and boulders. The Eskimos killed two reindeer and report these animals abundant everywhere in the neighbourhood and along the coast for a good distance to the southward, after which they are found abundantly only after a day's walk or more from the coast.

Observation station at Port Laperrière.

The calm continued on the 4th, and we attempted to tow the yacht with the small boat, assisted by the Eskimos in their kyaks as far as their encampment, but only made six miles, when we were obliged to stop just inside the entrance of a small bay owing to our being unable to stem the tide. There was considerable loose ice and a large quantity entered the bay during the evening. The land rapidly decreased in elevation as we proceeded westward, the cliff becoming less abrupt and under 500 feet in height, while the land in the rear appeared to be under 1,000 feet in elevation, but continued very rocky with soil only in the lower valleys. Next morning we started early with a strong south-west wind, and soon found the Eskimos encampment on the inside of a group of islands close to the coast, about three miles west of our anchorage and about south-west of the western end of Digges island which lies about ten miles from the coast. We landed and found the band to consist of seven families or thirty-two persons in all. I took photographs of them while awaiting our guide and found that there were no other families for many miles on either side of them. These people are the most distant of those trading at the Hudson Bay post on Great Whale river, which is situated nearly 600 miles from Digges islands; their next neighbours to the east send their hunts to Fort Chimo in Ungava bay. They start on their journey to the post in January, and do not reach home again until June, as they travel with their entire families and hunt their living along the way. The men in summer kill walrus,

Eskimos encampment.

seals and caribou for food, clothing and fuel, and only a few could boast of fragments of European clothing, such as shirts, skirts and hats. Their fur hunt consists chiefly of white foxes, together with fewer skins of red, cross and black foxes, wolves and white bears, which with walrus tusks constitute their articles of trade for powder, shot and tobacco. Fur-bearing animals.

In the afternoon on the falling tide which runs south, we sailed four miles further, until we were compelled to take shelter in a small bay, owing to the wind forcing the ice tightly upon the shore. In making for the harbour the kyak belonging to our guide upset while towing behind, and in trying to take it aboard the small boat, the latter also capsized throwing Lantz and the Eskimo into the water, but luckily we managed to save both. The coast passed during the day continued to become lower and the cliffs disappeared giving place to low rounded rocky irregular bottoms. Shoals extend for a couple of miles off the the land and were marked by the heavy ice grounded upon them. The land rises slowly into large rounded hills 300 or 400 feet high, situated some three or four miles inland, and the country although still quite rocky has many ridges of boulders and finer drift on the mainland. We remained ice-bound until noon on the 8th, when a south wind loosened the pack along shore and allowed us to beat our way to the south-west. As we proceeded, the ice gradually opened and by evening there was a lane of open water over two miles in length with stringers of ice outside. The guide said that the prevailing west and south-west winds had driven large quantities of ice in from the strait and that this was the last of it. The coast is everywhere very flat and low and nowhere rises 100 feet above the sea. A few reefs of granitic rock form low points at long intervals along shore, the remainder consisting of sand and boulders which also form the low irregular ridges, and have numerous traces of ancient sea beaches in their lines of well-rounded boulders. The water is shoal for a long distance off shore and the bottom is broken by steep lumps and ridges of boulders, probably formed by the shoving of heavy grounded ice upon them. The shoals were everywhere indicated by masses of heavy ice piled upon them and consequently we were in no danger of running aground. The land was covered with mosses, lichens, grasses and arctic shrubs, and is a favourite feeding-ground for the barren ground caribou, numbers of which were seen either singly or in twos and threes moving about close to the shore all day. Ice-bound for a few days.

Owing to light winds we only made eight and a half miles south-west on the 9th, and in the afternoon went a few miles inland after deer as they are very numerous about here, and our guide informed us Caribou plentiful.

that farther on we would not get any without going far inland. We killed a young buck and saw many more quite close. The country inland is very sandy, sloping slowly up from the water and broken only by low boulder beaches and an occasional outcrop of gneiss rising a few feet above the level of the sandy plain. The many small ponds and swamps that occur between the boulder ridges are favourite breed-

eese breed.

ing places for grey geese. Very little ice was passed, and we anchored about a mile off shore in three fathoms, there being no harbours any where along the coast and no islands. On the 10th, we made ten miles with a very light west wind, and in the afternoon twice grounded the yacht upon small hummocks of boulders on our way to the entrance of a small river; the second time we remained aground for two hours until floated by the rising tide, after removing a boat load of provisions and rigging a lifting gear with our spare spar. We anchored about a mile from the mouth of the river in the midst of a number of boulder shoals. Our course during the day was nearly

Description of coast.

south. The country was similar to that already described, being under 100 feet in elevation broken by long boulder ridges, and with a few low hummocks of rock rising above the drift. The water is shallow for several miles off the coast and the shore is masked by chains of low islands, formed chiefly of boulders that extend from one to three miles out. The channels between the islands were too shallow and the bottom too uneven to allow the yacht to pass and so we were forced to run our survey outside. We were visited by two old men in kyaks, who stated that all their people (nine families) able to travel, had gone inland to hunt deer, and that they would remain there until the snow came.

Kovik river.

The next morning we beat into the Kovik river and anchored at the foot of a small rapid two miles above its mouth, opposite three tents of Eskimos, containing a few infirm old men and women and some orphan children, who were all living on trout caught with a net. We went up the river in the small boat five miles to where it turns south-eastward, and could not get farther owing to the heavy sea and strong wind. We then climbed a rocky hill and saw the course of the stream for about four miles to the eastward, where it narrows as it passes into a gorge between low rocky hills, beyond which the Eskimos say it is very rapid and unnavigable. The river at the lowest rapid is about fifty yards wide and averages about a foot in depth. The rapids continue for a mile after which the river expands into a lake from a quarter to half a mile wide which continues eastward four miles and then changes to south for three miles, and again east three miles to where it passes into the gorge. The country surrounding the river is low and broken by rounded glaciated rocky hills that never exceed 100 feet in altitude. These hills are covered with loose blocks and boulders, while the valleys between contain terraced sand overlying stratified clay which contains large quantities of fossil shells. The river is abundantly stocked with fish; the Arctic trout is most abundant and varies from three to ten pounds in weight; ordinary sea-run brook trout and white fish are also common. The natives were unacquainted with the Atlantic salmon as were those spoken to in the neighbourhood of Cape Wolstenholme.

River abounds with fish.

There were only light breezes during the morning of August 12th, with which we reached the mouth of the river where our guide left us. Young and I landed on the south point to examine the rocks and take compass bearings. The day being overcast without wind, was favourable to the mosquitoes and they took full advantage of it. We were on shore less than half an hour and returned to the yacht hardly able to see. This was the worst place for flies in my experience, but luckily the wind came in from the northward at one o'clock and we were soon rid of the pests. We sailed west eight miles across the mouths of two long bays full of low islands and boulder shoals, and then south-west twelve miles along a straight shore, broken only by long points of boulders extending as reefs for upwards of a mile from shore, and anchored close to Kettlestone Knob a conspicuous hill of serpentine lying about half a mile from the mainland and connected with it by a narrow neck of boulders. The coast passed was all low with an occasional low ridge of dark rock rising a few feet above the drift. The shore was boulder-strewn on the points and sandy in the bottoms of the small wide bays, with an occasional outcrop of rock most common during the early part of the run. The bouldery islands off shore were fewer and smaller than to the northward of the river, and the shallow water did not extend so far out from shore along this straight coast, which afforded no harbours. Kettlestone Knob rises about fifty feet above the water and appears to be the resort of a number of families of Eskimos during the seal hunting in the spring. The sites of several camps were seen which had been lately vacated, also a number of sealskins full of oil inclosed in heaps of boulders to protect them from wolves and foxes. The rock had evidently been worked in places, and it is the source from which the triangular stone lamps are obtained.

Kettlestone Knob.

Serpentine.

Eskimos camps.

The next morning opened with a light south-west wind accompanied by fog and drizzling rain. After 9 a.m., we dredged for a couple of hours in from seven to thirteen fathoms of water, and were not very successful. Warned by a rapidly falling barometer we sailed into shallow water at the head of Kettlestone bay about three miles from the peninsula, and after sounding the channel with the small boat, ran the yacht into the mouth of a small river where good shelter was found behind a point of dark schistose trap rock. In the afternoon we took a walk inland over the low ridges of trap and up the course of the southern large brook which forms about half the river joining the northern brook about half a mile above the outlet. The country is broken by ridges of trap from 50 to 200 feet in height, with wide valleys between, filled with stratified clay and sand and with shingle beaches along the hill-sides. The valleys are dotted with ponds and small lakes. The ridges increase slightly in altitude inland, until they meet a high ridge of dark hills about twenty miles from the coast. These hills appear to vary in height from 500 to 1,000 feet and have many patches of snow on their sides. Their trend is north-east and consequently they run diagonally to the shore and come out on the coast in the neighbourhood of Cape Smith. A gale from the north-west accompanied by rain and fog caused us to remain at anchor all day in the mouth of the little river. The wind changed to east the next morning and moderated so that we got under weigh at noon, making twelve miles to windward in the afternoon, and anchored in a small circular harbour behind a ridge of boulders. The coast and country were similar to those already described, except that there are more rocky points breaking through the boulder ridges along shore and the water is somewhat deeper off shore. The ridge of high hills gradually approaches the coast and opposite the anchorage is about six miles inland

Ridges of trap rock.

We started at 6 a.m., on the 16th, and made seventeen miles, beating against a light head wind accompanied with showers and fog and anchored at dark under a small island about two miles to the westward of the inner end of Smith island. There is a very strong tide-rip where we anchored but owing to the thick fog we could not get any better place. The coast passed during the day had the same bouldery shores, broken by occasional points of granite with a few small islands of boulders close in shore. The country inland rises more abruptly than formerly and was terraced with numerous old beaches of boulders, but the general elevation is under 200 feet to the foot of the trap hills which reach the coast opposite the anchorage and which form the highlands of Smith island and the north shore of Mosquito bay. On the 17th, Young and I climbed the trap hills on the mainland while the men were fishing for cod. They caught two which measured twenty and twenty-two inches in length and said that they were true cod, similar to those that they had been catching all their

Cod fish caught.

lives on the Grand Banks of Newfoundland. They attributed their failure to catch more to the unsatisfactory nature of the bottom where they were fishing.* Large schools of harp seals were seen accompanied by flocks of gulls apparently chasing the cod in the vicinity of Smith island. I have since learned that cod is plentiful along the shore from Portland promontory to Cape Jones, and is found as far south as Paint hills in James bay. The Eskimos living on the Belcher and other groups of islands lying off that part of the coast catch numbers of these fish, some of large size. Large cod.

The hills on the mainland vary in altitude from 300 to 500 feet, being considerably lower than those a few miles inland. They are arranged in parallel ranges, in consequence of which the coast, where they reach it, is cut into a number of long narrow bays with a low valley at the head of each, down which flows a small stream connecting chains of lakes. The rocks are a dark-green brownish-weathering trap that has been intensely glaciated into smooth rounded bosses. The drift on the slopes is terraced to the summits, where beaches of boulders rest on the otherwise bare rocks. In the afternoon we shifted our anchorage intending to go to the head of one of the narrow bays, but found it too shallow and so made a harbour on the inside of Smith island. The current in the channel is strong and we had great difficulty in stemming the tide with a good breeze behind us. East wind continued on the 18th, with fog and rain, so we remained at anchor. The men again tried for cod but caught none, owing to the sandy bottom everywhere in the neighbourhood of the anchorage. Young and I made an excursion into the interior of Smith island which was found to be formed of hills similar to the mainland, but higher (600 feet) with valleys between, filled with stratified clay and sand, and up the hill-sides are terraces of boulders to over 500 feet above the present level of the sea. Smith island must form a prominent land mark from seaward, rising as it does abruptly above the level of the low coast on either side. It is about ten miles long by about four miles broad in the widest part. Its outline is very irregular, being broken into numerous small bays by the trap ridges. The channel between it and the mainland is a mile wide with only sufficient water for small craft to pass through it, and rendered dangerous by shoals and small rocky islets. Excursion into the interior of Smith island.

We started early on the 19th, with a north-west wind and sailed eastward ten miles through a number of low islands formed largely of trap, to the entrance of a long bay which we followed for ten miles

*Report of Progress, Geol. Surv. Can., 1877, part C. page 28.

further to its head. The mouth of the bay for three miles is blocked by numerous small islands which are the tops of low submerged ridges of trap. The water between the ridges is uniformly about five fathoms deep, but when crossing the ridges it is very shallow. Above the islands the bay varies in width from half a mile to a mile and a half and gradually becomes shallow towards its head where a small river enters that flows in the continuations of the valley from the northeast. On the north side of the bay the trap hills form a steep wall from 200 to 400 feet in height with higher hills inland, while a lower ridge of trap on the south side separates this from a similar long narrow bay.

Mosquito bay.

These two bays form Mosquito bay which is much smaller than represented on the charts. We found two families of Eskimo encamped at the head of the bay and procured from them some trout and venison. One of the men was engaged to guide us to the Sorehead river about a day's journey to the southward.

Next morning we left early with our guide, who later informed us that he was a stranger in these parts and did not know anything about the shoals outside. We crossed the mouth of the second bay of which we could see the head. It is about four miles wide at its mouth and is not as long as the northern bay, its surface being largely covered with low islands and boulder reefs, the difference from the northern bay being due to the trap rock being displaced by granite. From the south point of this bay the coast runs nearly south for seven miles and is only slightly indented by small coves between points of boulders and rock. A great number of low islands of rock and shingle lie for several miles off shore and in trying to pass between them and the mainland we narrowly escaped disaster on the numerous hummocks of boulders found everywhere. There was a fresh fair breeze blowing and a heavy sea swell running at the time so that it was very dangerous.

Ascend Sorehead river.

Fortunately we got clear of the islands and turning eastward entered the mouth of Sorehead river and ascended it for four miles when the yacht grounded. The country and coast passed during the day were low and similar to those to the northward of Cape Smith and characteristic of the granitic regions of this coast. Accompanied by Young and Lantz, on the 22nd I ascended the river about ten miles, when it became too small and rapid for further progress with the small boat, so we camped at the foot of a continuous rapid. The river is about one hundred yards wide at its mouth and continues so for about two miles and a half to the mouth of a large brook which enters from the northward, where it drains a number of small lakes between rocky hills on that side. Above this brook the main stream is only about 100 feet wide with steep clay banks from ten to forty feet high, the river being cut into a clay plain from two to three miles wide that fills the valley between the low rocky hills on both sides. The stream gradually becomes smaller and where we stopped it was less than fifty feet wide and one foot deep. The valley gradually narrows from three miles at the mouth of the river, where the banks are almost level with the water, to less than half a mile at ten miles up, after which it soon passes into a narrow rocky gorge that rises rapidly to the general level of the hills, from 200 to 300 feet above the sea. The next morning we climbed the hills to the southward of the camp and took photographs showing the character of the country. We then returned down stream to the yacht. The highest hills are about 400 feet above sea level and are formed of well glaciated granite with very little drift scattered over them, the finer material having been removed to the valleys and the boulders arranged in beach ridges on the flanks of the hills, the sea having covered the highest summits. The hills are of various forms with wide valleys between them and these are usually filled with irregularly shaped shallow lakes and ponds. We saw several coveys of rock ptarmigan, large numbers of Canada geese and one barren ground caribou. In the next two days we made thirty-five miles, passing numerous rocky islands and boulder reefs with shallow water between them with a low mainland broken into irregular bays by numerous rocky points. Shortly after starting on the 26th, we unfortunately ran on to a small hammock of boulders and as the wind was increasing the position was dangerous. We took four loads in the small boat to an island near by and as the tide rose in the afternoon, by hauling at the anchors placed astern and lifting on the spare spar in the bow we managed to get afloat at 5 p.m., with little damage to the yacht, but did not get the ballast and outfit in place again until 9 o'clock.

Clay plain.

Game seen.

On the 27th we sailed six miles south-east to the mouth of a large river called the Povungnituk, which we ascended three miles. It had an average depth of five fathoms to within five miles of where it is broken by rapids, below which sandy shoals extend nearly to the anchorage. We put our net in here and caught twenty-six large trout and whitefish which we split and salted for winter use. The following day it blew a gale from the westward, so that we could not leave the yacht. On the 29th we ascended the river to the rapids. Here the stream is divided into three channels by two large islands. I estimate the total volume to be the discharge of a channel 600 yards wide, three feet deep with a current of three miles an hour. The eastern channel has about twice the volume of the western. This was the first large stream met with, and from what is known from the Eskimos no

Povungnituk river.

other considerable stream flows into Ungava bay, Hudson strait or Hudson bay between it and Payne river, which empties into Ungava bay on the 60th parallel or directly opposite the mouth of this river. Several families of Eskimos had encamped below the rapid and had gone up the north branch of the river shortly before our arrival. In the afternoon we sailed eight miles to the southward, passing a low rolling coast with many shoals and islands outside. On the 30th, in the morning, we made six miles across a wide bay with rocky shores, and in the afternoon crossed another wide bay and rounded a long, low point, making fifteen miles more before anchoring behind some boulder reefs. The afternoon's sailing was the most difficult yet experienced owing to the extremely shallow water and numerous reefs and sharp lumps of boulders extending for miles off the land.

Minerals found in schists near contact with granite.

The next day we continued down the same flat coast for ten miles, to the mouth of a large bay extending several miles to the northward, but so shallow and obstructed with shoals of boulders that we could not go up it. I have since learned that the Kogaluk river flows into its head. As there was a contact between the granite and dark basic schists at the mouth of the bay, the afternoon was spent examining the rocks and several large bands of pyrite, pyrrhotite and chalcopyrite were found in the schists. We were unable to move for the next two days owing too a heavy gale. On the 3rd September, although still blowing hard, we made fifteen miles along the same low coast cut into long irregular bays by low rocky points and fringed with islands and boulder reefs. We anchored at the head of one of these bays. A gale of wind lasting until the 6th kept us at anchor in this bay when we again started southward, but owing to the heavy sea running, we were obliged to keep well out from the land. The land continues low for fifteen miles, being largely composed of ridges of boulders never more than fifty feet high. In the next twelve miles it gradually becomes higher and more rocky, and where we anchored behind the peninsula of Portland promontory, the hills are from 100 to 300 feet high. Portland promontory is not at all like the sketch on the chart, and there is no channel inside it. It is joined to the mainland by a narrow neck, and is surrounded by large rocky islands which continue for several miles outside. The coast is exceedingly cut up by irregular bays dotted with rocky islands. A heavy gale of east wind accompanied by rain again delayed us for two days, when taking advantage of a strong north wind on the afternoon of the 9th, we rounded the point and made thirty-nine miles to Hopewell narrows. The distance shown on the chart from Portland promontory to Hopewell narrows is too short, so that instead of entering the sound well to

Portland promontory inacurately mapped.

the southward of the narrows we passed in just above, and as there was not enough water to float our boat through the passage, we had to beat out again losing half a day in doing so. The coast from Portland promontory is high and rocky with sharp granite hills rising from 300 to 500 feet above the sea. The sound is formed by a chain of long islands separated from one another by narrow openings. The chain runs roughly parallel to, and from a half to two miles from the coast. The islands are from 100 to 350 feet high, and are formed of stratified rock capped with heavy beds of dark-green trap, all of which dip gently towards the sea, and in consequence the islands have gentle slopes seaward, while they present steep cliffs toward the land. *

Islands of stratified rock.

The 10th, and 11th, were spent at anchor in a small cove just north of the narrows as the wind was again too strong for sailing. On the 12th, we managed to beat around the island and entered the sound again immediately south of the narrows. There was a very heavy sea outside and heavy breakers in the channels between the islands. In the afternoon we sailed southward twenty miles and anchored behind a large island close to the mainland opposite the most southern opening to the sound. Next morning we passed through the opening and started down the coast before a gale from the north-west, but had to seek shelter after making five miles, as the seas were coming in over the stern, and we were obliged to let down all sail during the frequent squalls of snow. We found temporary shelter behind a point and later a good harbour behind a small island four miles further south, which we reached after a good deal of danger and trouble. The coast here is very rugged without any harbours for large craft. The shore is rocky and rises quickly into ragged hills from 400 to 600 feet high. Next morning the hills were white with snow and the small ponds covered with ice. The wind changed to south-west and we were obliged to beat against it all day with a heavy cross sea. We made thirty miles to the southward and anchored in a small cove three miles north of the second island of the Nastapoka chain. The coast passed during the day continued high and rocky with hills inland from 500 to 900 feet high, the shore being rocky and nearly straight with very few harbours. The first Nastapoka island is similar to those of the Hopewell group, except that there is no capping of trap.

Coast rugged with few harbours.

We beat all next day against a light south wind which died out in the afternoon obliging us to tow for two hours in order to reach the first harbour in a small cove about a mile north of the mouth of Langland river. This harbour is quite open to the westward and is not good. Our day's journey was sixteen miles down a coast similar

* See illustration Report of Progress Geol. Surv. Can., 1877, p. 19 c.

to that last described, and the anchorage is opposite the third island of the Nastapoka chain which is continuous to the southward for about one hundred miles or to within a short distance of Little Whale river. The chain is composed of forty-four islands, great and small, there being ten islands upwards of five miles in length. Like the Hopewell chain they are formed from beds of stratified unaltered rocks, all dipping gently seaward and presenting steep cliffs, from 100 to 400 feet high towards the land. The rocks are largely silicious and nearly every bed is more or less ferruginous, while some of them often of considerable thickness are almost pure iron ore. The ore is largely magnetite or a mixture of magnetite and hæmatite when associated with the sandstones, grits and jaspilyte, but with the limestones and dolomites, beds of siderite and ankerite are found, and as these, from analysis of specimens obtained by Dr. Bell, in 1877, contain a large percentage of manganese they form excellent ores for Bessemer steel. The various ores occur in great abundance in the rocks of all the islands and it is impossible to estimate the quantity of iron in this chain,* which must compare favourably as to quantity and quality with the immense deposits worked to the southward of Lake Superior, where some occur in a series of rocks very similar to those found on the islands of the Nastapoka chain. During the night it rained heavily and in the morning of the 16th, there was thick fog which continued all day with frequent showers. In the afternoon we sailed to the mouth of Langland river feeling our way, as we could not see fifty yards ahead, and anchored just inside the sand bar at its mouth. The entrance to the river is a narrow channel about ten yards wide at the bar which broadens outside and becomes shallow, so that there is less than a fathom of water in the shallower parts. Above the bar the river widens into a basin about 200 yards across, but filled with shoals. This basin extends inland about half a mile to where the river descends from a rocky ridge in a beautiful fall 60 feet high. The fall is narrow and is divided into two channels by a small island on its brink. It descends into a semi-circular basin about 100 yards in diameter and having sharply sloping walls of sand 100 feet high cut into the sandy plain which lies between the ridge and the coast.

Character of iron ore on Nastapoka islands.

Comparison of quantity and quality of iron ore.

On the morning of the 17th, we crossed the sound and measured a section of the rocks exposed on the third large island of the Nastapoka chain, and also took a number of photographs of the rocks and scenery from the top of the island. There was a light wind from the eastward but it died out at 3 p.m., being followed by a light southwest wind which obliged us to turn back from Whale point and take anchorage in a wide bay on the inside of Davieau island, there being no harbours on

Section measured on island of Nastapoka chain.

* See Report of Progress Geol. Surv. Can., 1877, pp. 16 and 21 c.

the mainland. The mainland about Whale point is lower and less broken than to the northward, but is still quite bold. We passed a couple of small rivers between the Langland and the point. On the 18th, a strong south wind accompanied with rain, fog and a very low barometer kept us at anchor in our harbour and I measured a section of the rocks on the island in the neighborhood. In the evening the wind shifted to northwest and this blew into our harbour, raising a heavy sea and making things unpleasant for the night. The next morning the wind moderated a little and being fair we started and soon arrived at the mouth of the Nastapoka river where we stopped to trade provisions with some Eskimos encamped there. The wind was now blowing a gale and the sea caused by the strong wind acting against the current setting north up the sound was short, heavy and breaking constantly. As there was no harbour on the mainland we were obliged to cross to the islands and did so with difficulty and with great danger of losing our small boat which was towing far astern, in fact, it was simply marvellous how it escaped being swamped as several times it was snatched away from under the comb of a great breaker. After a good deal of cautious manœuvring we managed to cross to the islands about ten miles to the southward of the Nastapoka river, and then ran on looking for a harbour which was finally found and where we anchored behind a long point with a reef outside. Here we remained during the next day, the wind blowing so hard that we could only make a landing against it with difficulty in the small boat. While here I took photographs of the thick beds (80 feet) of almost pure magnetite and others of the surf breaking on the outer side of the island. This gale was accompanied with heavy squalls of snow which gave a very wintry aspect to the scenery.

Photographs taken of iron ore beds.

On the 21st, the wind moderated towards morning and getting under way we made thirty-one miles to Richmond gulf before noon. We entered the gulf and anchored just inside, in a small bay on the south side. In the afternoon I examined the rocks in the neighbourhood. They belong to the same series as those found on the islands, the stratified rocks being first seen on the mainland some five miles south of the Nastapoka river, from there they continue as a facing of the granite hills to within a few miles of Great Whale river. On the 22nd, after a hurried examination of the north shore of the gulf we passed out again on the end of the falling tide and with a light southeast wind made Little Whale river at 9 a.m. After passing the river the wind died out and we drifted until noon, when the wind came from the north and freshened all the time, so that when we arrived at four o'clock at the northern entrance to Manitounuk sound it was

Richmond gulf.

blowing half a gale. We ran into the sound and anchored in a snug harbour behind a long point of sand extending from the island near the entrance. The Manitounuk chain of islands is about twenty-five miles long and extends to within six miles of the mouth of Great Whale river. The islands have a close resemblance to those of the Hopewell chain, being composed of similar stratified beds capped with great thicknesses of dark-green trap, often roughly basaltic in structure. The sound formed by these islands is a charming place after the barren, inhospitable coast to the northward. The colours of the trap and underlying stratified rocks in the high cliff of the islands contrast beautifully with the dark-green of the spruce and the lighter shades of the willows and mosses. The prevailing colours of the stratified sandstones are various shades of pink ; the limestones vary from buff through cream to light-blue, while the trap weathers a warm brown and purple and where the cliffs have recently fallen the colour is dark-green, so that there is no lack of colour in the picture.

Manitounuk islands.

On the 23rd, we sailed slowly down the sound, stopping in several places to examine the rocks and hunt for minerals in the trap. The wind continued strong from the northward and blew in fierce squalls off the high cliffs of the islands, so as to frequently throw the yacht down, although we were sailing with a three-reefed mainsail. Knowing that we would be unable to cross the bar at Great Whale river we anchored in a cove in one of the islands about five miles from the south end of the sound. The wind died out during the night and blew lightly from the eastward the following morning, enabling us to reach the mouth of the river at noon, but not being able to sail up to the Hudson's Bay post against the light wind and strong current, we remained at anchor until evening, when we towed up along shore and anchored opposite the post, thus finishing the work with the yacht for the season. We found that Mr. Gillies, who is in charge of the post, had not yet returned from Moose factory, whither he had gone in August, but he had left a letter placing his house at our disposal and we took full advantage of his kind offer.

Reach Hudson's Bay post at Great Whale river.

The next week was spent in dismantling the yacht and settling into winter quarters at the Hudson's Bay post with Mr. Gillies who arrived three days after us. The yacht was hauled out on a low sandy point in a small cove about half a mile above the post and was thoroughly covered up and secured for the winter. Mr. Young and myself were given rooms in Mr. Gillies' house with whom we messed. The men had a room in the servants' house and ate in the kitchen. Our cook was installed in the kitchen as chef and had two female assistants (one

High Rock, Manitounuk Islands, Hudson Bay.

Indian, one Eskimo) and we were all comfortable and happy. When the yacht was secured the men were set to work making large dog sleds for winter travel, and when they were finished the remainder of October was employed in chopping our share of firewood. Having finished that, I sent Lantz and Ford away on November 1, a few miles to the eastward where they hunted their food and lived in a tent. Young was engaged plotting the surveys made during the past summer and myself putting my notes in shape and devoting considerable time to the study of the Eskimo language.

Lantz and Ford remained away from the post until January 28, when they returned to make preparations for our spring work. On February 13 I sent Mr. Young, accompanied by Schupe and two Eskimos, to carry a micrometer survey along the coast from Great Whale river southward to Fort George at the mouth of the Big river. On the 16th the mail packet arrived from Moose Factory bringing us the first news we had had from civilization since we left there the previous June.

Micrometer survey by Mr. Young.

On February 23, I started northward with two Eskimos and their dog teams to explore the region situated to the northward of the Nastapoka river. We were greatly delayed by rough ice along the coast and continuous rough stormy weather, so that it was the 2nd of March before we reached Whale point situated on Nastapoka sound near the 57th parallel of north latitude. From there we proceeded almost due east for forty-two miles through a sucession of small lakes and ponds lying between bare rounded hills of granite.

Explore region north of Nastapoka river.

Starting from a small bay directly north of Whale point the route rises gradually for three miles over indistinct terraces and gravel beaches the highest of which, about 600 feet above sea level, forms a sharp ridge with a downward slope inland of 50 feet to a small lake, that lies in a narrow valley with nearly perpendicular granite walls rising from 100 to 500 feet above the lake. From the east end of this lake the route passes over a number of short portages between small lakes and ponds the level of each being somewhat higher than the last, so that at a distance of ten miles inland the water level is nearly that of the surrounding country, and the rolling granite ridges are seldom more than 300 and are usually less than 100 feet above the water surface. This country for 20 miles inland is quite devoid of trees, while farther on spruce and larch occur in clumps in protected places, at first as quite small shrubs but farther inland at Lake Minto, they grow about fifteen feet high and at their bases often exceed nine inches in

Lake Minto. diameter. Continuing through a chain of small lakes for forty miles we came to the height of land and about five miles beyond it and at a slightly lower elevation, the western end of Kasiagaluk or Lake Minto was reached. The course of this lake was followed due eastward for nearly forty miles when further travel had to be abandoned owing to our failing to meet with the bands of barren ground carribou which usually frequent the lake at this season, and the consequent starving condition of our dogs.

Description of Lake Minto. Kasiagaluk or Lake Minto is one of the largest lakes of the Labrador peninsula, being according to the Eskimos, upwards of one hundred miles long. The portion explored consisted of two bays, each about forty miles in length, with numerous minor bays running off from both, and the main bodies being covered with large islands. The northern bay is the larger, and varies from two to ten miles in width, while the southern bay is from one to five miles wide. The main body of the lake, at the junction of these western bays, is fully fifteen miles wide, and from there to its eastern end gradually narrows so that it imperceptiby passes into the Leaf river, by which it is discharged into Ungava bay about half way between Hopes Advance bay and the mouth of the Koksoak river. According to the Eskimos, the Leaf river is easily navigable, being without any direct falls or heavy rapids, so that the natives are able to ascend it to Lake Minto in their large skin boats.

Mr. Young met near Richmond gulf. The return journey to Great Whale river was made without any incident of note on the way there. Mr. Young was met near Richmond gulf, he having during our absence carried the micrometer survey to Fort George, and on his return from that place continued the survey northward to Richmond gulf. The two parties returned together to the Hudson's Bay post at Great Whale river, where they arrived on the 13th March. Lantz and Ford, during our absence, had been sent inland up the Great Whale river with a load of provisions for the use of the party during the spring exploration in that region. They did not arrive back until the 19th, reporting great hardship owing to the deep soft snow and the open water at the rapids, where they had to make roads through the woods. On account of bad weather and sickness among the men, a start was not made up the Great Whale river until the 30th April, when the party, consisting of Young, our three men and myself left the post. Owing to the unfavourable reports of the men who had returned from inland, it was decided to go without dogs, and each individual started, hauling a small sled loaded with about 200 lbs. of provisions and outfit. The month of

April proved very unsuitable for this kind of work. The earlier part of the month was very cold and without the customary rains, so that the snow remained in a pulverulent condition, into which the sleds sank deeply, and required great efforts to drag them along. From the middle to the end of April, the weather was very boisterous with almost constant successions of heavy rains and snow storms, followed by unseasonably mild weather which caused the ice to leave the rivers and small streams, and obliged us to abandon our work on them and to travel as hurriedly as possible overland to the coast, in order to avoid being caught inland by open water, with no means of transport. The Indians of the region were caught in the same predicament as ourselves, and most of them suffered great hardships before reaching the places where their canoes were stored for the winter.

Weather unfavourable for trip up Great Whale river.

The course of the Great Whale river valley from its mouth is nearly due east for eight miles, to the first heavy rapid and fall. The river along this course varies from 200 to 500 yards in width and is obstructed by a number of small islands of rock or boulders. Its banks are usually high and formed of stratified clay overlain by sand except where the rocky walls of the valley come directly to the shore. The valley itself averages about a mile in width and its sides are formed of rounded granite hills that rise from 200 to 400 feet above the water. At the first fall the total descent is about thirty feet, consisting of a direct cascade of ten feet followed by a very heavy rapid. At the fall the valley contracts to about fifty feet and there is a small island in the middle which divides the stream into two channels of ten and twenty feet in width. This obstruction is passed by a portage of half a mile which ascends a gulley on the south side of a low rocky hill at the falls and reaches the river by an abrupt drop immediately above the fall. The valley above bears south-east for nearly ten miles to the second fall and along this course the river has an average breath of 400 yards with a swift current. The valley is about half-a-mile wide walled in by granite hills 300 feet high which are usually faced with terraced deposits of sand up to 150 feet above the river. The valley is well wooded with small spruce and larch rarely more than eighteen inches in diameter or above thirty feet in height.

Course of river described.

At the second fall the valley contracts to less than 100 yards in width and in a mile and a half the river has a descent of 200 feet. This is made up of direct falls of twenty, sixty and forty feet, respectively, the remainder being low falls and heavy rapids. The portage is on the south side and rises abruptly 300 feet when it passes along the side of a rock hill and descends into a small bay a short distance above the falls.

River divides into two branches.

The river above widens out and for two miles flows from nearly south. Here the river is divided into two almost equal branches, that from the south-east having been explored in 1888, and a description of it given in my report of that year's explorations.* We followed the northern branch, which for eight miles above the forks flows from N. 80° E. through a wide flat valley with low banks and swampy land on either side, the river averaging about 300 yards in width with a sluggish current. Beyond this, the course of the valley is about north-east and the river becomes crooked and irregular in width while the granite hills close in so that after five miles it is again flowing in a narrow valley between rocky hills that rise from 300 to 500 feet above the water. The next six miles is almost continuous rapids culminating at the upper end in two falls of 50 feet and 100 feet, the upper being the higher. This stretch of river is passed by two portages, the lower being nearly four miles long, the upper about half a mile long with about a mile between them where a small lake expansion of the river occurs into which falls a large tributary from the eastward. The total descent here is upwards of 250 feet, so that above it is nearly on the level of the surrounding country, and flows from the north-east again between low willow-fringed banks, the channel varying from 400 to 800 yards for the next four miles. Small spruce and larch grow thickly except where they have been destroyed by fire, there being very large areas where the trees have been totally destroyed.

Other branches of northern branch.

Beyond this the course of the valley changes to north-west for two and a half miles and then north-north-east for two and a half miles to the junction of the Abchigamich and Coast branches of the river. The character of the river valley and surrounding country along these two courses is similar to that just described, a sluggish stream flowing between low terraced banks nearly on a level with the surrounding country, which is broken by rounded granite hills and ridges, the greater part of the forest having been destroyed by fire.

A cache was constructed at the junction of the rivers, in which we stored everything not required for a ten days' trip up the Abchigamich river. This stream, according to the Indians, takes its rise in a large lake of the same name situated about 100 miles farther inland.

Abchigamich lake the source of three rivers.

A striking peculiarity of this lake is that it has several outlets and being situated directly on the height of land, it drains eastward by a tributary of the Koksoak river which empties into Ungava bay, while

*Annual Report Geol. Sur. Can., Vol. III, Pt. II, pp. 50-55 J.

its westward flowing outlets form the head waters of the Abchigamich river and also of the Little Whale river. Such lakes with double ontlets are not uncommon in Labrador, but it rarely happens that three rivers take their rise in the same lake.

Above the forks, the Abchigamich river, for three miles, flows from the east and for this distance it is very irregular in width and greatly obstructed by small islands. It cuts through wide, sandy terraces, the highest of which rise about 150 feet above the stream. At the end of this course the stream narrows and the valley is enclosed between steep granite walls that rise from 250 to 400 feet above the water. The general course of the valley, as far as explored, is from the south-east, but there are numerous minor deflections from this general course, especially where the stream is broken by rapids. These rocky hills are sparsely wooded with small spruce and larch, while much of the country has been burnt over. We only succeeded in ascending this river about twenty-five miles owing to the soft weather, which by melting the crust of the snow, rendered travel impossible after ten o'clock in the morning, and on several days when there was no frost we were unable to move at all. The river throughout this distance varied from 25 to 200 yards in width, having usually a strong current, with five rapids, each of which would entail a long portage in the summer time with canoes. Returning to the junction with the Coast river, we started up that stream with the intention of following it to its head in a large lake about twenty miles in rear of the mouth of Little Whale river and then descending that stream which also flows out of this lake.

Mild weather prevented completion of work.

We were unable to complete this work owing to the unusually early break up of the ice, which forced us to leave the river and pass overland by the valley of a small stream which reaches the coast opposite Boat-opening in the Manitounuk sound. The Coast river is slightly smaller than the Abchigamich river, and the first course of its valley above the junction of the latter stream is nearly north-west for eight miles. The valley for this distance is filled with sand, terraced up to 200 feet above the stream and backed by low, rounded granite hills. The river varies from 50 to 200 yards in width, and is without rapids. The valley next bends sharply to the east for eight miles, and the river is broken by a number of short, heavy rapids, terminating at the end of the course in a rapid of a quarter of a mile with three beautiful falls, and a total rise in the level of the stream along this course of about 140 feet, so that the highest terrace at the end is only about 60 feet above the river. This terrace is very persistent, and undoubtedly marks a sea limit during the period of subsidence of the country, and shows the height to which the land has since risen, the upper terrace being now approximately 700 feet above sea level. The country surrounding this stretch is similar to that last described, but the granite hills become more rugged, and are covered with a thin growth of spruce and larch trees rarely twelve inches in diameter. The river next flows from the north for six miles, and about three miles up this course is joined by a large eastern tributary, nearly as large as the main stream. Along this stretch the character of the stream changes, as it now flows through small lake expansions connected by short rapids without any definite valley. The terrace along the upper part of the course is not continuous, and when seen is only about thirty feet high. The country is less rugged, and the rocky hills are marked by large deposits of boulder drift which lie in long drumlin ridges. The direction from which the river flows is again east for three miles, then north for four miles, and again east for eight miles, being exceedingly rough along the last course with eight heavy rapids or chutes ; and having ascended above the terraces flows in an undefined depression through a slightly rolling country. As before stated we abandoned work at the end of this course and returned down stream to the first bend, where we ascended the valley of a small southern tributary, and after four miles crossed the summit and continued south down another small tributary, making numerous detours over rugged hills, where the river was open at rapids, until we came to the edge of the plateau about four miles from the coast, over which the river is precipitated in a continuous rapids, falling upwards of 600 feet before reaching the sea. We arrived back at the Hudson's Bay post at Great Whale river and immediately began preparations for our summer's work. On the 12th of May, holes appeared in the river ice, and by the 21st the river was quite free of floating ice, but the open water only extended about a mile off the mouth of the river, while the ice on the sea appeared quite solid. The latter part of May was cold and stormy and delayed the painting of the yacht, so that it was not launched until the 29th. On the 1st of June we went aboard ready to start north for Richmond Gulf, as soon as the ice moved off the coast.

Preparations for summer work.

Attempts to get away were made on the 4th and 5th, but it was not until the next day that we succeeded in making our way through the floating ice, and getting into Manitounuk sound where we anchored in open water at the Paint islands about half-way up the sound. The following day we reached the Boat-opening and from the summit of one of the islands, saw a narrow streak of comparatively open water along the coast to the northward, with heavy ice outside. The following morning we started at day-light and had no difficulty in reaching the mouth of Little Whale river at 9 a.m., as a light east wind had driven the ice off shore. At Little Whale river we found several families of Eskimos in a starving condition, and after relieving them we continued on to the mouth of Richmond gulf, where we found the tide rushing out strongly and carrying with it much floating ice. While awaiting the change of tide, the wind shifted to seaward and the ice closing in forced us to attempt to stem the tide. We started in with as much sail as we could carry and had got about half way up the narrows, when we were struck by a sudden squall, which almost drove the boat under. To save the yacht we were forced to luff up, and drop the mainsail and could only run the boat head on to the rocky wall of the channel. Luckily a small cake of ice resting on the rocks was struck first, and we escaped, with only the loss of our bob stay and some slight dints in the bow, from what might have been a disaster, as it would have been impossible to save the yacht if it had sprung a serious leak along side the perpendicular cliff where it struck. We finally made a small harbour just inside the narrows and getting out two anchors rode safely through the heavy gale of that night, which was accompanied by snow and squalls off the heads 1,000 feet above us, that caused the boat to tremble and sunk her several inches in the water as they burst down upon her. We remained in Richmond Gulf lake, which was found free of ice, until the 22nd June, the time being employed in a survey of the lake and a close study of the relations of the unaltered bedded rocks found on the shores and islands of the lake. The entrance to Richmond or Hazard gulf is situated eleven miles north of the mouth of Little Whale river, and opposite the north end of Belanger island, the second southern island of the Nastapoka chain. The entrance is formed by a deep rent in the rocks of the coast, and is about two miles long and varies in width from 100 to 400 yards. The water is very deep and the walls of the channel rise in perpendicular cliffs from 100 to 1500 feet, the height increasing inwards from the coast owing to the bedding of the rocks dipping seaward. This narrow channel connects a large salt water lake with Hudson bay and in consequence the water rushes in and out through it with great velocity, with the rise and fall of the tide allowing only short periods of quiet when the tide is high or low.

Eskimos starving at Little Whale river.

Survey made of Richmond Gulf lake.

Richmond Gulf lake is a large body of salt water, occupying a depression immediately behind the coastal range of trap-capped hills. Its greatest length from north to south is thirty miles while its greatest breadth along its southern shore is twenty miles. In form it is roughly triangular with the apex of the triangle at the north end. The western

Description of lake.

side is occupied by sharp cliffs, formed of bedded rocks capped by a thick overflow of trap. These cliffs are very jagged, and indented by deep bays, and as the rocks rise as they extend inland, the cliffs of the headlands are fully 1,500 feet above the water, while those at the head of deep bays are not above 1,000 feet to their summits. The cliffs are rarely perpendicular, but rather resemble gigantic steps from the irregular weathering of the rocks forming them. Along the south and eastern shores the bedded rocks have been faulted and in places replaced by granites, so that the coast is more irregular and less bold than along the western shore, the hills rising from 500 to 1,000 feet.

The southern part of the lake is covered by large high islands formed from tilted beds of the stratified rocks and traps. These rocks having been much faulted, the cliffs of the islands do not face in the same direction but vary from east to south. A number of large streams enter the lake on its east side; among these the Clearwater is the largest, while a couple of miles south of its mouth is the Wiachewan which has a beautiful fall of 315 feet where it descends to the lake.

Rivers entering.

Farther northward is the Deer river which like the Clearwater flows out of Clearwater lake. At the north end another fairly large stream called the North river flows in from the eastward, through a wide valley. The coast outside Richmond gulf is almost treeless, only small spruces growing in protected gorges. The change when the lake is entered is very striking as all the slopes of the hills and islands are well wooded with spruce and larch and only the summits of the hills are barren. Balsam poplar is found as straggling trees on some of the islands showing that the northern limit of this species almost coincides with that of the supposed much hardier spruce and larch. The waters of the lake are plentifully stocked with fish including arctic trout, brook trout and whitefish. Dredgings were made in from fifteen to twenty-five fathoms of water in a long narrow bay in the southwest angle of the lake, where the bottom was found to be soft mud.

Fish plentiful.

The following list of species was determined by Dr Whiteaves from the dredgings so procured :—

Pecten (Camptonectes) Grœnlandicus, (Towerby.)
Modiolaria discors (L).
Portlandia glacialis (Wood).
Nucula expansa (Reeve).
Astarte Banksii, var. *striata* (Leach).
Astarte crenata ? Gray, var.
Macoma calcarea (Gmelin).

Thracia myopsis (Beck) Moller.
Saxicava arctica (L).
Tonicella marmorea (O. Fabricius).
Litorina rudis (Maton).

And the following sponges, determined by Mr. L. Lambe.

Suberites montalbidus.
Craniella cranium.

The above species are common in the Pleistocene sands and clays of the Gulf of St. Lawrence and show that the present conditions of the waters of Hudson bay closely resemble those of the St. Lawrence region during the close of the glacial period. During our stay in Richmond gulf, the ice in Hudson bay had been closely pressed in upon the coast filling up the Nastapoka sound and completely blocking navigation. We sailed out of the Gulf on June 22nd and managed with considerable difficulty to pick our way through narrow leads to the mouth of Little Whale river. Here we remained hemmed in by ice, until the 2nd July when a strong breeze off shore opened a channel and permitted us to sail south to Great Whale river. The time of our enforced delay at Little Whale river was spent in examination of the rocks of that neighbourhood, and in tracing out the lead-bearing limestones found near there.

Delayed by ice at Little Whale river.

At Great Whale river we were again delayed by ice until the 7th July when we were advised by all the Eskimos to abandon our proposed trips to the Belcher islands which lie about seventy miles off the coast, and about which owing to the prevalance of westerly winds during the early summer, the ice would be very thick. This advice proved correct as the Hudson's Bay Company's ship "Lady Head" was beset with heavy ice as far south as Bear island in James bay, where the ice was left on the 20th August.

Trip to Belcher islands abandoned.

Instead of going to the outer islands we directed our course southward along the east coast in order to complete the survey of that entire shore from Cape Wolstenholme to the head of Rupert bay. Sailing southward from Great Whale river, much ice was encountered for upwards of 60 miles until we passed into the Sound between Long island and the mainland, where the last of the ice was encountered on the 11th when we reached Cape Jones, which marks the entrance to James bay. The distance from the mouth of Great Whale river to Cape Jones is eighty-five miles in a straight line, and the coast, with a few minor undulations, runs about south-west. The land along this portion is generally low and sandy, rising in broad low terraces to the rounded granite hills, usually situated a mile or more inland and only coming directly to the shore at points along the northern two-thirds of this distance. As far as Humbug harbour, twenty-two miles from Great Whale river, narrow ledges of Cambrian limestone have been tilted up upon the granite along shore and in several places good boat harbours are found behind these broken ridges. From the White Bear hills to Cape Jones, a distance of twenty-five miles, the shore is wholly composed of sand and shingle the granite only appearing in low hills in the immediate vicinity of the Cape. The ridges of limestone and other Cambrian rocks were seen thrown up along shore farther southward from Long island and the other islands off this part of the coast. These islands are particularly numerous between the south end of Long island and Cape Jones where they practically block the Sound. Long island is twenty-four miles in length and varies from one to three miles in breadth. It lies about five miles off the mainland, with its longer axis parallel to the coast, and its south end twelve miles from Cape Jones. It is made up chiefly of Cambrian limestone overlain with ferruginous cherty beds capped in places with trap. Its inshore side is generally formed of low cliffs of limestone with long intervals of low drift shores between. The highest part is not over two hundred feet above the sea. The coast southward from Great Whale river is not dangerous for large vessels to approach, and excellent shelter is afforded them inside the northern end of Long island, but to the southward and in the neighbourhood of Cape Jones the approach to the land is dangerous owing to the shallowness of the water and the uneven bottom with frequent reefs and boulder shoals.

Long island.

Trend of coast changes at Cape Jones.

From Cape Jones the general trend of the coast changes sharply to S. 40° E. and continues so to the mouth of the Big river, sixty miles away from the cape. To the southward of Cape Jones, the character of the coast changes greatly and becomes similar to the shores to the northward of Portland promontory. The shores are low and indented by numerous bays separated by low rocky points. The entire coast is fringed by innumerable islands extending in shallow water several miles out from shore. The general heights are so low that hills rising from 100 to 200 feet above the sea form conspicuous landmarks. The islands and outer points along this portion of the coast are barren, the trees being confined to the shores of the bays and the interior, where they form thick growths of spruce and larch. The boat channel from Cape Jones to Big river passes between the islands and is usually from one to two miles from the mainland. It is exceedingly crooked, passing by sharp turns through narrow passages between islands and shoals, and is quite impossible to follow without the aid of an experienced native pilot. For ten miles southward of Cape Jones, the islands and shores are formed almost wholly of drift and boulders, and appear to consist largely of glacial débris in the shape of low hummocks or drumlins. Beyond this, low exposures of granite and gneiss occur on some of the islands, increasing in number towards the southward, so that at Pipestone gutway, forty miles from the cape, the islands and shores are very rocky. Along this distance there is not an elevation of fifty feet on either the mainland or islands. Just north of Pipestone gutway is the mouth of a large bay which extends many miles inland, but is so shallow that it is unnavigable even with small craft. This is called Paul bay and is a favourite stopping place for geese and wavies on their migrations in spring and autumn, as the wide grass-covered flats about the bay are excellent feeding grounds.

Islands formed of glacial débris.

Southward of the gutway to the Big river the islands are fewer and all rocky. One of these islands called Wastikun, situated about five miles north of the mouth of the river is a prominent landmark rising as it does into a rounded cone 200 feet high. Fort George is a post of the Hudson's Bay Co., situated on an island at the mouth of the Big river, and is the headquarters of the Whale river district. Here is found the most northerly cultivated land on the east coast of Hudson bay. Excellent potatoes and other root crops are grown here and a good herd of cattle adds to the comforts of this northern outpost of civilization. The Big river is one of the largest streams of the Labrador peninsula, taking its rise in the central area of the peninsula, close to the headwaters of the Kaniapiskan branch of the Koksoak river which flows northward into Ungava bay, and of the Manicouagan river of the southern watershed.

Fort George.

Fort George was left on the 17th July and the survey and geological examination of the coast and islands continued southward. The distance between the mouth of the bay and East Main river in a straight line is 115 miles and the general course is S. 10° E. This portion of the coast is somewhat higher and more rocky than that to the northward and the islands lying off it are as a rule larger, while only the outer ones are barren. The Big river discharges by two main channels separated by a wide flat sandy shoal. The northern channel is that used by larger vessels, as it leads past a small safe anchorage called Stromness harbour situated among some rocky islands about three miles northwest of the river. This channel has two sharp bends in it, and is difficult to navigate, whereas the south channel runs straight seaward. From the mouth of the river, the boat channel runs

Big river.

due south sixteen miles to Earthquake island, so called from the legendary trembling of the island during a battle between the Crees and Iroquois. Twenty miles farther south are the Comb hills where a ridge of granite forms a long point and several large rocky islands. The name is derived from the straggling trees along the summits of the hills somewhat resembling a gigantic comb.

Paint hills.

The next place of importance is the Paint hills, situated twenty-five miles south of Comb hills. They consist of two chains of large rocky islands stretching about ten miles out from the coast and formed of dark green squeezed trap intruded by granite. These trap rocks carry considerable pyrite, which on the surface is often rusty and to this the name of the locality is due. The Solomon's Temple islands which lie about ten miles to the southwest of the outer island of Paint hills are a continuation of the trap area and have the same character as the inside islands. Cape Hope islands are situated thirty-five miles south of the Paint hills and consist of one large and several smaller islands of trap. The highest point of the large island is 250 feet above the water, and is consequently a very conspicuous feature of the coast which everywhere else rarely exceeds 100 feet in elevation. The distance from Cape Hope to the mouth of the East Main river is sixteen miles. Along this portion of the coast the rocky islands give place to a few low shingle shoals and the shore is only broken by occasional low rocky points. A number of these shoals and two rocky islands obstruct the mouth of the river, rendering it difficult to approach even with small craft.

Cattle and sheep kept at post on East Main river.

A small trading post is situated near the mouth of the river on the south banks, but the place is used more for a farm or ranch than for trade. A large herd of cattle is kept here as well as a number of sheep, and the surplus stock is distributed annually to Rupert House and Moose Factory. The East Main river is not as large as the Big river, and drains the country between the latter and the Rupert. It was explored in 1892-93, and a full account of it is given in the report on the Labrador peninsula.* From the mouth of the East Main, the general trend of the coast is south-southwest for forty miles to Sherrick mount. The coast along this portion is exceedingly low, and rocky hills only come out to the shore in a couple of places; elsewhere wide bays with sandy shores and boulder strewn points are found rising slowly inland and faced with wide mud flats bare at low water. The islands off the coast are few in number, and owing to the shallow water surrounding them, hard to approach. In fact, although the

* Annual Report Geol. Surv. Can., Vol. VIII, (N.S.) pp. 77-102 L.

coast is free of islands, it is exceedingly dangerous to approach, owing to the shallow water extending far out over a very uneven bottom covered with boulder ridges. Sherrick mount is a bold peninsula of granite connected by a low sandy neck to the mainland. Its highest point has an elevation of 700 feet above the sea, and in consequence this cone-shaped hill can be seen rising above the horizon long before the surrounding lower country is visible. This peninsula marks the entrance to Rupert bay, into which flow the Rupert, Nottaway and Broadback rivers, all of which have brought down large quantities of sand and mud. In the course of time this has silted up the bay, so that at present it is only navigable in the channels kept open by the currents of these rivers, which if properly buoyed would allow ships of ten feet draught to enter the Nottaway river which flows in at its southern end. Two of these rivers have been explored, the Nottaway by Dr. R. Bell and the Rupert by the writer. The latter takes its rise in Lake Mistassini 300 miles to the eastward, while the Nottaway and the Broadback drain a great area of country to the south and south-east. Sherrick mount.

We ended our survey work at the mouth of the Rupert river on the 19th August. From there we crossed the southern end of James bay to Moose factory, where the yacht was unloaded, hauled out and stored for future use. The collection of rocks and natural history specimens was sent by ship to London, and thence back to Canada, while the party, assisted by four Indians, ascended the Moose river in a large canoe to the Canadian Pacific Railway, and so returned to Ottawa. Survey work ended.

GEOLOGY.

General remarks and description.

The rocks of the entire east coast of Hudson Bay are very ancient, and with the exception of those which form the chains of islands along shore between Portland promontory and Cape Jones, and also a narrow margin on part of the coast in the same region, they have all been cut by granite which has not only intimately penetrated them, but by its heat and pressure has so changed them to crystalline schists and gneisses that only in a few places can any trace of an original sedimentary origin be found. The unaltered sedimentary rocks with their associated sheets of trap and diabase bear not only a remarkably close resemblance to the so-called Cambrian rocks of other parts of the Labrador peninsula, but also to the iron-bearing rocks of the southern Geology.

shores of Lake Superior and the Animikie and Nipigon rocks to the north of Lake Superior. So close is this resemblance that hand specimens of nearly all the various rocks of these different areas can be duplicated from the Hudson Bay region, and this close resemblance is also found in the thin sections of these rocks when microscopically examined. A collection of hand specimens brought home by Mr. J. M. Bell in 1900, from the region of Great Bear lake, when placed beside the specimens from Hudson bay were found to bear so close a resemblance as to be undistinguishable without reference to the labels. The close resemblance of this series of rocks occurring over an area extending from southward of Lake Superior to north of the Arctic Circle, and from the eastern part of Labrador to the neighbourhood of the McKenzie river shows that the conditions under which they were deposited must have been nearly identical throughout this wide area. The finding of new areas of these rocks as the northern country is more fully explored points to an almost continuous deposition of this formation over the whole Archæan area of Canada. No fossils have as yet been discovered in any of the beds of this formation, but the presence of certain concretionary forms in its limestones and the amount of carbon in many of the shales lead to the belief that at least low forms of life existed at the time these rocks were deposited. The lack of fossil evidence as to their age, which is taken to be very great, makes their classification in the Cambrian probably erroneous, as in all likelihood they are of pre-Cambrian age and in the opinion of the writer are the oldest known sedimentary rocks of Canada. Notwithstanding this opinion they will continue to be classed as Cambrian in order to correspond with the areas of similar rocks of Labrador which have already been so classed.

Similarity of sedimentary rocks over wide area.

Thickness and composition of series.

This series consists of several thousand feet of sedimentary rocks, commencing at the bottom with a considerable thickness of coarse arkose, formed largely of more or less rounded grains and pebbles of quartz and feldspar, cemented by infiltrations of quartz, and evidently representing a great mass of decomposed granite, from which the finer mica and decomposed feldspar had been washed out in a shallow sea. This, towards its summit shades into a great thickness of banded arkose, sandstone and argillite greywacke all of which are feldspathic and the argillites and greywackes also contain quantities of finely divided bisilicates and probably represent the finer material of similar decomposed granite. The basement granite from which these rocks were derived has not been recognized in the region under discussion. The upper beds appear to pass into argillites, greywackes and cherts, all more or less impregnated with oxide of iron which often is found in them as large masses of pure magnetite or a mixture of magnetite and hematite associated with red jasper. These beds are overlaid with cherty carbonates of lime, magnesia and iron, and are in turn capped by limestones, dolomites, carbonaceous shales and sandstones which form the upper beds of the series. These deposits, to the upper portion of the iron-bearing beds, appear to have been laid down in shallow water as ripple-marks are found on many of the beds. The upper beds of limestone and dolomite were deposited in deeper water. At the close of the period of deposition the beds emerged from the sea, and then took place an enormous eruption of dark-green trap and diabase, which was injected as sheets or laccolites between the bedding of different measures of these rocks from the summit of the arkose upwards. Not only was the diabase injected but it also flowed out over the surface, and there, cooling less slowly and without pressure, formed a fine-grained trap in many places full of small cavities formed by the expansion of contained gases, and subsequently filled by infiltration with chlorite, epidote calcite or agate. These surface flows are well seen in the trap capping of the Hopewell and Manitounuk islands and the coast about Little Whale river. At these places several different flows can be seen resting upon one another. The diabase also formed large vertical dykes cutting the sedimentary rocks, and these were the probable outlets of the diabase from the interior. The outburst of these dark-green igneous rocks, which did not greatly affect the rocks that they penetrated, was followed by a far greater outburst of granite and other allied acidic rocks which had a very marked effect upon the sedimentary rocks through which they burst. The granite irruption was co-extensive with the area now known as the Archæan region which embraces the greater portion of eastern Canada and extends southward into the United States, thus occupying fully a third of the northern half of North America. The irruption of the granite was almost universal over this waste region, and it is now found in large areas where no remnants of the former sedimentary crust remains. More often it is associated with bands and masses of silicious biotite gneisses, dark schists and crystalline limestone, which have been so altered by the heat and pressure of the granite intrusion that only in in a few places are traces of their original sedimentary character preserved. Not only did the intrusion change these rocks into crystalline schists but the accompanying hot solutions of silica have penetrated between their thinnest laminæ and there deposited extra quartz, thus further disguising their original structure and composition. The investigations of Adams and Barlow on the relations of the Hastings group of Eastern Ontario, show that the undoubted sedimentary rocks

Magnetite and hematite of upper beds.

Diabase dykes.

Granite intrusion changes sedimentary rocks.

of that region can be traced into crystalline gneisses and schists, and the silicious unaltered dolomites pass into a crystalline tremolite limestone. In the Labrador peninsula, similar changes of the limestones have been noted and the accompanying iron ores pass into magnetites associated with quartz often in the form of a magnetite gneiss. Along the east shore of Hudson bay in the rocks intruded by the granites, the limestones and iron-bearing beds are absent and the altered beds appear to be confined to the arenaceous beds of the series and the accompanying diabase sheets.

In the southern part of the area fronting on James bay, many of the very quartzose gneisses and schists, under the microscope display rounded grains of quartz, apparently arranged in bedded planes and sometimes showing obscure lines of growth outside the originally rounded grains. All of these rocks show signs of subjection to enormous pressure which has destroyed their original structure and it is only in very favourable cases that a clue to their original clastic condition is found. The diabasic traps afford the best example of the metamorphism induced by the granite. These dark-green rocks were very extensively developed along the east coast of Hudson bay and large areas of them are met with from near the Kovik river in lat. 61° 30′ southward to beyond the East Main river in lat. 52°. These basic rocks have different associations with the granites in the different localities where they are found. In some places they are surrounded by large masses of granite and then are usually much altered by the pressure induced by the intrusion, the extreme phase of the alteration being to dark and light-coloured hornblendic and chloritic schists. From this extreme the diabase is found passing up through lesser stages of alteration until it appears as masses only slightly altered near the contact with the granite upon which it rests.

Example of metamorphism.

The granite outbursts were not universal throughout this vast region, and the areas of so-called Cambrian sedimentary rocks represent areas where the earlier crust remained unbroken by any such intrusion ; and it is along the edges of these areas that the evidence of the later age of the granites is found, as there the granites are seen in a few places to penetrate the sedimentry strata and their associated diabases.

Granite irruption followed by period of rest.

The granite outburst appears to have been followed by a period of quiet, during which the great masses cooled and solidified, and in doing so, probably contracted in size. This contraction probably disturbed the equilibrium in the crust by lessening the pressure on the side of the granite mass, and so causing the pressure outside the area to act upon the unaltered areas of the older sedimentary rocks as a thrust from seaward or towards the large areas of cooled granite. The result of this force acting upon the rocks close to the surface was to cause a buckling of their strata and a forcing of large blocks of the series over one another, and also over the now solid granite, so as to form them into long ridges which slope more or less gently away from the granite masses and present steep broken cliffs towards it. This throwing of the strata into ridges also causes repetitions of more or less similar sections of the formation in each ridge, and the development of cross faults in the ridges greatly complicates the work of identification of the various beds of the formation as seen in the cliffs. This phenomenon of ridges with sharp cliffs facing inland or towards large masses of granite is a universal characteristic of all the areas of these old sedimentary rocks throughout Labrador, and seems to be equally characteristic of the Lake Superior regions and of those westward of Hudson bay.

This explanation of buckling and a nearly horizontal movement of the bedded rocks afford a solution of many of the difficulties met with in a study of the stratigraphical relations of these rocks in themselves and in regard to the granites below them, and accounts for the unconformable contacts of totally different members of the series with the granites, in localities, but short distances apart, which cannot be done on the theory that often the lower beds are wanting in certain places owing to their not being deposited on uplifted portions of the sea bottom as no signs of such an equality exists, and all the lower deposits point to the existence of a nearly flat sea bottom extending over the continent and covered with a shallow sea at the time when they were deposited. There are also frequent discrepencies in the sections of the bedded rocks themselves, which are sometimes proved to be caused by such nearly horizontal over-riding of one part of the series by another portion, and cannot be accounted for in any other manner at present. Solution of stratigraphical problems.

The idea of this buckling and over-riding of immense blocks of these rocks was brought to the writer's attention by a study of the ice along the shore of Hudson bay when pressure is exerted upon it by storms from seaward during midwinter when the ice is very hard. The ice under these conditions is forced up into the ridges over the rocks on shore, and also for some distance out from shore into ridges upon itself owing to a buckling and fracturing along lines parallel to the resistance of the shore. These ridges are greatly modified by the breaking of the ice forming them into blocks by cross cracks, so that the ridges instead of resting uniformly upon the underlying ice or rock and having a uniform height, are thrown up into all shapes with a more or less regular dip seaward, and sharp faces toward the land, Result of pressure on shore ice.

while the height of the ridges varies with the tilting of the separate blocks, and also with the degree to which the ice has been fractured into such blocks. These results of the action of pressure on shore ice appear to be identical on a small scale with what happened to the so-called Cambrian formation subsequent to the cooling and probable contraction of the granites.

Following this movement of the bedded rocks in geological time came a much later outburst of diabase, which occurs in the form of dykes cutting all the older rocks. These dykes vary in breadth from a few inches to upwards of one hundred yards. They generally run more or less parallel to the coast, and perhaps fill deep cracks in the surface or were developed along lines of weakness. No large centres of gabbro or diabase have been found from which these dykes flow, nor are there any flat-lying flows of trap in connection with them.

No recent geological change.

No record of any other geological change has been noted along the east coast of Hudson bay from the injection of these newer diabase dykes until the advent of the glaciers in Post-Pliocene time. And during this great interval of time, the rocks forming this coast appear to have been continuously above the level of the sea, thus preventing the deposition of any fossiliferous beds. During the Silurian and Devonian times, there may have been a slight depression along the coast allowing the deposition of narrow rims of limestones of these ages, but if so they have been totally eroded by the glacial and other action, so that the only evidence of such deposits are a few fragments of limestone scattered along shore, and these may have been transported by floating ice from the northern or western parts of Hudson bay.

During the glacial period the entire coast was covered with ice, and the records left by the glacial striæ show that the centre of glaciation at first was in the southern interior of Labrador, close to the present watershed of the south-flowing rivers. The second set of striæ show that the centre of dispersion moved north to about the middle of the peninsula, while the latest set of striæ are from the north-east and prove the last centre of glaciation to have been in the northern half of the peninsula of Labrador. Since the close of the glacial period, the land has risen to a height of upwards of 700 feet above its level during the ice age. There are no indications* that this rise is still going on, and if it is doing so it is too slow to observe.

* It may be mentioned that this opinion is not shared by Dr. Bell who has examined the east coast of Hudson bay from Moose Factory to Cape Dufferin, on Portland promontory, as well as the western side of the bay, and has published many reasons for an opposite conclusion. See "Rising of the Land around Hudson Bay." Bull. Geol. Soc'y. Am. 1895; "Evidences of Northeasterly Differential Rising of the Land along Bell river." Bull. Geol. Soc'y. Am. 1897. See also Smithsonian Report for 1897, pp. 259-367.

Economic results.

From an economic standpoint, the investigation of the rocks along the east coast of Hudson bay has shown† that extensive deposits of iron ore occur in the unaltered sedimentary rocks of the Cambrian. These ores occur as beds interstratified with certain silicious rocks of the middle portion of the series, and appear to have been deposited from solution in a shallow sea. The upper beds of ore occur as ankerite, or a carbonate of lime, magnesia and iron, and as such are usually associated with a large percentage of manganese, which renders these ores valuable in the manufacture of Bessemer steel. Beneath the carbonates are silicious beds in which the ores are present as oxides, either magnetite or hæmatite, or a mixture of both, associated with red jasper. These beds may be due in part to infiltration of iron leached from the carbonates above, but much of the iron appears to have been originally deposited in the present beds.

The carbonate ores are found on all the islands of the Hopewell chain, on a number of the Nastapoka islands, and on Long island. The greatest thickness of ore noted was about twenty feet and it was broken by partings of black chert. The oxides are largely developed in the Nastapoka islands where their thickness is often more than fifty feet, but all of these measures are silicious and only part of them sufficiently rich for profitable mining. The oxide ores also occur on the islands and southern shores of Richmond gulf but of all the exposures seen there, none were sufficiently rich to be worked.

Granite intrusion causes segregation sulphides.

The intrusion of granite into the large areas of basic rocks met with along the coast at intervals from Kovik river to the southward of East Main river and the foliation of these latter by pressure has caused a segregation of the sulphides, always found scattered through the diabases, into long lenticular masses parallel to the foliation. And large veins of quartzose granite and pegmatite from the granites penetrating these basic rocks have also taken up some of their sulphides which may prove valuable ores. The area northward from Portland promontory to the vicinity of Mosquito bay appears to be the most promising for the discovery of sulphide ores in the form of pyrite, pyrrhotite and chalcopyrite as the diabases of that region have been greatly crushed and foliated and are also penetrated by a great many veins of quartz.

Little time could be given to the examination of that area and the chance specimens obtained from the mineral deposits there show that they contain a small quantity of nickel and copper without gold, but results obtained from hurriedly collected samples need not be taken as

† Report of Progress, Geol. Surv. Can. for 1877, Part C, pp. 16 and 21.

an indication of the absence of these metals in paying quantities in these rocks. The Paint Hills area of squeezed trap contains in places large segregation masses of pyrite which carry a small quantity of silver but no gold. Pyrites is also plentiful in the limestones of Long island and the islands north of Cape Jones. There is a bed of silicious dolomitic limestone full of cavities a short distance below the thick capping of diabase which extends along the coast from beyond the north end of Richmond gulf southward to the head of Manitounuk sound. In many places the cavities of this bed are filled with galena accompanied by pyrite and blende, all of which appear to have been leached out of the overlying diabase and to have been deposited in the cavities of the limestone. These deposits have not as yet proved to be sufficiently concentrated to allow of profitable mining.

Anthraxolite.

A vein of anthraxolite resembling anthracite coal is said to have been discovered on Long island.* This vein is reported to be about nine inches wide and cuts dark shales and limestone on the island. Similar veins of this mineral have been discovered in the interior of the Labrador peninsula, but it is only interesting as a mineral and is not economically valuable as the veins are too small to work with profit even if the mineral were equal to anthracite, which it is not, as it always contains a large percentage of quartz which renders it practically useless as a fuel.

Rocks suitable for building and decorative purposes.

In the upper portion of the Cambrian formation, as seen along the coast south of Great Whale river, on the Manitounuk islands, and along the coast, below the traps, are beds of fine-grained limestone, some of which might apparently be suitable for lithographic purposes. In many places the granites would afford excellent and beautiful building stones; most noticeable among these is the area of augite-syenite found on Walrus island, of the Paint Hills group. This rock is a beautiful porphyry holding pearly crystals of feldspar varying in colour from pink to violet or flesh-red, set in a dark-green ground-mass. Large slabs of this rock could easily be obtained which would be admirably adapted for interior and exterior decorations.

DETAILED DESCRIPTIONS OF ROCK EXPOSURES EXAMINED ALONG THE COAST.

Crystalline Series.

On the west side of Erik cove, rusty weathering biotite-gneiss (1 and 10)† is associated with thin bands containing much light-blue

* Reports of Progress, Geol. Surv. Can. for 1875, p. 325 and 1877 p. 24 c.

†The numbers accompanying the rocks refer to those of the microscopic slides described by Mr. G. A. Young in a MS on fyle in the office of the Geol. Survey.

cherty quartz. The gneisses, where not decomposed, are dark-gray in colour with small flakes of dark mica and contain at times considerable graphite and pyrite disseminated in small plates and grains. The fine-grained feldspar is often splotched with buff. These rocks are usually greatly dotted and are generally rust-coloured from the decomposition of their contained pyrites. In a number of places a short distance above tide-level patches of white efflorесence were observed, having a saline, ferruginous taste. These rocks are all well banded and stand nearly vertical. They are cut by large dykes of red pegmatite, derived apparently from a red mica-granite-gneiss which also cuts the rusty gneisses and in places contorts the beds.

Similar rocks were seen upon the hills to the southwest of the head of the cove and also forming the steep cliffs of Cape Wolstenholme, where, for a distance of eight miles, these vertically bedded gray and light-pink gneisses, cut and contorted by dark-red granite-gneiss and pegmatite, form cliffs that rise sheer from the water to altitudes varying from 400 to 700 feet. In going southward, as the cape is left, the proportion of granite-gneiss increases and it would appear as if the rocks inland to the southward were more largely intrusive, and as if the dark, rusty gneisses and schists were older bedded rocks caught up and altered by the intrusion of great masses and sheets of granite which were foliated by pressure subsequent to its intrusion, so as to now appear to be interfoliated with the more ancient bedded series, which on close inspection is seen to be cut across the bedding by the intruded granite-gneisses. High cliffs of granite.

At Nauyok brook, west of Cape Wolstenholme and abreast the opening between Digges islands, the strike is N. 80° W.

Between Nauyok brook and the Eskimos encampment at Nuvuk, some ten miles farther to the southwest, the rocks are largely red granite-gneiss (3.4.6) varying from fine to coarse-grained and frequently having an augen-gneiss structure and being mostly micaceous, but often containing dark hornblende, and in places magnetite in small grains. These gneisses contain broken bands and patches of finer-grained dark-grey and greenish biotite-hornblende gneisses, (2) varying in size from large masses to small thin bands, the latter being often much contorted and fractured. Some of these inclosed bands are very basic and are composed chiefly of dark hornblende and augite with much plagioclase (5) while others are micaceous and quartzose, and some of the bands contain much dark-red garnet. All these rocks are cut by dykes of fine-grained, light-red granite, which in turn are penetrated by dykes of red pegmatite. Strike at Nauyok, S. 70° W.; at Nuvuk, S. 60° W.

Coast low for thirty miles.

No landing was made on the low coast for nearly thirty miles beyond Nuvuk, when the rocks were found to be low ridges rising in places above the drift plain and consisting of coarse-grained hornblende-biotite gneiss (7) and diorite-aplite or malchite (8) cut by many large pegmatite dykes running in all directions and holding much dark hornblende. Dip of gneisses N. < 30°.

Two miles further on, coarse light-grey mica-augen gneiss was seen often containing hornblende. This gneiss evidently contains much plagioclase and is richer in this mineral in some parts than others, as the rock contains patches varying in size from a few square feet to upwards of 100 square feet, in which it is of a dark-green colour owing to the decomposition to saussurite of the component plagioclase. These patches contain more silicates than the lighter unaltered patches. At Koitasut the rock is mainly a very coarse augen-gneiss, some of the rounded orthoclase crystals being two inches by three inches. This gneiss encloses fragments of broken bands of dark mica and mica-hornblende schistose gneiss. Strike N. 45° E.

Kovik river.

Beyond Koitasut the coast is low and drift-covered and is flanked by numerous islands of drift with shallow water extending several miles out from the shore, so that no examination of the rocks could be made until a small rocky island about five miles north the mouth of Kovik river was reached. There the rocks were well-banded dark and light-grey mica and hornblende schistose gneisses, some of the hornblendic bands being very coarsely crystalline. All the bands were garnet-bearing; the lighter and more quartzose micaceous bands containing the greatest proportion of this mineral. Strike N. 10° E. These rocks were cut by a dyke of fine-grained dark diorite-aplite (9-11-12) sixty feet wide and running N. 40° W. This dyke was injected subsequent to the foliation of the gneisses, as offshoots from the main dyke have been injected into partings of the foliation of the gneisses. There are also small quartz veins holding small patches of yellow-weathering dolomite.

For five miles up the Kovik river the rocks are almost wholly light pink mica-gneiss with broken bands of darker, more basic schistose gneiss. Strike W. to N. 60° W.

At the south point of the mouth of the river these granitic rocks enclose a wide band of black schist mostly mica-hornblendic with thin bands in which hornblende predomiates. All the bands are garnet-bearing and they appear to be an ancient basic irruption squeezed and altered by the inclosing granite. Strike N. 50° W.

The next exposure examined was at the south point of the next bay four miles farther on, where the rocks are a mixture of light-gray and pink epidotic hornblende augen-gneiss (15) with wide bands of dark basic schists. Strike N. 70° W.

Kettlestone Knob.

Beyond this we were again unable to land owing to shallow water for fifteen miles when we reached Kettlestone Knob, a high rocky knoll joined to the shore by a long narrow shingle bar, but from the yacht the low ridge along the shore between these places appeared to be wholly composed of dark basic rocks.

Kettlestone Knob was found to be largely composed of a light pearly-green altered diorite (14), the alteration product of a mass of gabbro still showing in places on withered surfaces plagioclase crystals as white grains, while in other places a foliation had been induced altering the rock to a steatite-schist. The whole had been greatly shattered and is now cut by a net-work of quartz veins. Inclosed in this ancient gabbro are a number of broken bands of light-green greywacke (13), holding cubes of pyrites and greatly contorted, having evidently been caught up by the gabrro when it was irrupted. A few small veins of calcite run off from these slate inclusions. This locality is resorted to by the Eskimos who manufacture their lamps and kettles from steatite. Ridges of dark-coloured schists occupy the land on both sides of Kettlestone bay and extend inland from its head. At the mouth of the small river flowing into the bay these rocks were found to be dark-green hornblendic schists interbanded with light-green chloritic schists with thin bands of calcite, which with the other bands are found not to be persistent when followed along the strike, all giving out after a few yards. These rocks are identical with the squeezed traps of Cape Smith and other localities to the southward which are described farther on. About two miles up the river a curious crushed diorite or amphibolite rock (17), was found consisting almost exclusively of dark-greenish hornblende and having an augen-gneiss structure, that is large rounded lumps of radiating crystals of hornblende were enclosed in a schistose matrix of the same mineral.

Curious amphibolite rock.

The dark schists occupy the shore for nearly two miles south of Kettlestone bay, when they again give place to coarse pink and red granites which inclose broken bands of the dark schists and also bands of fine dark-gray, crushed diorite aplite (18). Strike N. 30° W. to N.

10° W. The granites occupy the coast and a gradually narrowing area inland, to the foot of the high trap range which approaches the coast from the north-east and reaches it about five miles northward of Smith island. This area of trap is about fifteen miles wide, and forms a range composed of several ridges of sharp hills, running more or less parallel to one another in a north-east direction inland. They form the large high island known as Smith island and determine the north side of Mosquito bay.

The trap, where undisturbed and fresh, is usually very fine-grained and dark-green in colour, apparently having been rapidly cooled, but no amygdules were seen, so that it may not have been a surface outflow although it appears to have been such.

Trap rock altered to Huronian schists.

In some places small patches have a diabase structure, while in others fairly large crystals of light-green plagioclase have been porphyritically developed. The rock weathers a rusty brown and appears to be in most places largely decomposed to chlorite. Nearly everywhere the trap has been fractured, most often in irregular prisms, probably from contraction on cooling. These series of prisms are inclined irregularly at various angles to the horizontal; usually they are nearly vertical. In many places the cracks have been in part filled with quartz and calcite, epidote, prehnite, chlorite and axinite being also found in them. In a great many places the irregular prisms have been decomposed for a thickness varying from one to three inches from the surface into a dark-green fibrous hornblende, while the interiors are more or less changed to a lighter green chlorite. Subsequent to these decomposition changes, foliation and squeezing of the trap were probably induced by the irruption of the granite, as these phenomena are more marked along the southern edge of the trap mass near its contact with the granite. As a result of these dynamic alterations, various stages of schistosity are seen in the trap, varying from a slight elongation and rounding of the irregular prisms to an extreme phase where their shape and character are almost obliterated, and the trap is altered to a typical Huronian schist, consisting of alternate dark and light-green bands of hornblendic and chloritic schists holding thin bands of calcite and quartz formed from the squeezing and lengthening of the masses of these minerals, which originally filled fissures between the trap prisms. When examined in small areas across the strike these banded schists resemble a bedded series of clastic and pyroclastic rocks tilted up at high angles, but when followed along the strike each band was seen to end sooner or later, and the whole mass was found to consist of a series of very long thin lozenges so drawn out as at first sight to be taken for a continuous alternation of finely banded light and dark schists. Areas in which the trap had not been broken into prisms, or where the decomposition to hornblende had not set up around the rims of the prisms, presented when greatly squeezed the appearance of a continuous chloritic schist, but even in the most homogeneous of these a careful tracing of individual bands always showed that they were not continuous, but terminated like those of the banded schists. Areas of similar trap occur at intervals along the east coast of Hudson bay all the way to the southern part of James bay and where they have been disturbed and squeezed by granite intrusions they show all the phases of schistosity described above.

Granite of Mosquito bay.

The south shore of Mosquito bay is formed of low rounded hills of granite. At the south point of the bay much of the rock is fine, to coarse-grained red and grey granite, with very indistinct foliation in places. It is made up largely of feldspar, quartz, mica and epidote, (19, 20, 21); when coarse-grained the feldspar is porphyritic. The mass has been considerably shattered and the small veins are filled with salmon-coloured calcite, with epidote and quartz. The granite is cut by a dyke of dark-grey micaceous rock having the schistose structure parallel to the walls. This dyke is from two to three feet wide and runs N. 40° W. There are also a few segregations or broken bands of mica-hornblende-schist enclosed in the granite. The whole is cut by small dykes of fine-grained pink granite.

Metamorphic clastic rocks.

On the islands off shore and about four miles south of the above point the granite is not plentiful, the rocks being largely light and dark-grey fine-grained epidotic biotite–mica schist (22,23). The light-coloured bands are very quartzose. Some of the darker bands are reddish and look like altered ferreginous cherts. A number of thin quartz stringers holding pyrite are seen along the foliation or bedding planes. They have the appearance of metamorphic clastic rocks. Strike N. 40° W. On the north shore of the Sorehead river, near its mouth, similar bands of dark schistose gneiss occur, but they are more highly altered than the last and the beds are much broken by a red biotite gneiss (24). Strike N. W. Only coarse augen-gneiss (25) was met with on a trip of eight miles up the Sorehead river. The colour of the gneiss varied from gray to light pink and it was mostly micaceous, while some areas were epidotic. General strike north. At the south point near the mouth of the river a large mass of coarse to medium-textured dark greenish-gray diorite (26) appears to cut augen-gneiss, but is itself cut by dykes of pegmatite. On the islands about two miles farther out the rocks are well-banded gray and red gneisses, the gray predominating and apparently having been intruded along the foliation planes by sheets of the red gneiss. Strike N. 60° W. At Magnet point there are large exposures of dark schistose diorite-gneiss (27) largely formed of mica and hornblende and containing much dark red garnet; also chloritic bands. These rocks must contain much iron as the local attraction of the compass is very great.

At Magnet islands there is a great deal of light-gray basic granite composed chiefly of feldspar and mica. It incloses much mica and mica-hornblende-schist, which are usually garnet-bearing and often pyritiferous. Strike N. All these rocks are cut by a large dyke of dark fine-grained diabase. On a small island just south of Thompson harbour there is a dark-greenish fine-grained augite-diorite (28) containing considerable magnetite and green hornblende, often in crystalline splotches. The gneiss is penetrated by a few dykes of white pegmatite and has gash veins of bluish opalescent quartz. There is also a coarser band containing more hornblende. Strike N. 30° W.

Diabase dyke.

Two miles to the southward of the exposure last examined, a small island was found to be largely composed of light-coloured granite and pegmatite inclosing fragments of mica and mica-hornblende-gneiss. The next exposure seen was on a small island about three miles north of Cape Anderson where the rock was a coarse-grained dark-green augite-diorite (29). It weathered dark-green with curious reticulating, reddish spots and veins and is highly magnetic. It is cut by veins and masses of granite.

The granites appear to again predominate about Cape Anderson and an exposure visited two miles south of it was wholly light-coloured granite-gneiss. Strike N. 30° W. The granites continue most abundant to the Povungnituk river. On a small high island near the head of deep water in that stream there is a fine exposure of crushed augite-diorite (30). It is cut by small dykes of red granite and pegmatite and is in contact along the strike of the foliation with a mass of coarse-grained light-pink granite-gneiss, which is evidently newer than the darker gneiss, as it incloses fragments of the latter, and is more basic near the contact than elsewhere. Strike N. 35° W. The rocks at the first rapid of the Povungnituk river and everywhere in the neighbourhood are all coarse red augen-gneiss containing broken bands of finer-grained mica-gneiss. Strike N. 25° W.

Augite-diorite.

Near the rapid is a dyke of dark fine-grained diabase (31) over 100 feet wide and running N. 75° W. On top of the hill the augen-gneiss incloses broken bands of dark altered gabbro in which some schistose structure has been developed.

For eight miles to the southward of the Povungnituk river, the light-coloured augen-gneisses predominate, and they cut and inclose much dark basic schistose gneiss, both hornblendic (33) (32) and micaceous, the former evidently an ancient irruptive rock, while the latter may represent a highly altered form of ancient clastic rocks.

No landing could be made in crossing Reef bay, nor for about fifteen miles beyond Reef point, owing to the low coast and the shallow water filled with reefs which extended well out from shore. The rocks seen on the low islands and points were largely dark schists and gneisses cut by wide dykes and masses of light-coloured granite and pegmatite. A large diabase dyke was seen cutting the rocks of the islands and shore at Reef point, and several others were seen to the southward of the point.

At Shoal harbour the rocks were coarse mica-granite, with many contorted and broken bands of finer mica-schist and gneiss cut by small pegmatite dykes. On the small low islands near shore and about a mile from Checkered islands, there are large exposures of typical dark and light-coloured Huronian schists. Strike, N. 20 W. These are largely chloritic and micaceous with hornblendic bands, and also some stringers or bands of quartz and calcite. They are an extreme phase of foliated trap, and the bands when carefully traced were found to pinch out like those of the Cape Smith area. These rocks contain much iron in the form of magnetite, pyrite and pyrrhotite, and some of the bands are sufficiently rich to be considered ores. One band about four feet wide was largely composed of pyrrhotite, with splotches of blue opalescent quartz. An analysis of this ore by Dr. Hoffmann gave the following results: copper, 0·06 per cent; nickel and cobalt, 0·08 per cent. Iron ores.

At Checkered islands, a great mass of old irruptive diorite (34) is cut by huge dykes and masses of pegmatite granite, which has affected the basic rock for upwards of 100 feet from the contact. The diorite having taken up light-coloured feldspar from the pegmatite, so that near the contact it looks like a light-gray syenite.

On the mainland adjoining the islands, large masses of pegmatite penetrate the altered schistose traps mentioned above and with basic eruptives (35,36) near their contact, change them into a fine-grained crushed diorite gneiss from the accession of feldspar. The schists are here associated with other very quartzose micaceous and hornblendic schistose rocks (37) usually holding dark-red garnets and quite distinct from the squeezed traps. They probably represent beds of altered clastic rocks associated with the traps. Many of the hornblende schists contain a large proportion of magnetite in grains. Strike N. 10° W. This locality is directly on the contact of the granites with the basic rocks, as for several miles up the west side of Kogaluk bay only coarse granite was met with.

Contact of granite with basic rocks.

A landing was made on a small island off the south point of Kogaluk bay where medium-grained light-pink biotite and biotite-muscovite-gneisses (39-40-41) were found holding broken bands of mica and-mica-hornblende schists. Strike N. 10 W.

About Mistake bay similar rocks (42) were met with on the mainland, some of the broken bands of hornblendic schists being rusty-weathering.

The next exposure examined was on a small island about three miles off the mouth of the Nauberakvik river where there are dark hornblende mica-schistose gneiss cut by dykes of dark-greenish hornblende-granite (44) containing much bluish opalescent quartz with magnetite and some mica. Both rocks are cut by dykes of pegmatite (43) containing considerable bluish quartz while the feldspar is beautifully mottled yellow and flesh-red. The schistose gneiss is in contact with a mica granite which near the contact is fine-grained but elsewhere very coarse in texture. Strike of schists N.S.W.

On the islands west of Alle Harbour is a coarse mica-granite-gneiss inclosing large masses of fine diabase (46) and bedded schists. Some of the schistose diorite (45) is pyritiferous and all of the dark rocks are penetrated by many dykes of pegmatite. On the mainland opposite, the rocks are largely granitic (47) and are cut by a newer diabase dyke forty feet wide, and running nearly parallel to the foliation. The gneiss near the contact with the dyke contains considerable chlorite. No further close examination of the rocks was made before Hopewell narrows was reached, but from the yacht the islands north of Portland promontory and the mainland to the south of that place were seen to be similar dark gneisses and schists, inclosed and cut by light-coloured granites and gneisses, which preponderate over the dark rocks on the mainland. On the mainland at Hopewell narrows the rocks are chiefly coarse-grained mica-hornblende-granite-gneiss foliated with fine-grained light-bluish very silicious mica-gneiss which may be an altered impure quartzite such as occurs on the Hopewell islands, in the unaltered rocks found there. This fine-grained gneiss is in broken bands inclosed in the coarser gneisses. Similar gneisses were seen to occupy the mainland to about four miles south

Rocks at Hopewell narrows.

of Hopewell point, where they were again examined and found to be largely coarse red mica-gneiss inclosing broken bands of dark mica or mica-hornblende schists usually very silicious.

The coarse-grained granitic rocks predominate along the mainland southward to beyond the mouth of the Nastapoka river, and as well as the darker schitose gneisses, they inclose at intervals along the coast, large patches of trap often but little foliated and closely resembling that overlying the unaltered sedimentary rocks of the Hopewell islands and the coast further southward.

On the trip made inland from Whale point to Lake Minto, the rocks everywhere met with for sixty miles were all granitic, usually coarse-grained and often having an augen-gneiss structure. The prevailing colour was pink, with areas of darker red and some grayish. Very few inclusions of the schistose gneisses were noted until within a few miles of the end of the exploration on Lake Minto where large masses of basic schists and diorites were found inclosed in the granites.

Large area of granite rocks.

The extensive area of country lying between Great and Little Whale rivers and extending inland some fifty miles is also almost wholly occupied by granitic rocks, only a few broken banded schistose gneisses at rare intervals were seen during the exploration of the northern branches of the Great Whale river.

Area of unaltered clastic rocks.

The coast from a few miles south of the mouth of the Nastapoka river southward to Boat harbour, eight miles north of the mouth of Great Whale river is occupied by a series of unaltered clastic rocks associated with bedded traps. Further south these rocks only occur as patches on the mainland and the small islands as far south as Cape Jones, the remainder of the coast being composed of the crystalline series, granite as usual predominating.

At Cape Jones the point is formed of medium-grained light-gray and greenish biotite-gneisses (130) composed largely of quartz and feldspar; when in large masses they are not well foliated. They cut and inclose masses of greatly contorted dark-greenish biotite-hornblende-gneiss and also a dark-green rusty-weathering gneiss rich in garnet and pyrite. General strike S. 80° W.

In places, cracks in the gneisses have been filled with brownish-weathering dolomite thus forming a dolomitic gneiss breccia. At the Indian encampment at Cape Jones, the granite is very coarse in texture with a rough augen-gneiss structure. It is intimately interfoliated with dark mica-schist and appears to have been injected as small dykes along the foliation planes of the latter.

On an island about one mile north of the mouth of the Pishop Roggan river medium-grained pink and red biotite gneiss was found cutting and inclosing large masses of very dark, medium-grained biotite-diorite (131). Strike W. About the same distance south of the river similar rocks were seen.

At Attikuan, light-pink and gray, medium-grained biotite-gneiss, not well foliated (133), contains a few angular fragments and broken bands of dark basic schist. In places the light-coloured gneiss is very coarse-grained and its feldspar is often decomposed to sausserite, the rock being in such places exceedingly fractured. Strike S. 60° W. The same coarse-grained light-pink gneiss, holding small fragments of dark schist was noted on the islands four miles south of Attikuan and again five miles further south.

Medium to coarse-grained gray and pink biotite gneiss (134) sometimes containing much epidote occurs at Kakachischuan on the north point of Paul bay.

At Pipestone gutway the rock is a red coarse augen-gneiss holding many bands of dark pyroxene gneiss (137). Strike N. 80° W. This mass is cut by a dyke of diabase 170 feet wide and running S. 50° E. But being thrown by a heavy fault it appears on an island to the westward. The dyke close to the contact on both sides is very fine-grained and compact, but towards the centre it is more coarsely crystalline (125-136-138). Where coarsely crystalline it is about half decomposed and this decomposition product is used by the natives in the manufacture of pipes. Alongside the main dyke on its east side is a smaller dyke about one foot wide; it is very fine-grained and almost glassy.

Diabase used in manufacture of pipes.

At Wastikun island and on the islands of Stromness harbour, the rocks are largely red, coarse biotite-gneiss with broken bands of dark basic schist and gneiss.

On Governor island, off the mouth of Big river, a large mass of dark-green diorite-gneiss is cut by coarse red augen-gneiss (141); strike N. 19° W. The diorite-gneiss is evidently a squeezed and decomposed diabase, as in many places a porphyritic structure with small rounded crystals of pale-green plagioclase is still seen; in other places it has been fractured, partly decomposed and drawn out into overlapping bands. Where the basic schist occurs in small masses in the gneiss, it is of a lighter colour and is more feldspathic with much mica.

Two miles south of the last exposure, coarse, pink biotite-hornblende-augen-gneiss was again met with on a small island. This gneiss under the microscope shows signs of great pressure (143). It is only hornblendic in patches, and in some places is garnet-bearing. It incloses large masses of fine to medium-grained, very quartzose, biotite-gneiss, pink and gray in colour (142.) These rocks have a distinctly clastic appearance, and are probably altered impure quartzites or arkose. The microscopic examination bears out this view (144–145), as the quartz in places is seen to be in elongated grains. Again at a small island about two miles beyond the last, these rocks (146) are met with in identical conditions, and are here cut by a huge dyke of diabase 210 feet wide running N. 20° W. It is fine-grained near its contact with the gneisses, moderately coarse in texture towards the middle and everywhere slightly porphyritic (147).

In Aquatuk bay the augen-gneiss predominates, but there are many considerable bands of the quartzose fine-grained gneisses which have the appearance of altered clastics (142). The islands off the north point of Aquatuk bay are largely coarse, pink and red biotite-gneiss, often with an augen-gneiss structure. They cut medium to fine-grained dark schists and gneisses, some of which are squeezed diorites (148) while others are very quartzose and are probably squeezed clastics (149–150.) These bands appear to have been injected with numerous thin bands of granite along the foliation planes; strike S. 70° W. The rocks on the small islands off the middle of the bay are red unfoliated biotite granite cut by small dykes of diabase (151).

Squeezed clastics.

On Earthquake island the predominating rock is fine to medium-grained pink and red biotite-hornblende granite, largely unfoliated and apparently inclosing large angular masses of a coarse, lighter coloured hornblende-granite. In places this latter granite has a porphyritic structure due to large crystals of white feldspar. All are highly shattered and the cracks often filled with red oxide of iron. At the south end of the island the granite is lighter-coloured and is mixed with broken bands of very quartzose schistose mica-gneiss (152, 153). All are cut by many small veins of pegmatite at times holding numerous small crystals of biotite. Strike N. 80° W.

At the point of the mainland opposite Earthquake island the same coarse red pink granite (154) occurs holding broken bands of darker gneisses. The granite is most abundant on the shores of Dead Duck bay. At the south point of this bay the rock is wholly coarse augen-gneiss, in places unfoliated and cut by many large dykes of red pegmatite. Where old cracks occur in the granite and pegmatite the feldspar is much decomposed and dark red in colour. Strike N. 75° W.

At Gray Goose islands there are medium to fine-grained, pink and gray very quartzose biotite-gneisses (156-157) separated from overlying finer-grained biotite gneiss by ten feet of a coarse hornblende dioritic granite (155) much broken and cemented by pegmatite. Several large dykes of red pegmatite cut the gneisses which appear to have been inter-foliated with thin sheets of granite sometimes carrying hornblende. All are cut by small dykes of very fine-grained diabase (159). The schistose gneisses appear on the main shore about a mile north of Long point and continue for about a mile south of the point when they are cut out by the coarse augen-gneiss. On the mainland opposite Burnt island, coarse biotite and biotite-hornblende-augen-gneiss, light pink and gray in colour, were found inter-sheeted with more or less regular bands of highly quartzose biotite-gneiss (160) usually dark pink in colour and sometimes holding small garnets. There are also dark schists, usually micaceous but at times hornblendic.

Contacts difficult to determine.

All are cut by small dykes of fine-grained pink granite which is banded parallel to the length of the dykes and so does not conform to the general foliation. The augen-gneiss being irrupted along the foliation of the quartzose gneiss, there is often difficulty in determining their contacts.

On Burnt island, the coarse augen-gneiss predominates and in places contains large patches of quartzose-gneiss, the foliation of which does not conform with the general foliation and which appear to have been originally large fragments of clastic rock floated in the granite magma. Strike S. 80° W.

Near the mouth of the Beaver river these rocks (161) are cut by a large diabase dyke which has broken into and incloses fragments of the granite along its walls.

At Comb hills the rocks are chiefly medium to coarse-grained dark-pink biotite-hornblende-gneiss often containing large crystals of feldspar. These are associated with light-gray and pink, very quartzose biotite-gneisses and dark biotite and hornblende-schists. They are all cut by large dykes of very quartzose white pegmatite. Several large dykes of diabase cut these rocks on the outer islands of Comb hills.

On Pigeon island coarse and fine-grained light to dark-gray schistose hornblende-biotite-gneisses (162, 163) are cut by a fine-grained pink granite-gneiss which also incloses a dyke, five feet wide, of diorite gneiss. Strike S. 85° W. The next exposure examined was on a small island, five miles north of Loon point, where the rocks were mostly very quartzose gray biotite-gneisses (158, 164, 165) sometimes holding small dark-red garnets and at times hornblende. They are associated with fewer bands of pink gneiss and are all cut by large dykes of nearly pure red orthoclase. Strike N. 85° W.

At Loon point there are about 500 yards of dark-green chloritic schists separated by several bands, from one to three feet thick, of a light-coloured friable biotite gneiss (166, 167). A few of the dark bands weather rusty from the decomposition of disseminated pyrite. They are abruptly cut by pegmatite and hornblende granite-gneiss (168). The above are apparently sheets of altered diabase which had been injected between the sandstone beds and both subsequently altered by pressure and heat during the period of the granite intrusion.

The Paint Hills islands are arranged in two chains extending out from a deep bay in a southwest direction upwards of ten miles and, after an interval of six miles, form the Solomon Temple islands. All these islands are formed from a sheet of diabase of which the breadth varies from three to five miles and which continues inland in a north-east direction from the head of the bay, thus having a known length of upwards of twenty miles. On these islands all varieties of diabase are found, together with all forms of its decomposition products and alterations due to pressure. The eastern end of Walrus island is occupied by a large mass of curious porphyritic augite-syenite (169, 170, 171, 172, 174) composed almost wholly of porphyritic crystals of pearly feldspar (perthite) which vary in colour from light pink to flesh-red and violet tints and occur in long, thin crystals up to two inches in length; along with the feldspar is dark green augite, often completely changed to epidote, especially in the vicinity of a large dyke of the newer diabase, where the granite is deep flesh-red and its pegmatite contains large masses of beautifully crystallized epidote together with tourmaline and a brownish mineral (danalite?) The syenite is penetrated by many small veins of quartz carrying small quantities of pyrite.

Islands formed of diabase.

The diabase dyke which alters the granite is 120 feet wide and is very coarsely crystalline towards its middle. This area of granite is newer than the diabasic schists which it has displaced and it incloses fragments of the schists along the contacts.

The remainder of Walrus island is occupied by altered diabase (177-178) and the phenomena already described in connection with the areas of Cape Smith are here seen very perfectly illustrated. In places the unfoliated massive diabase is seen, in other places it has been fractured with a roughly basaltic structure and the prisms show a

Altered diabase.

decomposition rim of green hornblende, while the spaces between the prisms are filled in part by calcite and quartz. Again pressure has elongated the prisms and induced foliation which in the extreme phase causes the rock to pass into a well foliated banded schist alternating dark and light with thin bands of calcite and quartz formed from the masses filling the original cracks in the basalt. This alteration, due to pressure is further complicated by various alteration products formed from the decomposition of the original diabase which itself varied from a fine-grained basaltic form through various textures to a very coarsely porpyhritic variety inclosing crystals of light-coloured plagioclase several inches in diameter and thence into anorthosite (182). These rocks therefore now afford all varieties of chloritic hornblendic, epidotic and other basic schists (175,176, 181,197) as well as non-foliated masses of similar rocks (190,173, 180,207.) The other islands of the Paint hills and Solomon Temple groups are formed of similar foliated and altered diabase, sometimes associated with thin bands of friable sandstone and fine graphitic schists (201-202). In a number of places the squeezed diabase is rich in pyrite which on analysis was found to contain a small quantity of silver but no gold. The pyrites appears to occur in segregation masses along certain bands and some of these masses contain many tons of ore and have been staked as mineral claims.

Mineral claims.

On the northern island the schists are cut by many dykes of granite and pegmatite. There appears to have been at least three series of these dykes the oldest being a red hornblendic, syenite or granite, (183, 184,185,186,187,188), the second a lighter coloured biotite-granite while the last was a pegmatite usually very quartzose and carrying pyrite and in places molybdenite. Some of these pegmatite dykes, especially on the outer northern islands contain much green feldspar or amazon stone. All these dykes in turn are cut by the newer diabase dykes, (195.) The general strike of the foliation of the schists is S.65°W. In places the hornblende dykes or augite syenite (189,190-191,192,193) have been badly fractured and the fragments rounded and inclosed in the green schists, thus forming excellent examples of catyclastic conglomerates. In a loose block found near the contact between the epidote and the large diabase dyke on Walrus island the rare minerals spodumene and danalite were detected by Dr. Hoffmann (229). The contact between the schists and gneisses (196-200) on the northern side of the mass is very complicated bands of both being mixed together and with hornblende syenite (205,204,203,199,198). To the southward of Paint hills the granites and light-coloured gneiss again occupy the shores and inlands; and at Watt island the prevailing rock is medium-

Spodumene and danalite.

grained light-gray, very quartzose biotite-gneiss with many fractured bands of dark mica and mica-hornblende schists. All are cut by many dykes of red pegmatite. Strike S. 80°W. About Moar bay the same quartzose gneisses and dark-schists are seen, cut by red granite and pegmatites, the irrupted rocks increasing towards the south side of the bay, where more than half the rocks are granites. Strike N.75°W. At the south point of Moar bay the light coloured gneisses (208) are again most abundant and are accompanying with thick bands of darker schists (209); accompanying the darker schists are bands of pinkish quartzite, which have the appearance of baked sandstone. Strike N.85°W to N.55°W.

From Moar bay southward to the islands of Cape Hope the rocks are largely a coarsely crystalline biotite-hornblende-gneiss (210, 212, 213), very poor in quartz and often containing epidote and, although now foliated, they were originally irrupted granite cutting and inclosing broken bands and fragments of quartzose gneisses (211) and dark schists, many of these bands being garnet-bearing. Strike W.

The prominent islands of Cape Hope are formed from another area of squeezed diabase (217) similar in character to that of the Paint hills but containing less pyrite. The mass is cut by a similar system of acidic dykes, the oldest being a fine-grained hornblende-granite (216), the next in age a lighter coloured granite (215) while the newest are pegmatite (214). The schists and dykes cutting them are all traversed by dykes of newer diabase.

Acidic dykes.

In the northwestern part of the large island there are veins or bands of calcite included in the schists which hold many fine crystals of dark-red garnet up to an inch in diameter. From Cape Hope to the East Main river the rocks seen were all granitic (218) and inclosed only a few bands of dark schists. Strike S. 75° W. At the mouth of the East Main river there is a light-pink epidote-syenite (219). Very fine exposures occur along the coast between the mouth of the East Main river and Sherrick mount, the rocks coming out only at long intervals in low points and islands. Six miles south of the East Main river is a small island of squeezed diabase (220). The next exposures are at a low rocky point just south of the Kaniapiskau river, where the rock is a dark-gray schistose mica-gneiss (221) full of dark red garnets much decomposed to mica. Strike N. 75° W. At Loon point similar schistose gneisses (223) occur; they are often very quartzose, and are cut by large irregular dykes of white pegmatite which in places contain crystals of biotite up to three by five inches in size. Strike N. 80° W. All are cut by a dyke of rusty diabase forty feet wide (222).

Large biot crystals in white pegmatite.

At Sherrick mount* and on the islands around it, the very quartzose mica-gneisses (224) prevail and are associated with dark basic schis tose gneisses some of which contain pyroxene. All these schists and gneisses usually contain much garnet (225-226-227-228). These rocks are cut by coarse grained, often porphyritic biotite-granite-gneiss which is at times hornblendic; and all are traversed by large dykes of white pegmatite. Strike N. 85° W. to N. 60° W.

The last rock exposure in the southern part of James bay is seen at Stag rock* where the rocks are dark biotite-quartzite containing many garnets interbanded with light-gray quartzite holding little garnet or mica. They are cut by large dykes of light-gray pegmatite containing much bluish quartz. A fine grained pink or gray granite also cuts the schistose bands. Strike N. 85° W.

CAMBRIAN.

General Observations.

Unaltered sedimentary rocks.

The islands lying along the coast from Portland promontory to Cape Jones are formed of a practically unaltered series of sedimentary rocks, often associated with outflows of trap. These rocks are also found resting continuously upon the granites, and associated crystalline rocks of the mainland from a short distance south of the mouth of the Nastapoka river to Boat harbour in Manitounuk sound, and beyond there in broken patches as far as Humbug (Hamburg?) harbour, some thirty miles south of Great Whale river. These rocks of the islands and the mainland all dip westward or seaward at angles varying from 5° to 45°, and the breadth of the strip resting upon the mainland varies from a few yards to upwards of twenty miles at Richmond gulf, where they attain their maximum development. This series of rocks bears a close resemblance to those found along the Koksoak and Hamilton rivers, in the interior of Labrador, which were called Cambrian in former reports, and are classed under that name in the present report, although there is no fossil evidence for such a classification. They are probably older than much of the granite of the Labrador peninsula, which has been called Laurentian, and they are probably the unaltered equivalents of many of the schists and gneisses inclosed in and cut by these granites.† Except in a very few places, the contacts between these sedimentary rocks and the underlying granites appear to be unconformable and due to faults, but in the few places where the rocks were seen to rest undisturbed upon the granite,

*Report of Progress, Geol. Surv. Can., 1875, page 323, Do. 1877, p. 17 c.

†These speculations involve questions to which the answers are only individual opinions.—R.B.

the latter was found to cut and alter the bedded series, thus undoubtedly showing the granite to be the newer rock.

Composition of series.

This series of sedimentary rocks is largely composed of arkose, feldspatitic sandstones and quartzite, feldspathic argillite, greywacke, dolomites and limestones, all more or less ferruginous; and associated with them sills and dykes of trap and diabase, which also occur as surface flows.

The constituent matter of all the rocks (with the exception of the limestone and dolomite) is such as would allow them readily to pass into micaceous and hornblendic schists and gneisses by the intrusion of newer granites.* In some of the rocks of the lower portion of the series, consisting as it does of beds of ferruginous feldspathic arkose sandstones and argillites, this change would readily take place from the accession of heat and pressure due to such a granite intrusion; and to the northward of Great Whale river patches of such rocks were found in a partly altered state inclosed in granite; while to the northward of Richmond gulf portions of the trap overflow are found inclosed and altered by similar granite. As before stated the contacts of the bedded rocks and granite are usually unconformable and appear to be due to a nearly horizontal movement of the bedded series subsequent to the intrusion of the granite, due to pressure acting from outside the great areas of granite. This series of sedimentary rocks being close to the surface, and consequently above the line of folding, broke, as ice does upon the shore when pressed from seaward, and piled cake on cake not only upon unyielding granite but upon themselves. Their present positions show that such a horizontal pressure was exerted upon them, as they lie in ridges, roughly parallel, with their dips seaward. The action of a similar thrust force is observed wherever these rocks have been seen throughout the Labrador peninsula, the beds lying in a series of ridges all dipping in one direction with broken cliff faces on the opposite side. Along the east coast of Hudson bay there are three such ridges of the first magnitude; namely, that of the coast line, that of the islands, and another which forms the outer islands from fifty to seventy miles off the coast.

Result of horizontal pressure.

On the Koksoak river sixteen such ridges were noted in only the eastern half of the area. The main ridges are themselves broken into minor ones, and in Richmond gulf and on the Nastapoka islands, faults transverse to the direction of the main lines of fracture have fractured the rocks up into immense blocks and interfered with the symmetry of the dips, thus emphasizing the analogy which these rocks

* See last foot-note.

bear to shore ice acted upon by pressure from seaward, which not only piles the ice up in ridges upon itself and the shore, but also causes it to break into cakes.

DETAILED DESCRIPTION OF CAMBRIAN EXPOSURES.

Cambrian rocks.

The unaltered Cambrian rocks were first met with on the south side of Portland promotory where they form the Hopewell chain of islands stretching south eastward along the coast for fifty miles. At Portland promotory are large masses of diabase and dark schists cut by dykes and masses of granite, and these schists are probably the equivalents of the trap outflows which cap the bedded rocks of this region.

The following is a section in descending order made on the island at Hopewell narrows, at about the middle of the chain, and is fairly representative of the rocks exposed by the inner cliff of all these islands, the rocks dipping seaward at low angles :—

	Feet.
1. Dark-green, brownish-weathering, diabasic trap (51) composed chiefly of augite with a small amount of much altered plagioclase. This rock flowed out at, or near the surface, and two partings show that the flow occurred in three outbursts........	100
2. Light greenish-gray quartzite (49)...........................	50
3. Dark carbonaceous shale and shaley limestone..................	40
4. Dark-red and green chert, stained by oxide of iron, and containing rhombs of siderite in groups and bands (50)	10
5. Light and dark-blue, fine-grained, cherty quartzite.............	75
6. Dark-gray sandstone with calcareous partings, so that the rock is split into flags. Contains many rounded grains of transparent quartz...	10
7. Bluish-white quartzite..	50
To sea-level.	
	335

For thirty miles from the south end of Hopewell sound the coast is free from islands and the rocks of the mainland are granite, with occasional small patches of dark green trap, resting upon them at intervals along shore. The islands of the Nastapoka chain extending from lat. 57° 50′ to lat. 56° 05′ a distance of over 100 miles, and lying from one to three miles off the mainland, form an excellent protected channel for vessels of all sizes.

Section on Broughton island.

The following section was taken on Broughton island, the third large island from the northern end of the sound, and nearly opposite the mouth of Langland river. Section in descending order :—

		Feet.
1.	Dark greenish, ferruginous chert, always containing more or less magnetite, broken into thin bands by partings of magnetic ore, which are usually too thin to work without much separation from the lean ores. These rocks at times contain splotches of red jaspar and of ankerite which weathers brownish (54-57-58)..	150
2.	Dark argillaceous shale, greenish on fresh fracture, breaks into rusty weathering blocks....	42
3.	Light bluish-gray chert..	1
4.	Red jaspilyte, generally lean in iron (56)...	8
5.	Dark greenish-gray, silicious shale with thin beds of green sandstone. Contains much chlorite....	6
6.	Fine-grained, light-greenish feldspathic sandstone	9
	Concealed	10
7.	Fine grained, light-green, feldspathic sandstone spotted with minute brown marks. In heavy massive beds from three feet to five feet thick (55).....	30
8.	Fine-grained, greenish-gray, greywacke splitting into flags from two to six inches thick (53)......	20
	To sea-level.	276

The above is a typical section of the northern islands of the Nastapoka chain, except that in some places the above strata are capped by from twenty to fifty feet of irregularly weathering rusty beds.

The next section measured was on the south end of Davieau island and is as follows in descending order:—

		Feet.
1.	Rusty weathering, brownish-gray carbonate of iron, mixed with broken thin bands of dark-greenish chert..	20
2.	Dark-gray chert with many partings of dark-brown argillite (60) containing considerable oxide of iron....	120
3.	Red and green lean jaspery ore with ferruginous dolomitic partings.	8
4.	Red and green silicious argillite......	50
	Sea-level.	198

About the middle of Davieau island the following section was obtained:— Sections on Davieau island.

		Feet.
1.	Shaley, silicious carbonate of iron with bands of massive dark chert from one to two inches thick	25
2.	Red fine-grained arkose containing much magnetite and hematite (62).....	8
3.	Rich jaspillyte with thin pure bands of magnetite (65).....	20
4.	Dark-gray chert containing much disseminated magnetite (61-63).	9
	Sea-level.	62

At the narrow part of Gillies island near its middle, there is an exposure of 100 feet consisting of 30 feet of rich jaspilyte over-and underlain by gray ferruginous cherts. The foregoing sections appear to represent the middle beds of the series of the Cambrian, the top and bottom beds being wanting.

About Richmond gulf the Cambrian rocks are well represented on the shores and islands. In several places contacts with the granites are seen but except at the north end of the gulf and in Wiachewan bay the contacts appear to have been due to faults subsequent to the intrusion of the granite. At the north end of the gulf the granite was found cutting and altering sandstones and trap while at Wiachewan bay where the sandstones abutt against a large mass of coarse granite, they are baked to a white quartzite for about 50 feet away from the granite and are penetrated by numerous small quartz veins.

The high cliff ridge, which separates the gulf on its western side, from the waters of Hudson bay, exibits everywhere fine sections of rock. These sections disclose an unconformity between the upper and lower beds of the formation caused by a thrust of the upper beds over the lower. The line of fault forms an acute angle to the bedding plane and in consequence the beds of the portion above the fault are thicker as they are traced southward.

Sections disclose unconformity.

The following descending sections were taken at intervals along the coast ridge from the north end of Richmond gulf to Little Whale river ands how the thickening of the upper beds at the north end of Richmond gulf :—

	Feet.
1. Dark-green porphyritic diabase	50
2. Light-coloured sandstone with a few thin bands of buff weathering dolomite (107)	45
3. Yellowish-weathering fine-grained silicious limestone, with massive, buff weathering beds near top	75
Unconformity.	
4. Below this the rocks are medium to fine-grained arkose and quartzite with occasional bands of finer red felspathic sandstone (108)	790
Section of coast rocks on south side Little Whale river two miles inland :—	
1. Dark-green trap or diabase	150
2. Dark-grey flags of impure sandstone with yellow spots, and some thin sandy bands	33
3. Light-pink and gray sandstone	10
4. Dark-gray carbonaceous sandstone, with shaley limestone, and black shale, the sandstone giving out toward the top, so that the upper 6 feet is mostly shale, with a few thin limestone bands	30
5. Light-gray sandstone, parted by thin beds of arenaceous limestone	45
6. Light-buff weather, light-blue silicious limestone with many partings of light-blue chert, so that the upper 20 feet is flaggy	94

7. Light-coloured cherty limestone, weathering buff, and full of cavities lined with quartz and containing weathered pyrites and sometimes galena and blende	30
8. More compact light-blue cherty limestone	160
Concealed	50
9. Light-grey sandstone, holding many blocks of chert, and forming an angular chert	140
Conglomerate	10
10. Light-blue cherty dolomite weathering buff, with patches of dark-blue chert	210
Unconformity—	
11. Coarse, dark-red, arkose composed chiefly of red feldspar, decomposed hornblende and quartz in pebbles	175
To drift plain.	
	2,097

From the above two sections it will be seen that the sedimentary beds between the trap capping and the unconformable arkose below increase in thickness from 120 feet at the north end of Richmond gulf to 672 feet at Little Whale river, while an intermediate section taken on the south side of the outlet of Richmond gulf gives a thickness of 315 feet for the same part of the series, while to the northward of the first section they thin out altogether leaving the trap resting upon the arkose of the lower portion. This thickening of the beds cannot be due to irregularities of deposition but to a fault and thrust which has caused them and the overlying traps to override the underlying arkose rocks. The action of this fault is observable on the north side of the narrows of the outlet of Richmond gulf, where a small knob of granite rises into the bedded series and was overridden by the upper series which in so doing followed its contour on the western side but did not descend the eastern slope leaving a space there which was subsequently filled by the breaking and dropping down of the bedded rocks due to pressure of their weight.

Thickening of beds due to a fault and thrust.

The following sections of the rocks were made from the cliffs on the shores and islands of Richmond gulf, and are useful as giving an idea of the difficulties encountered in forming an ideal section of the series. On the west shore just inside the outlet there is a long peninsula connected with the mainland by a narrow neck.* This peninsula is formed wholly of bedded rocks which vary in colour from nearly white to dark-red, and in texture from a medium-grained sandstone, to a very coarse grit, containing rounded pebbles of quartz and feldspar up to two inches in diameter. These rocks are very quartzose and always carry much broken and rounded feldspar, and have evidently been formed from the disintegration of granitic rocks almost in place, the bedding being arranged like deposits in a shallow sea as the finer beds exhibit signs of ripple marking. The rocks are such that with the

* A description and view of Castle peninsula are given at page 14 c., Report of Progress, Geol. Surv. Can., for 1877.

accession of heat and pressure they would readily return to a gneissic condition.* These beds everywhere underlie the other clastic rocks of the series and are probably the lowest rocks of the series, but nowhere was the gradation into the unaltered lower granites seen, from which they are supposed to have been derived. The total thickness of these beds as exposed on the peninsula is upwards of 500 feet and probably nearer 1,000 feet. The following section in descending order was taken along the cliff on the south side of the narrows of Richmond gulf.

Thickness of beds.

	Feet.
1. Dark-brown very fine-grained diabase much cracked and cemented with impure red and green chert (89)	240
2. Very fine-grained dark greenish-gray diabase, much shattered, the fragments often rounded fissures; filled with an impure red chert, so that in places the rock has the appearance of a conglomerate (90)	350
3. Lighter greenish-gray diabase slightly coarser than (90) much less fractured (91)	225
4. Brecciated dark green diabase, cut by a few small quartz veins and containing small cavities filled with quartz, and flesh-coloured calcite and small quantities of pyrite	850
Unconformity.	
Concealed	300
5. Dark-green fine-grained fragmented diabase	500
Concealed	50
6. Dark red arkose, fine-grained and very silicious (92)	100
7. Coarse-grained gray arkose containing pebbles of quartz and felspar up to one-half inch diameter	10
8. Mixed beds of dark red greywacke and arkose with more silicious and coarser partings (69, 71, 81)	6
9. Medium-grained pink arkose sandrock (64)	4
10. Dark yellowish-red arkose sandrock	4
11. Light-pink arkose sandstone (79)	10
12. Dark purplish-red fine-grained arkose	1½
13. Greenish medium-grained arkose (70)	2
14. Light-greenish compact quartzite	1½
15. Light-pink arkose sandstone	7
16. Red banded arkose sandstone	3
17. Light-pink arkose sandstone	6
18. Mixed dark and light-red sandstone (80)	10
19. Light-pink and light-red sandstone	4
20. Red banded and light-red sandstones	1
21. Light-pink and light-red sandstones	2
22. Banded red and light-red sandstones	1
23. Light-pink and red sandstones	6
24. Banded red and pink sandstones	55
25. Dark-gray greywacke, containing small quantities of magnetite (76)	2
26. Banded pink to red arkose sandstone (78)	300
27. Red arkose with more angular fragments	50
Unconformity.	
	3,101

* The "Origin of Gneiss". Proc. Am. Assn. for the Adv. of Sci. 1889, pp. 227-31.

The arkose beds of the peninsula appear to rest immediately below the above section, and there is probably but a little break between them.

Resting unconformably upon the above is the following descending section representing the upper members of the series, separated from the lower by the costal thrust-fault before mentioned.

	Feet.
1. Dark-green, fine-grained diabase	100
2. Pink sandstone with numerous partings of dark ferruginous shale	15
3. Light-gray and pink sandstone, with very thin ferruginous partings	75
4. White, very fine-grained sandstone	40
Concealed	25
5. Buff weathering, light-blue cherty dolomite, with concretions of chert, and coarser grained darker coloured limestone	40
6. Yellow weathering, very fine-grained light-blue very cherty dolomite, with thin partings of light-blue chert	60
Concealed	50
7. Buff weathering, dark-gray, silicious limestone, with frequent partings of dark chert. The limestone is full of cavities lined with quartz and calcite, pyrite and blende, and at times galena, but all too scattered to be of economic value	8
To fault.	
	413

The next section was made down a small brook falling into the south-west corner of the bay formed by the peninsula, just inside the entrance to Richmond gulf. Section at entrance to Richmond gulf.

This section is from the fault dividing the upper beds downward, as follows :—

1. Dark greenish-gray, rusty brown-weathering greywacke (75)	35
2. Dark-green greywacke (73, 74)	5
3. Dark-green greywacke, with brown splotches of jaspery ore	15
4. Light-gray sandrock, mottled with spots of oxide of iron	10
5. Dark-red fine-grained slate greywacke, containing considerable iron ore and small angular fragments of jasper (87)	40
6. Dark-red argillite, with small patches of green (88)	5
7. Dark-green splotched greywacke	10
8. Dark-red ferruginous greywacke, with partings of red argillite	50
9. Dark cherty greywacke	5
10. Pink fine-grained arkose sandstone	4
11. Dark-red ferruginous silicious greywacke	10
12. Mostly dark-green ferruginous splotched greywacke with thin bands of red greywacke and red argillite	50
13. Dark green, compact, ferruginous greywacke with a few dark-red slatey bands	150
14. Shaley, red ferruginous chert (impure magnetite-hematite)	50
15. Green, cherty rock splotched and veined with red jasper	150
To shore.	
	589

The next section is situated four miles to the eastward on a hill facing northward. It is as follows in descending order :

1. Coarsely porphyritic fine-grained diabase	100
2. Light buff-weathering dolomitic full of light-blue chert and carrying small quantities of blende	20
3. Cherty, light-bluff limestone containing much pyrite and blue chert	100
4. Dark silicious limestone with partings of dark carbonaceous shale	80
5. Fine-grained, dark and light-gray flaggy sandstone with partings of dark-greenish arenaceous shale capped with a thin bed of light buff weathering cherty limestone	15
6. Light-blue, yellow-weathering dolomitic chert	3
Concealed	15
7. Dark-grayish chert	6
8. Light-gray and white fine-grained sandstone	115
9. Coarse light-gray sandstone splotched with rounded fragments of white feldspar	10
10. Light-gray sandstone, medium to fine-grained and thickly marked with minute brown spots together with light grayish green cherty beds separated by beds of dark brownish calcareous ferruginous sandrock containing small fragments of green jasper. Beds from ¼ to 2' thick (114)	105
Probable unconformity.	
11. Light-pink arkose sandstone	75
12. Light and dark-red arkose sandstone with many partings of red argillite	55
Concealed	185
13. Dark-red arkose sandrock carrying some carbonate of iron ; most plentiful in the upper beds there forming a lean cherty ore	45
14. Dark-red arkose sandrock containing considerable chlorite interbedded with pink more silicious arkose	140
15. Dark-red ferruginous arkose with many partings of dark-red argillite	75
16. Chiefly pinkish sandrock with a few bands of dark red greywacke sometimes greenish in colour	60
17. Very dark-red fine-grained greywacke	50
Dark-red ferruginous arkose splitting into flags (113)	75
Concealed	80
18. Dark-reddish and grayish arkose with partings of dark-red argillite and a few bands of coarser pink arkose (all ripple-marked)	33
19. Light-pink fine-grained arkose	10
To sea level.	
	1,452

Ripple marks.

The rocks of Cairn island and other islands in the southern part of Richmond gulf are largely pink and red arkose with (84) red and green micaceous argillite, and green greywacke. Nearly all the beds show ripple marks. The arkose in the upper beds shades into sandstone (93) from the elimination of feldspar. The following section made on the mainland immediately south of the narrows at Cairn island is interesting as showing the manner in which sheets of diabase have been injected between the bedding of the sedimentary rocks at this place.

1. Fine-grained purplish-green diabase with numerous amygdules of chlorite and at times calcite. Penetrated by veins and large splotches of reddish diabase (95)	400
2. Light-colored medium-grained green and pink arkose	85
3. Fine-grained decomposed diabase	28
4. Light-gray and pink flaggy arkose	30
5. Dark-green diabase	10
6. Light-greenish fine-grained arkose	40
Concealed	100
7. Dark-green diabase	60
8. Light-greenish fine-grained arkose	330
To contact with coarse biotite granite (96).	
	1,083

The contact of the arkose with the granite is a vertical fault from two to five feet wide and there is no appearance of alteration in either rocks near the contact. Contact of arkose with granite.

To the southward an upward continuation of the above section is as follows :—

1. Dark-green diabase	200
2. Dark-red argillite	2
3. Dark grayish-pink sandrock	25
Concealed	10
4. Lean red jaspilyte	55
Concealed	15
5. Impure red jaspilyte	10
Concealed	15
6. Slatey impure jaspilyte	35
7. Diabase full of jasper veins	15
8. Slatey iron jaspilyte	10
9. Cherty dark-gray limestone	10
Impure jaspilyte	50
Diabase	400
	852

This diabase is the top member of the preceding section.

To the eastward of Cairn island the arkose rocks occupy a strip from 50 to 500 yards wide along the south shore of Richmond gulf, except for about a mile where the granite comes out to the shore. The islands in the south-eastern part are composed of interbedded diabase and arkose.

The granite comes out to the eastern shore at the foot of Whale bay, at the south point of Wiachewan bay, about three miles north of the mouth of Clearwater river; again to the northward of the mouth of Deer river and at the northern end of the gulf. Everywhere else along this shore and on the islands lying off it, the rocks are bedded arkose, greywacke and argillite, associated with flows of dark green diabase. The only other section of the rocks on Richmond gulf which may be given is one measured in descending order at the cliff on the west side forming the point to the southward of Fishing-lake bay. Here the arkose of the bottom is not so thick as usual and the upper beds are more largely developed than elsewhere along this shore.

	Feet.
1. Fine-grained dark-green diabase (112) in places having porphyritic crystals of light-green feldspar; in other parts containing small amygdules of agate and chlorite or empty so that the rock is often honeycombed	55
2. Light-gray fine-grained sandstone (111)	8
3. Light-gray, coarse-grained sandstone (110)	40
4. Light-coloured dolomite with partings of chert and towards the middle of the measures large boulders of light-coloured grit	65
5. White compact limestone	10
6. Light-blue fine-grained silicious limestone with frequent partings of white and light-blue chert	80
7. Light-coloured yellowish to white, fine-grained sandstone with small specks and veins of yellow carbonate of iron	25
8. Light-gray medium to coarse-grained friable sandstone with calcareous matrix holding a few large dark-red garnets	15
9. Light-bluish limestone	5
10. Light-gray fine-grained dolomite with numerous partings of black graphitic shale from one to fifteen inches thick	60
11. Dark-blue compact dolomitic limestone weathering buff in beds from 3 to 24″ with shaley partings	70
12. Dark shaley limestone splitting into large flags from ½ to 4″ thick.	100
Unconformity.	
13. Arkose and sandstone	720
To sea-level.	
	1,253

Other sections made.

Several other sections were made of the rocks forming the cliffs about Richmond gulf, but as those above given are quite sufficient to show the nature and succession of the rocks in this region the former are not included here. The diabase-capped sedimentary rocks occupy the coast from Little Whale river southward as far as the head of Manitounuk sound, where the ridge of trap-capped rocks passes into the Manitounuk islands. The following descending section was measured at Big Rock on the northern island of this chain where the greatest thickness of the measures occur.

	Feet.
1. Dark-green, fine-grained diabase, slightly basaltic in structure	225
2. Very dark, fine-grained greywacke slate, and fine greywacke, baked light-green for 15″ from contact with overlying diabase	36
3. Rusty weathering arenaceous limestone full of partings of sandstone and containing some carbonate of iron	52
4. Light-blue and pink, fine-grained sandstone	93
5. Light-pink sandstone	40
Concealed	25
6. Light-blue and pink sandstones	18

7.	Dark shaley limestone	3
8.	Light-blue and pink sandstone	15
9.	Dark-gray silicious limestone containing grains of transparent quartz ; weathers rusty	33
10.	Light-pink sandstone	31
11.	Light-pink sandstone, very fine-grained with numerous partings of shaley limestone	23
12.	Very fine-grained dark sandstone (84)	6
13.	Grey sandstone with numerous thin partings of shaley limestone.	18
	Concealed.	30
14.	Light-gray and bluish quartzite, with patches and pebbles of limestone, ripple marked	443
	To sea-level	20
		1,111

A second ridge varying from 100 to 2,000 yards occupies the shore and the small adjacent islands from the northern end of Manitounuk sound to within five miles of the mouth of Great Whale river. The rocks forming this ridge are all fine-grained, light blue or pink dolomitic limestones, often silicious and containing concretions and partings of blue chert (122). The concretions are sometimes upwards of two feet in diameter, and are formed of thin alternate layers of limestone and chert, giving them the appearance of the fossil remains of some low form of animal organism. This ridge of limestones is continued to the south of the mouth of Great Whale river as patches resting upon the granite, as far south as Sucker creek.

Dolomitic limestones.

Long island and the other islands between Great Whale river and Cape Jones are also formed of Cambrian rocks.

On Bear island the following descending section was measured :

1.	Dark-gray micaceous sandstone becoming lighter coloured on top	20
2.	Fine-grained black quartzite in beds from 3 to 24 in. thick. Contains considerable pyrites (120) (121)	30
3.	Dark-blue shaley limestone	4
4.	Dark-gray micaceous sandstone	20
		74

The following section was made about four miles from the north end of Long island. The cliff face on the eastern side gave as follows :

1.	Light-blue dolomitic limestone containing many quartz grains (125)	30
2.	Fine-grained, compact, light-blue, dolomitic limestone, very massive ; weathers buff	60
3.	Light-coloured, massive limestone, with partings of darker shaley limestone	25
4.	Massive light-coloured limestone	50
5.	Dark-blue fine-grained shaley limestone (124)	18
6.	Fine-grained massive limestone with partings and concretions of black chert (123)	20
		203

There is an interval of a half mile to a second ridge inland on the island which gives the following descending section :—

1. Fine-grained dark green diabase (127)	50
2. Dark brown, yellow-weathering carbonate of iron with some calcite and interbanded with black chert (126)	20
	70

The underlying rocks are concealed by the drift.

On the islands to the south and east of Long island, pink and gray sandstones (129) overlie thick beds of massive concretionary limestone often carrying much pyrite.

Tickness of rocks difficult to define.

The above detailed descriptions of several of the sections measured in the Cambrian area, show how difficult it is to arrive at any definite conclusion as to the thickness or succession of these rocks. In the first place the capping of diabase which was probably a flow at or near the surface does not rest always upon the same beds, there being a difference of several hundred feet between the beds immediately underlying the diabase of the Manitounuk islands and those in the same position at Richmond gulf. The rocks, resting unconformably upon the lower arkose beds along the west side of Richmond gulf, also vary in thickness and in the number of the measures which rest directly upon the arkose. This difference is due to cross faults parallel to the direction of the thrust which allowed varying thickness of the upper rocks to be shoved over the lower in each huge cake lying between any two such faults.

The sequence of the formation in descending order is assumed to be as follows :

The upper portion is taken to be represented by the diabase-capped, light-coloured sandstones and limestones of the Manitounuk islands. These appear to rest upon a maximum thickness of 300 feet of cherty limestone, followed below by sandstones and argillites passing downwards through several hundred feet of dark red argillite sandstone and greywacke into the arkose at the base of the formation. The iron-bearing series of the Nastapoka islands are the equivalents of the red sandstones and argillites above the arkose. The total thickness of the formation is reckoned as follows in descending order :

	Feet.
1. Diabase capping	400
2. Manitounuk series	450
3. Limestones	300
4. Light coloured sandstones, &c	150
5. Dark red sandstone, argillite and greywacke	700
6. Arkose sandrock and greywacke	600
7. Arkose	1000
Total thickness of sedimentary rocks	3600

Glacial Geology.

The entire western side of the peninsula of Labrador during the glacial period was overspread by an ice-cap of a thickness sufficient to cover the highest summits, and to flow uniformly over mountain and valley from the interior of the peninsula outwards towards the coast. From the evidence of the glacial striæ now found marking the rocks, there would appear to have been movements in the position of the centre of dispersion of the ice, and perhaps periods of only slight glaciation corresponding to the interglacial periods of the United States. Along the east coast of Hudson bay, three marked sets of striæ are found, and from these it is seen that the earliest ice flow started from a central gathering ground between the 50th and 51st parallels of N. latitude, near the çentre of the peninsula. The second set of striæ show that the centre of glaciation had moved in a north-west direction to beyond the 54th parallel, while the latest set shows a continuation of the north-west movement leaving the centre of dispersion between the 55th and 56th parallels, and about one hundred miles inland from the east coast of Hudson bay. In many places only one set of striæ is visible, and these, the latest, show along the northern half of the coast that the flow of the ice was radially towards the coast, as the striæ on the rocks facing Hudson bay show that the ice flowed westward, while those facing Hudson strait show a northward flow..

Three sets of glacial striæ.

On the Moose river which falls into the southwest corner of Hudson bay a very interesting fact in regard to the glaciers was noted in the direction of the striae found on its banks in the interior. The oldest striae there were from northwest to southeast and prove that the Keewatin glacier overran the region north of Lake Superior before it was covered by the Labrador glacier which has left newer striae from the north-northeast. Subsequent to or accompanying the period of ice accumulation there was a marked subsidence of the land which was followed by an uplift. This uplift is marked by terraces of sand and clay, often carrying marine shells and accompanied by old sea beaches, the highest of which are upwards of 700 feet above sea-level. The data to hand is not sufficient to determine if the elevation was constant and equal along the east coast of Hudson bay owing to the fact that the land for long stretches along that coast nowhere rises sufficiently high to mark the level of the highest terraces, which are seen at greater elevations elsewhere.

Subsidence of land followed by uplift.

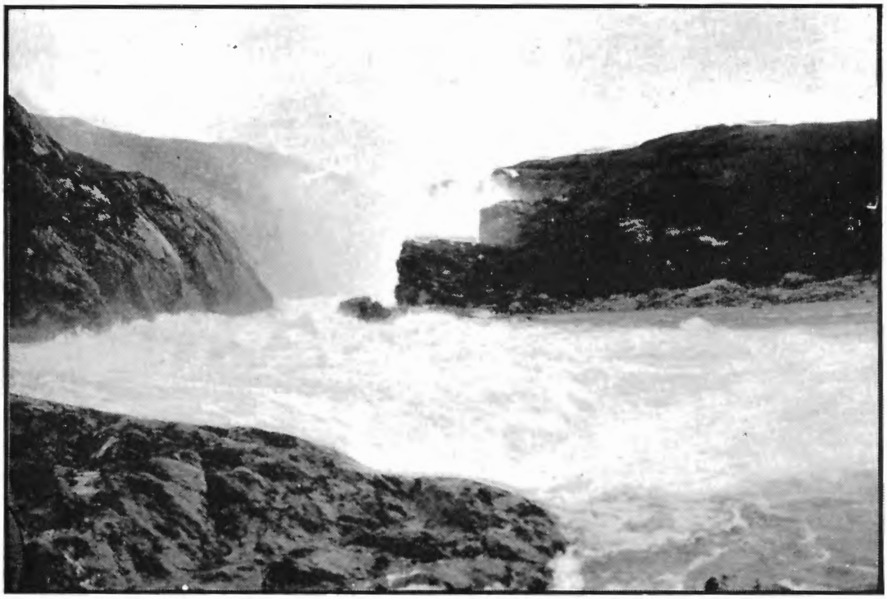
LIST OF GLACIAL STRIÆ.

NOTE.—The courses of the striæ given in the following list are true or astronomical bearings, and record the directions from which the ice-sheet moved in each case.

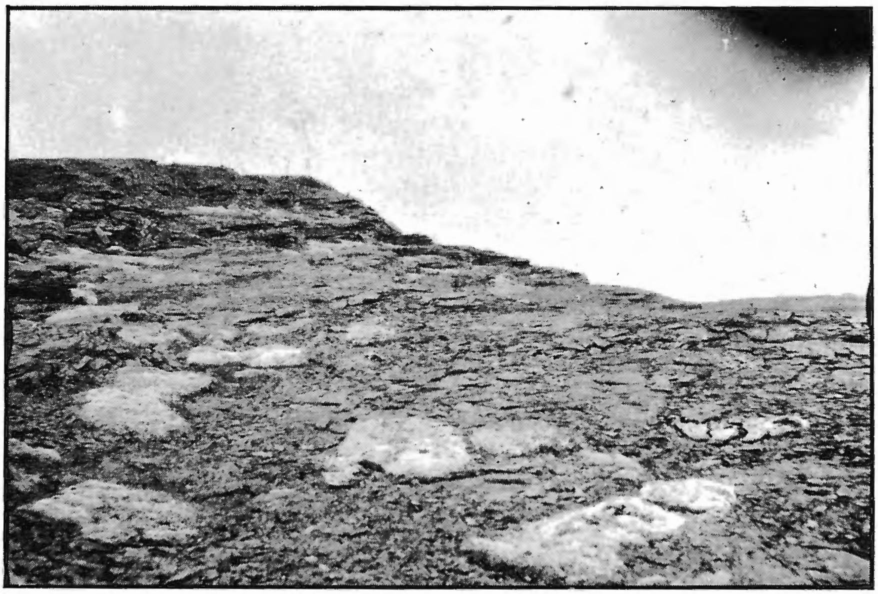
Head of Erik cove	
Down the valley	S. 40° W.
Near the summit of hills	S. 10° W.
On summit	S. 20° W.
Nauyok island	S. 30° E.
Mainland in rear of Nauyok island	S. 60° E.
Camp bay (4th Aug.)	S. 10° W.
Nuvuk	S. 10° W.
Small island 10 miles west of Nuvuk	S. 20° E.
Icy cove	S. 10° W. S. 20° S. S. 35° E.
Two miles in rear of Icy cove	S. 10° W. S. 25° E
Thirty miles S.W. of Icy cove	S. 80° E.
Koitasut	N. 75° E.
Two miles north of Kovik	N. 75° E.
Kovik	N. 65° E.
South point of Kovik river	N. 65° E.
Kettlestone knob	S. 75° E.
Kettlestone river	S. 70° E.
Six miles north of Cape Smith	S. 75° E.
Cape Smith	S. 50° E.
North side Mosquito bay 5 miles from Cape Smith	S. 75° E.
" " 10 " "	E.
" " 2 " head of bay	S. 85° E.
South point, Mosquito bay	S. 65 °E.
Island 4 miles south of Mosquito bay	E.
Mouth of Sorehead river	E.
Eight miles up Sorehead river (on hill)	S. 80° E.
South point, mouth of Sorehead river	E.
Magnet islands	E.
Thompson harbour	N. 75° E.
Two miles south of Thompson harbour	N. 70° E.
Two miles north of Cape Anderson	S. 65° E.
" south " "	S. 80° E.
Two miles up Povungnituk river	N. 80° E.
First rapid " "	S. 80° E.
Shoal harbour	E.
Checkered islands	E.
North side Kogaluk bay	S. 80° E.
Island off south point Kogaluk bay	S. 85° E.
Island off Nauberakvik river	S. 85° E. N. 75° E. N. 55° E. N. 30° E.
Alle harbour	N. 70° E. S. 35° E. N. 30° E.

Mainland at Alle harbour	N. 75° E.
Summit of island, Hopewell narrows	N. 50° E.
Summit of Broughton island	N. 70° E., (newer) S. 65° E.
Richmond gulf on summit of N. end	S. 60° E.
" " summit south of Fishing lake	S. 58° E.
" " island No. 1	N. 80° E.
" " east point Cairn island	S. 80° E , S. 70° E.
" " summit opposite narrows, Cairn island	S. 85° E.
Great Whale river, one mile above H. B. post	N. 85° E.
" " " one mile above 1st fall	E.
" " " five miles above 1st fall	E.
" " " at first fork	S. 75° E.
" " " canon of 3rd fall	E.
" " " five miles up Abchigamich branch	S. 80° E.
" " " fifteen miles up Coast branch	N. 85° E.
" " " end of survey " "	S. 75° E.
Two miles south of Great Whale river	E.
Ten " " " " "	S. 85° E.
Black Whale harbour	E.
Otaska harbour	N. 80° E.
Humbug harbour	N. 85° E.
Split rock	N. 40° E., N. 60° E.
White Bear hills	N. 50° E.
Long island	N. 50° E., (older) N. 68° E.
Cape Jones	N. E., (older) N. 60° E.
One mile north of Pishop Roggan river	N. E.
Attikuan	S. E.
Kakachischuan	N. 55° E., (older) S. 35° E.
Pipestone gutway	N. 63° E., (older) S. 55° E.
Governor island, Big river	N. 60° E.
Two miles south of Governor island	N. 65° E., (older) N. 85° E.
Five miles " " "	N. 57° E., (older) N. 80° E.
North point of Aquatuk bay	N. 52° E.
Middle islands, " "	N. 52° E.
Earthquake island	N. 55° E.
Mainland opposite Earthquake island	N. 50° E.
Dead Duck bay	N. 55° E.
" " " south point	N.E.
Gray Goose island	N. 35° E.
Mainland opposite Burnt island	N. 38° E.
Burnt island	N.E., (older) N. 62° E.
Comb Hills harbour	N. 42° E.
Pigeon island	N. 37° E.
Five miles north of Loon point	N. 30° E.
Paint hills, Walrus island	N. 26° E.
Paint hills, Walrus island	N. 37° E.
Paint hills, Walrus island	(older) N. 77° E.
" "	(newest) N. 30° E.
Paint hills, island No. 10	N. 67° E.
" "	(oldest) S. 52° E.
" "	(newest) N. 28° E.
Paint hills, island No. 14	N. 68° E.
" "	(oldest) S. 52° E.
" "	(newest) N. 23° E.

Paint hills, island No. 19		N. 63° E.
" "	(oldest)	S. 52° E.
Paint hills, island No. 21		N. 21° E.
" "	(newest)	N. 21° E.
Paint hills, island No. 23		N. 68° E.
" "	(oldest)	S. 52° E.
Watt island		N. 31° E.
"	(older)	N. 63° E.
Moar bay		N. 26° E.
"	(older)	N. 68° E.
Long point		N. 26° E.
North point Old Factory river		N. 28° E.
South " " "		N. 26° E.
Cape Hope island		N. 26° E.
" "	(older)	N. 60° E.
High Rock island		N. 23° E.
" "	(older)	N. 42° E.
Five miles south of East Main river		N. 35° E.
" " "	(older)	N. 55° E.
Kaniapiskau river		N. 33° E.
Loon point		N. 35° E.
"	(older)	N. 55° E.
Sherrick mount		N. 30° E.
"	(older)	N. 55° E.
Stag rock		N. 33° E.
Missinaibi river Conjuring House portage		N. 10° E.
" Black Feather rapid		N. 20° E.
" Tom King rapid		N. 18° E.
" Sandy Bay portage		N. 20° E.
" " "	(older)	N. 50° W.
" Albany rapid		N. 28° E.
" "	(older)	N. W.
" Devil rapid		N. 25° E.
" Island portage		N. 25° E.



NASTAPOKA FALL ON MIANLAND OPPOSITE GORDON ISLAND.



UPPER IRON BEDS, ON GILLIES ISLAND.

GEOLOGICAL SURVEY OF CANADA
ROBERT BELL, M.D., Sc.D. (Cantab.), LL.D., F.R.S.

REPORT

ON THE

GEOLOGY AND PHYSICAL CHARACTER

OF THE

NASTAPOKA ISLANDS

HUDSON BAY

BY

A. P. LOW, B.Sc.

OTTAWA
PRINTED BY S. E. DAWSON, PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
1903

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PORT HARRISON, HUDSON BAY,
November 20, 1901.

TO ROBERT BELL, M.D., LL.D., SC.D. (CANTAB.), F.R.S.,
Director Geological Survey of Canada.

SIR,—I beg to send you herewith my Report on the Nastapoka islands of Hudson bay. Acknowledgment is due to the President and Directors of the Dominion Development Company, for allowing me, while in their employ, to collect the material contained in this report and to send it to you for the benefit of the public.

The surveys required in this connection and their delineation, are the work of Mr. G. A. Young, M.Sc., to whom acknowledgment for his efficient and kindly assistance is here made.

I have the honour to be, Sir,
Your humble servant,

A. P. LOW.

REPORT

ON THE

GEOLOGY AND PHYSICAL CHARACTER

OF THE

NASTAPOKA ISLANDS

HUDSON BAY

Introduction.

The present report is based upon observations made by the writer during the summer of 1901, while engaged in the location of mineral claims for a private company. This work called for a close examination of the ore-bearing measures and associated rocks on the Nastapoka islands, to determine the extent and value of the ores, and to gain a knowledge of the relations of the ore beds to the surrounding rocks, a matter of importance in connection with the laws governing the granting of mineral claims by the Dominion Government. These examinations resulted in the securing of considerable detailed information concerning the rocks.

The report is divided into two portions, the first part giving a general description of the islands as a group and a general idea of their geology, and the second part a detailed description of the physical features and geological formation of each of the larger islands.

The report was written at Port Harrison in N. Lat. 58° 30′ on the east coast of Hudson bay, during the winter following the exploration, and the writer has had to depend, while writing it, wholly upon his notes, and on the knowledge previously acquired of these and other areas of similar rocks in the Labrador peninsula, as no written information bearing upon the subject was available at the time.

The rocks of the Nastapoka islands were first reported upon by Dr. Robert Bell, who examined them in 1877, and whose report was published in the Report of Progress of the Geological Survey for that year. The islands were again visited in 1898 by the writer, who made a hurried examination of them while passing southward along the east coast of Hudson bay; the results of the observations then made are published in the Annual Report, Geological Survey of Canada, vol. XIII. pp. 29D *et seq.*

PHYSICAL FEATURES OF THE NASTAPOKA ISLANDS.

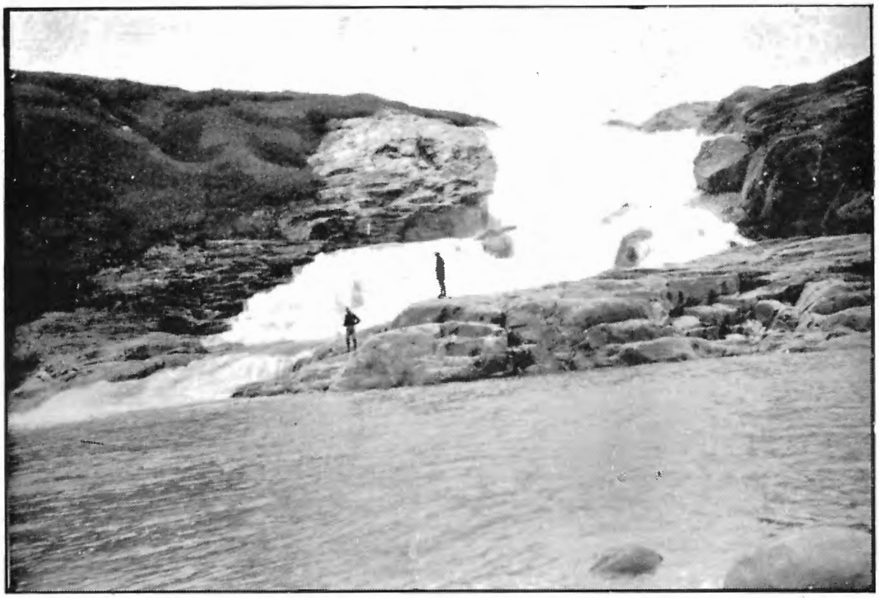
The Nastapoka islands lie close to the east coast of Hudson bay. They extend northward from five miles beyond the mouth of Little Whale river, to a point about twenty-five miles north of the mouth of Langland river, or, from N. Lat. 56° 5′ to N. Lat. 57° 50′, a distance of one hundred and twenty miles.

From their southern end to White Whale point in N. Lat. 57°, the general direction of the coast and islands is due north, while beyond that to the head of the chain the general direction is north-northwest. The islands form a chain roughly parallel to the coast and, with the exception of the distance between the two most northerly islands (which are nineteen miles apart) lie close together, the distance between island and island rarely exceeding a mile and usually being much less.

Nastapoka sound lies between them and the mainland, and varies from one to three mile across, the average width being somewhat over a mile. The sound so formed is like a broad river, and, except when the wind blows directly up or down, it is safe and easy to navigate with the smallest craft; while the depth of its channel will allow the largest ships to pass through it without danger. When the winds follow the channel, the strong currents caused by the tides raise an irregular sea.

The inner or eastern sides of all the islands are formed of abrupt cliffs with deep water close in-shore, while breaks in the cliffs form small bays with safe and unobstructed anchorages, easy of approach by large vessels. Towards the mainland the sound is also deep, but in places, especially about rocky points, reefs lie off the coast; and in the neighbourhood of the mouths of rivers there are shallows caused by the sand brought down by the streams and deposited outside. No safe or commodious harbours are found along the mainland, the mouths of Nastapoka and Langland rivers affording the only places of shelter for small craft on that side of the sound. The channel leading to Nastapoka river is narrow and crooked, and must be entered about a mile to the northward of the river and about half a mile from shore. It runs southward and gradually approaches the land until opposite the mouth

UPPER IRON ORE BEDS ON CHRISTIE ISLAND.



LANGLAND FALLS ON MAINLAND OPPOSITE BROUGHTON ISLAND.

of the river. The channel is from nine to twelve feet deep, with broad sandy shoals on both sides, where the water is less than a fathom deep. Inside the mouth of the river is a small, safe harbour in a basin below the rapids, which extend about one hundred yards to the falls, where the river descends perpendicularly one hundred feet. The entrance to Langland river is more dangerous, as the channel is less than fifty feet wide and very crooked with a bar across it at the mouth of the river, covered by less than four feet of water at low tide. The harbour inside is small but thoroughly protected and the only difficulty is in getting into it. The average rise and fall of the tide along the sound is about three feet.

The islands of the Nastapoka group vary in size from small wave-washed islets to one thirteen miles long and nearly three miles across in its widest part, known as Broughton island. Great and small, they number sixty-five in all, including the following larger islands in order from south to north: Flint, Belanger, Ross, Anderson, Lutit, Clarke, Gillies, Taylor, Miller, Gordon, Mowatt, Christie, Davieau, Nicholson, Broughton, McTavish and Cotter. The islands were named after officers of the Hudson's Bay Company who are or were connected with the company's posts situated on Hudson bay, and whose many kindnesses and willing aid extended to visiting members of the staff of the Geological Survey, have in a great measure ensured the success of the various explorations undertaken in the past through the vast northern regions practically under their control.

The physical character of the islands is similar throughout the chain; they are all formed from beds of stratified rocks, sometimes associated with flat sheets of trap. The rocks, although faulted, have a general dip towards the west; while, on their inner or eastern side, they are broken into sharp cliffs. The configuration of the islands conforms to the attitude of the rocks and consequently they all present sharp cliffs towards the sound, while on their western sides they slope gently and have low shores. The cliffs on the larger islands reach, in places, an elevation of upwards of 350 feet, but, as a rule, are between 100 feet and 200 feet high. They are broken into many small irregular bays and headlands, and the eastern shore is, as a rule, quite rocky, except in the bays where the lower cliffs are largely masked with sandy drift.

The surface of the islands, as before mentioned, has always a gentle slope westward, but this general slope is by no means regular, as the rocks have been thrown into roughly parallel ridges, similar in character, that is, each with a low cliff towards the east and a gentle slope westward, so that many of the islands are traversed by several low rocky ridges, running north and south, each ridge somewhat lower than that next to it on the east. Narrow shallow valleys occupy the intervals between the ridges, their bottoms usually filled with sandy drift and dotted over with small lakes and ponds.

The drift on the islands is formed into terraces and old beaches at different elevations from the present sea-level to the summits of the highest islands, marking the various levels at which the islands rested during the uplift of the land at the close of the glacial period; and showing that during that period the present islands were below sea level. Similar evidence on the adjacent mainland shows that the total elevation of the land since the ice age has been upwards of 700 feet.

The outer or western shores of the islands are low, with rocky points and outlying reefs separating wide bays with sandy or boulder-strewn shores. A number of small harbours occur along the outer shores, but their entrances are usually obstructed by reefs and the whole of the outer shores are dangerous of approach to large ships, owing to shallow water broken by submerged reefs which extends a considerable distance from this side of the islands.

The channels between the islands are usually deep, but they are in places obstructed by reefs. An entrance to the sound with large ships should only be made between the larger and higher islands, as, where the islands are small and low the water between them is generally shallow and the bottom lumpy.

A few stunted spruce trees grow on the western side of Belanger island near the south end of the chain. These are the only representatives of the forest, the islands being elsewhere barren.

Small, northern willows grow a foot or so above the ground in protected gullies and everywhere else the sandy soil is covered with arctic lichens, mosses, sedges and flowering plants, which never rise more than a few inches above the ground. Notwithstanding the absence of trees the surface of the islands has far from a desolate appearance in summer, when it resembles a highly cultivated region in broken country, whose face is beautifully diversified by the flowers and foliage of these arctic plants, while little lakes nestling between low ridges of barren rocks add charm to the picture.

GENERAL GEOLOGY OF THE NASTAPOKA ISDANDS.

The Nastapoka islands are formed from unaltered sedimentary rocks consisting of dolomites, sandstones, shales, jaspilytes, cherts and ferruginous shales. Associated with these rocks are sheets of dark green trap, which have been injected between the bedding of the stratified rocks or have been surface-flows contemporaneous with the formation of the sediments. A graywacke slate, which appears to have been formed by the deposit of volcanic ashes, is also associated with these rocks. The following is a general section of the rocks forming the islands; and is made from the measured sections, given in detail later in the report.

Descending order.

	Feet.
1. Rusty weathering, dark gray, siliceous rock containing ankerite (carbonate of iron and magnesia) and magnetite..	20 to 100
2. Dark-gray silicious rock containing magnetite with small quantities of ankerite..........	50 to 250
3. Red jaspilyte rich in hematite ore........................	10 to 100
4. Red jaspilyte poor in hematite ore........................	5 to 20
5. Purple, or greenish-weathering, dark-green, graywacke shales.......	10 to 70
6. Red jaspilyte poor in hematite ore........................	0 to 5
7. Light greenish-gray sandstone and shale...................	10 to 300
8. Fine grained dolomite.	0 to 50

The rusty weathering, dark-gray silicious rocks of the first division (1) are found on all the islands from Flint to McTavish, being wanting only on Cotter island. The typical rock is a dark gray chert made up of finely divided silica showing under the microscope small grains of quartz filled in by later accessions of that material in a finely divided state. It contains minute crystals of magnetite scattered through the mass, and also patches of crystalline carbonates. At the southern end of the chain it is cherty and sometimes light green in colour. These rocks are usually in thin beds, the parting between the beds filled with brownish ankerite, which also occurs in flat lenticular masses inclosed in the cherts; many of these masses are several inches in thickness and several square feet in area, so that the rock usually contains from twenty to fifty *per cent* of ankerite. These ores are too much broken and too intimately mixed with the cherts for profitable mining. The rusty character of the rock is due to surface decomposition of ankerite to limonite. The beds increase in thickness as the islands are followed northward, and reach their maximum development on Davieau island and northward to McTavish island where they have a thickness of fifty feet. These measures can be traced southward from the Nastapoka chain in the outer islands lying along the coast for upward of 150 miles, being last seen on Long island just north of Cape Jones, where they are overlaid by a considerable thickness of trap.

The second division of the section is an arbitrary one, and was made to embrace all the beds containing important deposits of magnetite. The upper beds of the division grade into those of division I, while the lower pass gradually into division III.

The typical rock of these measures is a dark gray, fine grained variety of quartzite chert, containing considerable magnetite scattered through it in minute crystals; it also contains small quantities of carbonates of iron, magnesia and lime. The beds are usually thin (from one to twelve inches) and the partings between them are filled with a mixture of silica and magnetite with small quantities of ankerite. These partings vary in thickness, but are generally thin between the upper beds of the division, and quite thick (six inches to forty-eight inches) towards the bottom, where they form important ores of iron; as the beds of chert are often, quite thin between two or more thick partings of ore and might easily be neglected in mining. The mixture of silica and magnetite in the ore is an intimate one, with the silica usually in a finely divided state.

The proportion of these substances is not constant, so that the ores vary from a lean ferruginous chert, to a rich ore containing upwards of sixty *per cent* of iron. Large quantities of the better ores occur in the lower beds of the division. The occurence of these ores between the beds of gray silicious rock, and their intimate association with finely divided silica point to their deposition and enrichment from the infiltrations of waters carrying solutions of iron and silica which were deposited by the waters in cracks and between the bedding of the already-formed silicious rocks. This mode of formation has been described by Van Hise for similar ores in the Lake Superior region.

On the three southern islands of the chain, there is a gradual change in the nature of these measures. They pass into a brownish-black, silicious shale, rich in iron and containing considerable carbon as small scales of graphite. This is the form in which they are found to the southward of the islands as far as Long island. The thickness of the division is very constant on the islands northward to McTavish, but it does not occur on Cotter island.

The rocks belonging to the third division, as before stated, grade into the division above them and the line between them cannot be drawn sharply.

The typical rock of this division is fine-grained and very silicious, with minute particles of silica coated with red oxide of iron, forming a coarse impure red jasper.

These jasper rocks usually occur in thin broken bands with the partings between them filled with a finely-divided mixture of hematite, magnetite and jasper. The hematite is greatly in excess of the magnetite. The association of the iron ores and the jasper is intimate and they must have been deposited simultaneously from aqueous solutions probably leached from the cherty carbonate measures above. Microscopic sections from these rocks are almost identical with those of jaspilyte figured by Van Hise in his monograph on the iron-bearing rocks of the Lake Superior region; and they must have had the same origin as he has assigned to those rocks, namely; enrichments deposited by water subsequent to the formation of the bedded rocks in which they are found as partings, and filling the most minute cavities.

The amount of ore in this admixture of hematite and jasper varies greatly; where the ore is poor, the jaspery rock predominates and incloses lenses of hematite, while where the hematite is most plentiful it incloses similar lenses of jasper. The detailed description of these rocks, given later, shows that the measures of this division contain an immense amount of hematite. The rocks of the division do not occur on all the islands, being wanting on Flint, Belanger and Ross. On Anderson they are represented by a few thin beds not rich in ore, while on Clarke they form the summit of the section with a thickness of eighty feet. They reach their maximum development on Gillies and Taylor where their ores are richest and most concentrated; farther northward they become thinner and poorer in ore, being twenty feet thick on Davieau and only eight feet thick on McTavish, where they die out. No trace of these measures is found underlying the upper rocks on the islands south of the Nastapoka group.

The fourth division, consisting of red jaspilytes is an arbitrary one, of use only as a subdivision of the iron-bearing rocks. Wherever the jaspilytes are well developed, the richer beds are underlain with leaner measures, unfit for working and these poorer ores constitute this division. On Clarke island these beds are twenty feet thick; on Gillies they vary from ten to twenty feet in thickness, on Taylor ten feet, while to the northward, they merge into the overlying division, all poor in iron ores.

The rocks of the fifth division differ from those of the rest of the section, in that they are of volcanic origin, probably trap-ash, rocks contemporaneous with an outflow of trap, which, on the northern and southern islands, occurs at the same horizon.

The rock is a purple or greenish-weathering, dark green, fine grained graywacke, with a horizontal shaly cleavage. It is formed from finely divided and partly rounded fragments of plagioclase, bisilicates (largely decomposed to chlorite) and rounded grains of quartz, which indicate a sedimentary character, while its other constituents point to an igneous origin, probably the ashes of a volcanic outburst deposited in a shallow sea.

In places the shales contain small partings of hematite; and at times portions of them are coated on the surface, so as to resemble metallic iron. These are not rich in iron ore.

These measures were first noted on Clarke island, where they have a thickness of seventy-five feet. On Gillies they are sixty feet thick; on Christie eighty-five feet; on Davieau less than fifty feet; on Broughton thirty feet; and on McTavish fifty feet. They disappear in the interval of nineteen miles separating McTavish from Cotter, being represented on the latter island by twenty feet of fine-grained trap, overlying the sandstone of the seventh division. Twenty five miles northward of Cotter, the trap is again seen in the Hopewell islands, where it overlies similar sandstones and attains a thickness of upwards of a hundred feet. On Belanger, Ross and Anderson islands sheets of traps, wholly or in part, occupy the horizon of the graywacke shales on the other islands. On Belanger thirty-five feet of graywacke shales rest upon three feet of trap, which latter overlies twenty feet of gray-wacke shale, resting upon twenty-five feet of trap.

On Ross and Anderson the trap underlying the iron-bearing rocks only rises slightly above sea level and its thickness is unknown. On Flint island, fifteen feet of trap rest upon beds of arkose sandstone which probably was largely formed from volcanic ashes.

The rocks of the six divisions are limited to Gillies, Davieau and McTavish islands. This jasper rock is in thin beds or flags without hematite ores. On McTavish island the jasper splits into thin flags, is nicely mottled and would prove effective for interior house decoration.

The sandstone and associated silicious shales constituting the seventh division are found in the lower portions of all the prominent eastern points of the islands. The sandstone is always light coloured, with generally, a greenish or pinkish tinge to the gray. A number of massive beds occur in the measures, but as a rule, the sandstone is thin-bedded and flaggy with the surface of the flags ripple-marked. It is essentially composed of quartz grains, but often holds considerable quantities of the carbonates of lime and magnesia, especially on the northern islands, where it is difficult to determine whether some of the beds are silicious limestone or calcareous sandrock. Many of the beds contain small splotches of ankerite ; and at times small garnets are found in the upper, massive beds. The shales form partings between the sandstone beds, indicating that the whole of the measures were deposited in shallow water. The shales are very silicious and usually of a light green colour.

The dolomites forming the eighth and lowest division are only met with at the eastern point of Belanger island. They are very much contorted and broken where seen ; and the contact between them and the overlying sandstones is concealed by drift, so that it is impossible to state whether or not they conformably underlie the sandstone. The sandstone where last seen above the drift is undisturbed, in marked contrast to the dolomites below, and there may be a line of fault between them.

The rocks forming the Nastapoka islands have a general dip to the westward, or towards the sea ; the angle of dip is generally low-from 5° to 15°. This general westward dip is by no means uniform and regular, as the rocks are thrown into roughly parallel ridges running north and south and separated by intervals varying from a few feet to several hundred yards across. These parallel ridges are the result of up-throws along lines of fault, the up-throw being always on the western side, and consequently the rocks on that side are always higher and have steeper faces than those on the opposite side of the fault. The amount of displacement at any of these faults is generally small and rarely exceeds one hundred feet. As a result of the displacements caused by these faults the surfaces of the islands always give one or more repetitions of the upper measures.

The stratigraphy is further complicated by another series of faults lying transverse to the first system. These two series of faults have broken the measures into huge blocks more or less rectangular in shape, and the unequal throw of the transverse faults has tilted these blocks so that they often dip diagonally to the northward or southward of west, resembling, on a gigantic scale, ice piled along shore by pressure from seaward. The present condition and position of the rocks must have been due to some such pressure acting from seaward, which forced them against the inert masses of granite and crystalline rocks forming the mainland, causing them to buckle along lines parallel to the coast and forcing huge cakes of rock to over-ride one another.

The buckling at these parallel faults, on the islands, represents on a smaller scale what took place along a great line of fault which extended fully three hundred miles along the east coast of Hudson bay, from

Cape Jones to Portland promontary, and caused the uplift of Long island, the outer islands between it and the Nastapoka islands and the Nastapoka and Hopewell islands, all of which belong to the same geological horizon. The uplift along this fault line must have been several hundred feet, while the horizontal movement of the rocks was much greater than the uplift. A second great line of fault and overthrust is indicated by the position of other unaltered rocks of this formation which lie upon the granites and other rocks of the mainland, from the north end of Richmond gulf to the vicinity of Cape Jones, a distance of nearly two hundred miles. The rocks of this division also exhibit a series of minor parallel faults like those described above. The Belcher and other islands stretch in lines parallel to the coast, from northward of Cape Jones to beyond Portland promontory, and are from forty to seventy miles off the land. These islands resemble in physical character to those lying close to the coast and have probably been thrown up from the sea bottom by a similar great overthrust along corresponding lines of fault. The rocks of the Nastapoka islands are not only faulted, but are also thrown into anticlinal and synclinal folds. These folds are always gentle and only on McTavish island does the angle of such a fold exceed 20° on either side, and even this moderate fold is broken along its crest. This slight folding before the buckling of the rocks shows that at the time the pressure, causing movements in them, was exerted, the rocks were at or close to the surface, and the lack of pressure from super-imposed strata allowed them to break rather than fold, as they would have done had they been deeply buried beneath newer formations.

The geological position of the rocks of the Nastapoka group is difficult to determine, owing to the great and minor faults which have displaced them and other measures of the formation to which they belong. The mainland, from opposite Flint island to Anderson island is occupied by a series of similar unaltered rocks belonging undoubtedly to the same formation. They are largely dolomites, limestones and sandstones, generally resting unconformably upon beds of arkose and arkose sandstone, but opposite Anderson island lying immediately upon granites. A great thickness of bedded trap overlies these stratified rocks. These unaltered rocks of the mainland dip gently west ward, and if no line of fault followed Nastapoka sound, the rocks of the islands would rest conformably upon them, and consequently would be newer and higher in the measures of the formation than the rocks of the mainland.

A study of the measures displayed in the southern cliffs of Richmond gulf, opposite Belanger island, was made in 1899. Here an unbroken series was found rising, from a coarse arkose rock, through arkose sandstones and shales into light coloured pinkish and greenish sandstones and silicious shales very like those of the bottom measures of the islands. Resting conformably on these sandstones and shales was a considerable thickness of lean jaspilytes mixed with graywacke shales having dark gray ferruginous cherts above them, while on top were dolomite, limestone and sandstone capped with trap. From this it is inferred that the Nastapoka group of rocks with their important iron-bearing measures belong to the middle portion of the so-called Cambrian formation of the peninsula of Labrador. Consequently they are older than the rocks of the coast and underlie them. Though, thrust up by a great fault, they seemingly overlie these rocks which form the summit of the formation along the east coast of Hudson bay.

Large areas of similar unaltered sedimentary rocks occur throughout the peninsula of Labrador, and are probably the equivalents of certain of the iron-bearing series about Lake Superior and of those to the westward of Hudson bay, hand specimens from these localities being undistinguishable, so closely do they resemble one another.

On former maps of portions of the peninsula of Labrador, the areas of rocks belonging to this formation have been coloured as belonging to the Cambrian formation, and in the earlier reports on this region, the rocks were thought to be a part of that system, owing to their unaltered condition, in contrast with all the other rocks of that vast area that were either crystalline granites and other irrupted rocks, or crystalline schists and gneisses, so completely metamorphosed as to have lost all trace of their original sedimentary nature, if any were sediments. These highly crystalline rocks were classed as Laurentian or Huronian and were considered to be much older than the unaltered rocks of the so-called Cambrian areas. More extended and closer study of both the unaltered and crystalline rocks and of their relations to one another has changed the views of the writer; and he now considers the unaltered, so-called Cambrian rocks to be the equivalents of many of the gneisses and schists classed as Laurentian (Grenville Series) and the Huronian areas of the Labrador peninsula to represent a portion of the unaltered rocks and their associated basic eruptives (traps, trap-ash, &c.,) altered by the irruption of granite and rendered schistose by pressure. The granites which have been classed as typical Laurentian, always cut and alter the bedded rocks wherever seen in direct contact with them and are consequently newer than the latter.

The above observed facts extending over large areas of the peninsula, the result of several years study of the rocks, have led the author to conclude that the term Cambrian as applied to these unaltered rocks is a misnomer, as considered in their relations with the surrounding areas classed as Laurentian and Huronian, they are of similar or greater age than the rocks so classed; and the term Cambrian is confined elsewhere, to rocks of more recent formation than the Laurentian or Huronian.

The age of these unaltered rocks is unknown, but is undoubtedly very great. No fossils have as yet been determined from them, but there appears to be evidence of low forms of life both animal and vegetable in them; as without them it is difficult to account for the deposition of the large quantities of carbon in the shales of this formation. The taking into solution of iron and its redeposition was possible due to the action of organic acids. Certain of the limestones contain concretions of alternate concentric layers of chert and limestone, which resemble fossils of low animal organisation. During the past season, very thin layers of carbon with some resemblance to organic forms were found in the sandstones of Cotter island; these have the appearance of lowly organized plant life. If there are fossils in these rocks they represent a low type of life, lower than the known fossils from the lowest beds of the Cambrian, and consequently this formation is older than the Cambrian. It is proposed, therefore, to class these so-called Cambrian unaltered rocks as Laurentian, as they represent the oldest, known sedimentary rocks in the North East of America and probably in the world.

DETAILED DESCRIPTIONS OF THE PHYSICAL FEATURES AND GEOLOGY OF THE NASTAPOKA ISLANDS.

Flint island is the most southern of the Nastapoka chain of islands, and lies about five miles to the northwest of the mouth of Little Whale river. The island is roughly triangular in shape, with each side nearly three quarters of a mile in length. The convex base faces northwest, or towards the open sea; the other sides are concave with very short angular points breaking the regularity of the curves. The island is rocky with a few areas of terraced drift at the heads of the small bays. The summit of the island rises less than fifty feet above the sea. The rocks dip at small angles towards the northwest and are the cause of low and abrupt cliffs along the southern and eastern shores, and of gentle slopes towards the west.

The total thickness of rock seen on Flint island is about one hundred feet and is as given in the following section :—

	Feet.
1. Fine-grained, greenish chert....	
2. Rusty-weathering, greenish and brownish, silicious, ferruginous shale, in places containing small cubes of pyrite.....	50
3. Compact, greenish trap-rock, containing a few veins of jasper and magnetite, too small for working.........	15
4. Coarse, reddish green, arkose sandrock.....	30
To sea-level. Total...............	95

A vein of quartz containing a high percentage of manganiferous siderite occurs on the island, although its exact locality was not determined. Fragments from the vein, show that it is from eight to ten inches wide, and that about fifty per cent of its mass is ore. The ore is valuable owing to the large quantity of manganese carried by it, but the vein is probably too narrow for profitable working.

Belanger island lies about a mile and a half north of Flint island. Its nearest approach to the mainland is just south of the entrance to Richmond gulf, where the sound is less than a mile wide.

The island is roughly triangular in shape, but unlike Flint island, its northwest side is concave and the others convex, each side being about three miles long. The rocks have a general, gentle dip towards the northwest and the surface of the island conforms to the slope of the rocks; consequently, on the inner, or south and east sides, steep cliffs rise abruptly from the sea. These cliffs at the inner angle have a maximum height of nearly 500 feet, and decrease gradually in elevation towards the west and north. On the outer or northwest face the coast is low with wide sandy bays separated by low rocky points. Deep water is found close under the cliffs on the inner side of the island, while on the outside a number of reefs lie parallel to the shore in the shallow water, which extends a considerable distance from the land, rendering an approach from seaward dangerous. A rocky sprit just south of the inner point forms a small boat harbour, good only for north and westerly winds, as it is too small to prevent the sea from throwing in a heavy swell when the wind is from the south or east.

The surface of the island is broken by rocky ridges caused by minor faults in the stratification of the rocks. There are considerable areas covered with sandy and coarser drift, especially on the western part of the island. Gravel and boulder ridges are seen at different levels, quite to the summit of the island, and indicate the rise of the land since the post-glacial subsidence.

The surface of the drift and many of the rocks are covered with arctic lichens, shrubs and flowering plants, which seldom grow more than an inch or so, above the ground. Arctic willows grow to heights of two or three feet in protected gullies, and a few small, stunted spruce trees are scattered over the western part of the island; on the mainland the trees extend along the coast some fifteen miles farther north to Fishing lake opposite Anderson island.

The following section was measured from the high cliffs near the little harbour on the inner side of the island and shows the measures of the Nastapoka series from its bottom to near the summit.

	Feet.
1. Dark gray, silicious dolomite, rusty-weathering from contained iron; holds large lenticular patches and broken bands of ankerite (a carbonate of iron and magnesia)	50
2. Concealed (probably No 3)	150
3. Rusty weathering, dark green, silicious shale, highly ferruginous, and apparently of pyroclastic origin	35
4. Fine grained, dark green trap	3
5. Dark green, brown-mottled, ferruginous chert; in flags with thin partings of oxide of iron; probably an ash rock	20
6. Very fine grained, dark green trap	25
7. Light and dark gray, sandstone and quartzite, splitting into large flags	50
8. Gray quartzite	4
9. Greenish, silicious shale	2
10. Light gray quartzite	1
11. Light green, silicious shale	5
12. White quartzite	3
13. Gray and greenish, shaly sandstone	26
14. White quartzite	3
15. Light greenish, silicious shale and sandstone	75
16. Greenish, silicious shale	10
17. Light greenish gray sandstone	6
18. Greenish, silicious shale	6
19. Light gray sandstone, with a few thin partings of green shale	27
20. Light greenish shale and sandstone in thin beds	20
21. Light gray sandstone	2
22. Light greenish, silicious shale	11
23. Light gray sandstone	1
24. Light greenish and reddish shales	5
25. Light gray sandstone	6
26. Fine grained, light greenish, very silicious dolomite	8
27. Light gray, friable sandstone	1·5
29. Greenish and pinkish, silicious shales	10
29. Light gray sandstone	1·5
30. Greenish, silicious shale	2
31. Light gray sandstone	8
32. Concealed	20
33. Light greenish weathering, very fine grained, greenish-gray limestone or dolomite with thin partings of quartzite holding garnets.	

	Feet.
Some of the beds would afford good lithographic stone, but for the scattered grains of quartz in them.........................	30
34. Yellow-weathering, medium grained dolomite; with concretions of finer grained dolomite, from two to twelve inches in diameter. Associated and mixed with bands of light-green, very fine grained blue limestone; all much contorted..........................	20
To sea level. Total............................	643

In the above section, 3, 4 and 5 correspond with the rocks of Flint island, while 1, 3 and 4 are the equivalents of the iron-bearing rocks of the islands to the northward. In places on those islands other members of the section are met with to within a short distance above 33 which is nowhere seen excepting on Belanger island.

Ross island lies immediately north of Belanger, from which it is separated by a channel nearly a mile wide. This channel, being opposite the narrow entrance to Richmond gulf (a tidal lake some twenty five miles long by twenty miles wide), feels the sweep of the currents rushing in and out of the entrance. Consequently it is only during the most severe weather, and long after the rest of Nastapoka sound has frozen over, that this channel freezes. The Eskimos travelling along the coast during the early winter are obliged to pass outside Belanger and Ross islands in order to avoid this open water.

The longer axis of Ross island lies nearly north and south; its greatest length is two miles and its widest part never exceeds a mile across. In shape it roughly approximates a half moon with the horns directed westward. The island, on its eastern face, rises in steep cliffs from 200 to 300 feet above the sea, with deep water close to their base, so that it is impossible to anchor along the inner side. The outer shore forms a wide, flat bay, ending in low rocky points, the remainder of the shore being sandy.

A small island separated by a narrow channel lies, as a continuation of the cliff, off each end of the island. Beyond and close to the northern islet are two others, lying at right angles to its direction. Between these islands is an excellent harbour open only to the eastward.

The measures displayed in the cliffs are similar to those of Belanger island from the trap 6, upwards. Dark silicious shale predominates, with a thickness of nearly 200 feet. A few beds of dark gray chert are scattered through the shales, becoming more plentiful towards the top, where the shales pass into a cherty, ferruginous dolomite, or rather, a ferruginous, dolomitic, silicious rock of a dark gray colour. The beds of shale are often highly charged with oxide of iron; and minute crystals of magnetite are met with throughout the measures. The dark silicious rock contains considerable magnetite and also concretions and thin, broken bands of ankerite. These measures, although quite ferruginous can not be classed as practical ores of iron as the percentage of contained iron is too low.

Anderson is the next large island north of Ross. Its greatest length, from south-west to north-east, is three miles and a half; while in its widest part it is about two miles across. The shape of the island bears a rough resemblance to the outline of a ham with the shank pointed towards the north-west.

The southern and about half of the eastern shores are exceedingly steep and rugged so that no landing can be effected along them. The cliffs rise nearly perpendicularly to heights varying from 200 to 350 feet. Near the middle of the eastern shore the cliffs end abruptly and the land trends sharply to the westward forming a bag which is nearly land-locked by two small rocky islands, and affords a very secure anchorage. The northern part of the inner or eastern shore is largely rocky, but the cliffs are lower and less abrupt than those to the south-ward.

The island slopes gently towards the west; and a second ridge of hills, the continuation of the northern cliffs, forms an escarpment across its southern half, a wide valley separating this ridge from that of the southern coast. This valley is filled with terraced drift, and dotted with small lakes. The outer or western coast is generally low and sandy with a few rocky points and reefs.

The rocks of Anderson island belong to the same horizon as those of Ross island. They differ from them in being more silicious so that the shales are in a great measure replaced by the dark gray silicious rock which occurs in thin beds with partings of shale very rich in magnetite. Some of these partings have a thickness of two feet and the percentage of contained magnetite is high. The dark gray silicious rock also carries considerable magnetite scattered through it in minute crystals. The lower beds of this rock are inter-banded with thin layers of an admixture of jasper, hematite and magnetite (jaspiltyte). They are all of low grade.

Lutit island is separated from Anderson by a channel about 200 yards wide at its narrowest part. The island is a mile and a half long, from south-west to north-east, while its greatest breadth is about half a mile. It has low cliffs along its south eastern face and the interior slopes gently towards its western shore, which is low and sandy. The rocks exposed in the cliff are similar to those of Anderson island.

Clarke island is next northward from Lutit, from which it is distant three miles, the channel between being broken by a few low, reef-like islands lying outside the line between the larger islands. The island is roughly pear-shaped. It is two miles long and a mile and a half across at the broadest part, near the southern end. The inner cliffs are not much over 100 feet in elevation. Three small islands under the cliff form excellent small harbours, while two other small islands lying off the south-west point afford another harbour exposed towards the south. The island is rocky, but not very rugged ; the rocks slope westward and are not much broken by small faults.

The following section was obtained from the rocks exposed in the cliffs of the eastern and southern sides of the island :—

	Feet.
1. Beds of red jaspilyte, usually lean, the ore occurring as a mixture of hematite and magnetite, in flat lenticular masses in the jasper. These masses of ore vary both in richness and thickness, the thickest mass in these measures being four feet	80
2. Red jasper in thin beds, very poor in ore	20
3. Reddish-purple and greenish weathering, dark greenish-gray, fine-grained graywacke shales, composed largely of fragmental plagioclase, with mica, chlorite and other bisilicates and also containing small grains of quartz, and small crystals of magnetite. This is probably an ash rock, but in some places on the islands to the northward it has the appearance of a squeezed trap	75
4. Red jaspilyte containing considerable hematite-magnetite ore with an aggregate thickness of probably three feet	10
5. Purplish-weathering graywacke shales	60
6. Light gray sandstone	5
To sea level. Total	248

The section shows a great increase in the jaspilytes, which on Ander-island were represented by a few thin bands in the lower part of the dark gray silicious measures. The amount of iron ore in the jaspilytes is very large and it is merely a question of time before they are worked.

Gillies island lies four miles north of Clarke, the intermediate space being partly occupied by three small islands. It has a length of twelve miles due north and south, but rarely exceeds a mile and a-half in breadth and in two places narrows to less than a quarter of a mile across. The eastern shore-line is broken by wide bays which form good harbours for all but easterly winds, the only perfect harbour being in a small bay about a mile from the southern end.

This side of the island is generally rocky with cliffs more or less abrupt. The highest of these rise nearly 300 feet above sea level though their general elevation is below 200 feet. Where the island narrows, the shores are quite low and sandy, and they have a similar character about the heads of the bays. The western shore is low and covered with drift, with occasional rocky ridges extending into the sea to form low points and outlying reefs. There are a few small harbours so formed, but they are usually obstructed by reefs across their entrances and dangerous to approach in stormy weather.

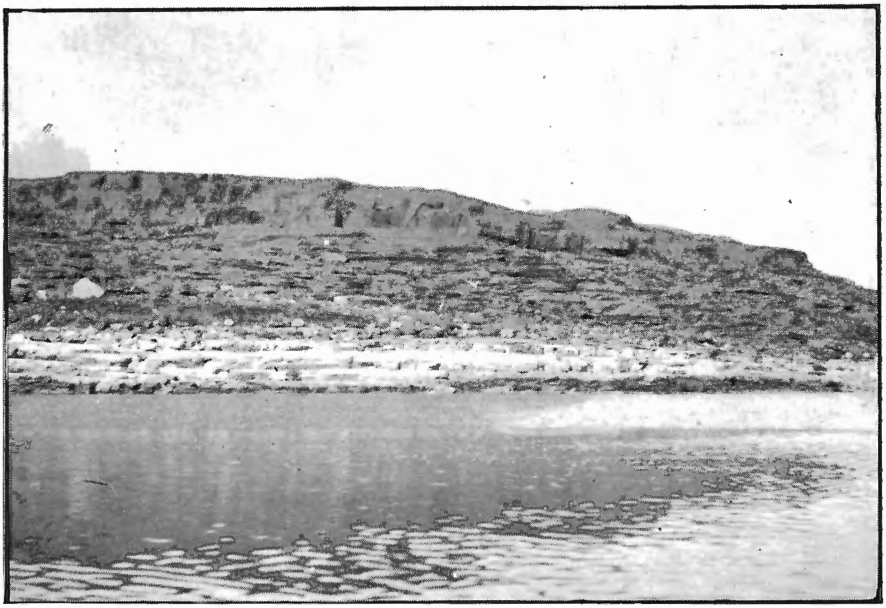
The surface of the island is nearly half-covered with drift cut into terraces with a display of ancient sea beaches at many levels extending to the summit of the island. The drift-covered areas are dotted by many small shallow lakes and ponds, the resorts of numerous aquatic birds. Several minor faults have thrown the rocks into low, roughly parallel ridges, that run in broken lines the entire length of the island.

The iron-bearing measures are well developed on Gillies island and constitute at least four-fifths of its rock-mass. At the southern end the dark-gray, ferruginous cherts, which towards their summit, contain much carbonate of iron, alone are seen. About a mile and a half from the south end the beds of jaspilyte appear from below sea-level in the eastern cliff. Northward for two miles, the strata slowly rise above the sea, and at the second bay, an east and west fault brings the measures north of it about 100 feet above those on its south side, and cause the lowest beds of jaspilyte to occupy the summit of the cliff on the north side, while they are only sixty feet above the water to the south of the fault.

The following section was measured down the cliff immediately to the north of the fault:—

	Feet.
1. Red jaspilyte moderately rich in ore	18
2. Red jaspilite lean in iron-ore	10
3. Purple and greenish-weathering, dark graywacke shales	60
4. Red jasper, containing very little iron ore	3
5. Light green, thin-bedded silicious shale	5
6. Light green, very silicious shales with thin partings of flaggy sandstone	25
7. Light greenish, medium textured massive sandstone	80
8. Light greenish gray sandstone (ripple-marked) in thin beds with narrow partings of light-green silicious shale	20
9. Light gray, medium grained quartzite, containing some mica in small scales	6
10. Light green sandstones and shales in thin beds (ripple-marked)	15
To sea level. Total	242

Another section was measured on the south side of the fault from the summit of the cliff to the top of the graywacke shales (3) which



CLIFF ON EAST SIDE TAYLOR ISLAND, IRON ORES OVERLYING SANDSTONE.

CLIFF OF JASPILYTE, EAST SIDE GILLIES ISLAND.

occupy the lower portion of the cliff with the underlying sandstones just showing above the sea :—

	Feet.
1. Dark gray silicious rock (chert) in thin beds parted by thinner beds or layers of brown carbonate and oxide of iron. The chert beds contain flat lenticular masses of silicious carbonate of iron (ankerite) varying in volume from minute particles to masses with a surface of several square feet and a thickness of several inches. The chert also contains a considerable percentage of magnetite scattered through it in minute crystals..	20–60
2. Dark gray silicious rock, which becomes richer in magnetite and loses many of the carbonate inclusions as the measures are descended. The bedding is more massive and the partings are thicker and richer in ore. The thickest partings of nearly pure ore are four feet through, but they are usually less than a foot thick. Towards the bottom the magnetite is mixed with hematite and the cherts at the same time change gradually to jaspilyte........	100
3. Red jaspilyte in bands, varying in colour from dark metallic blue to light red, and in composition from a nearly pure hematite to lean jasper. There is much good iron ore in these measures......	80
4. Very lean red jaspilyte with a few thin partings of rich hematite.	20
To top of graywacke shale. Total..................	200

The measures of 2 and 3 contain the workable deposits of iron ore. The ores of the upper division (2) associated with the gray cherts are magnetite with usually a small quantity of associated hematite.

As mentioned above, the ore beds form partings between the beds of chert, and the thickest are about four feet through, while in places the thinner bands are separated by only thin beds of chert, and it might be found profitable to work two or more of them at the same time.

The magnetite of the partings appears to be different from the minute crystals in the chert and is probably largely formed by infiltration of iron solutions from above, which have been deposited in the horizontal cracks along the bedding planes of the cherts, and have also replaced the flat lenticular masses of ankerite found in the upper cherts, which, in the lower, are similarly replaced by magnetite. The jaspilyte beds appear to have been originally very similar in character to the upper carbonate-bearing cherts, and have been altered to their present state by enrichments of iron, by the same process of infiltration aud deposition that occurred in the magnetite-bearing cherts above, the only difference being that the deposited iron is largely in the form of hematite with only a small proportion of magnetite. A close examination of the jaspilyte measures shows an intimate connection between the iron ore and the silica of the rock. The jasper, under the microscope, is seen to be formed of very small particles of silica coated with red oxide of iron, to which is due the change from the gray chert to the jaspilyte. The rock appears to have been originally constituted largely of finely divided silica, and its present composition is due to infiltration of waters carrying silica and iron, both of which have been deposited in the minutest cavities of the rock, and as growth-rings on the surface of the original finely divided quartz. As a consequence of the ores being derived by deposit from silicious waters, there is always present, even in the best ores, a quantity of intimately associated silica. The jaspilytes in the section are seen to grade from a nearly pure iron ore, to a ferruginous chert, very poor in iron, as is the case with the beds of division 4 in the section above. Where the rock is poor in iron, the jasper is separated by thin partings of enriched ore, and also contains flattened lenticular masses of hematite. As the rock becomes richer, these lenticular bodies become larger and the ore partings thicker, so that in the better ores the mass of the rock is largely hematite, containing thin, broken bands of the jasper and in the richest ore, only small, flat, lenticular masses of jasper which are quite unimportant in relation to the mass of the ore.

The measures below the iron-bearing series occupy the cliff for two miles northward of the fault, the lower beds of jaspilyte being seen along the summit. A second transverse fault then causes the measures on its north side to be about sixty feet lower than those to the southward, and, the cliffs bending westward towards the direction of the gentle dip of the rocks, the lower measures slowly pass below the level of the sea, and a mile beyond the fault the lower jaspilyte appears on the shore at sea level. From here to the north end of the island, with the exception of the lower parts of a few prominent points, the cliffs are formed entirely of the iron-bearing measures. These measures appear to thicken towards the north end of the island and to include a greater amount of jaspilyte, reaching a thickness of over one hundred feet, with an upper band of jaspilyte, rich in hematite and eight feet thick, situated in the dark gray silicious rocks eighty-five feet above the summit of the lower jaspilyte.

The rocks have a general westward dip at low angles, seldom exceeding 20° from the horizontal and usually much lower. This western dip is not regular, as the rocks are broken by a number of faults, which are roughly parallel to each other and to the longer axis of the island. The disturbance caused by these faults is never very great, the vertical throw being from five to fifty feet, with a repetition of part of the measures at each fault. Along with this parallel faulting are several transverse breaks, the two largest of which have been already mentioned.

The result of the faulting causes the surface of the island to resemble on a gigantic scale, thick ice shoved against a shore by wind-pressure from seaward, where the pressure has been sufficient to cause a buckling in the ice-sheet along several lines parallel to the shore, and has forced the outer cakes to over-ride the inner ones, while transverse fractures have broken the mass into cakes of various sizes. This is the appearance of Gillies island, covered with roughly parallel, but irregular, low ridges of rock, all dipping in a westerly direction with low escarpments towards the east. All of the ridges are broken into large blocks by transverse faults, and some of the blocks have a northerly tilt, while others slope diagonally southward, closely resembling the cakes of ice piled along a shore.

The repetition of the measures by these roughly parallel thrust faults has caused the surface of the interior and western parts of the island to show always the upper middle, or lower measures of the iron-bearing series, notwithstanding their moderate thickness and constant westward dip. This fact will no doubt be valuable in future mining operations as the richer ores will be found throughout the island either directly on the surface or at depths of only a few feet below it.

Taylor island is separated from the north end of Gillies by a deep channel, upwards of a mile in length and about a quarter of a mile in width running north-west. The island is three miles long, from north to south, by a mile and a half broad at the widest part in its southern half, the northern part tapering off to a long point.

The south and east shores are high and rocky, while the western side, as usual, slopes gently to the sea with numerous rocky points joined by stretches of low sandy shore. The eastern shore is indented by a bay half a mile wide, which stretches inland from its capes for nearly a mile and affords a commodious and safe harbour. A second harbour is formed by two rocky islands nearly inclosing a smaller bay south of the north-east point.

Two high rocky ridges traverse the island from north to south. One of these forms the high eastern cliffs which in places have an elevation of upwards of 300 feet. The other ridge runs up the western half of the island, and has a sharp escarpment along its eastern side. A wide low valley lies between the ridges, and is largely occupied by small lakes, the largest of which is tidal and is connected with the eastern bay by a short channel, above the level of low tide.

The high cliffs of the south-eastern part of the island give a good section of most of the measures of the Nastapoka series of rocks. The lower members are seen in the southern and eastern cliffs, while the iron-bearing series appears near the summit of these cliffs and in the western ridge, thus covering a greater part of the surface of the island. These iron-bearing rocks attain a maximum thickness on Taylor island, as is seen from the following section measured across the southern part from west to east :—

	Feet.
1. Rusty weathering, cherty rock ; contains much ankerite and splits into thin flags with thin partings and flat concretions of ankerite partly decomposed to brown oxide of iron	60
2. Dark grey silicious rock, or chert in thin beds with partings of ore, mostly in the form of magnetite along with some ankerite. The latter disappears as the measures are descended. The cherts hold small crystals of magnetite in their mass	55
3. Red jaspilyte, low in hematite ore	20
4. Red jaspilyte, rich in hematite ore	8
5. Red jaspilyte, low in hematite ore	20
6. Dark grey cherts with partings of magnetite-hematite ore from 1 in. to 30 in. thick	50
7. Red jaspilyte usually rich in hematite	20–50
8. Red jaspilyte lean in hematite	10
9. Purplish-weathering, dark green graywacke shales, less fissile than formerly and having a roughly columnar cleavage in the south cliff	50
10. Light gray sandstone and light green shales. The sandstone is in five massive beds from 2 to 10 feet thick and numerous thinner beds	100
To sea level. Total	393–423

A chain of twenty-five small islands extends northward from Taylor island thirteen miles to Mowatt island. These islands lie in roughly parallel lines formed from the exposed portions of partly submerged rocky ridges. They are generally quite low; and the rocks seen in their cliffs are usually the purplish graywacke shale, or the overlying jaspilytes. The two largest islands are named Miller and Gordon, the latter being the larger, and a little over a mile long by half a mile wide. In its south-east cliff from twenty to forty feet of rich jaspilyte is seen above the graywacke shales. Elsewhere the low cliffs are formed of the dark gray cherts, never very rich in iron ore.

Mowatt island is roughly oval in shape ; its longer axis lies north and south, and is two miles long ; the shorter is slightly over a mile. The island is broken by low rocky ridges, with considerable drift in the intermediate valleys, which are dotted with small lakes and ponds. As usual, the eastern side has abrupt cliffs.

About twenty feet of sandstone rises above the sea in the south-east cliffs ; elsewhere the lowest measures seen are the purple shales or the beds of jaspilyte. The iron-bearing series is not only thinner but the amount of contained ore is less than on Taylor island. The lean jaspilyte resting upon the graywacke shales is six feet thick with fifteen feet of the richer jaspilyte resting upon it. This in turn is overlaid by nearly 200 feet of dark gray chert with, usually, thin partings of magnetite ore; the whole being capped with a considerable thickness (50 feet) of rusty-weathering chert containing considerable ankerite in lenticular patches or as partings between the cherty beds. Much of the surface carbonate has been decomposed to brown oxide of iron.

Christie island is separated from Mowatt by a narrow channel, which is only 100 yards across at its narrowest part. Two good harbours lie on the east side of the narrows, one in the bay at the northern end of Mowatt, the other to the south of Christie, where a long sandy point practically incloses a small bay. Another harbour is formed by a small island lying off the western entrance to the passage between the islands.

Christie island is roughly triangular in shape. The base is towards the south and is two miles and a half long, while from north to south the greatest length is three miles. The eastern cliff in many places rises upwards of 300 feet above the sea. The interior surface of the island is rocky and traversed by low scarped ridges running roughly north and south. The intermediate valleys are filled with drift and dotted with lakes.

The following section was measured from the cliff at the south-east point of the island and gives the total thickness of the measures exposed :—

		Feet.
1.	Dark gray, rusty-weathering chert; containing considerable ankerite partly decomposed to limonite	50
2.	Dark gray chert, with thin partings of magnetite, none sufficiently thick for working	115
3.	Red jaspilyte, lean in hematite	15
4.	Dark greenish and purplish-weathering graywacke shales	85
5.	Light gray, compact sandstone, with bands holding small red garnets	18
6.	Light green, silicious shale	5
7.	Light gray sandstone, pitted with small spots of brown carbonate. Beds 6 in. to 24 in. thick	8
8.	Light gray sandstone with partings of shale	5
9.	Light gray sandstone	1·5
10.	Light gray sandstone separated into thin flags by narrow partings of light green silicious shale	2
11.	Light greenish silicious shale, with many partings of sandstone flags	10
12.	Light gray sandstone	1

	13. Light greenish silicious shale with partings of flaggy sandstone (ripple marked)	8
	14. Light pinkish and greenish sandstone in beds from 6 in. to 30 in. thick	13
To sea level.	Total	336·5

At the summit of the outer cliff there is a sharp synclinal fold, the rocks dipping W $<$ 45° on one side, and E $<$ 30° on the other. The rocks at the axis of the fold are badly shattered. This is one of a few cases noted where the rocks of this series have folded, as in nearly every case where folding might have taken place the rocks have broken and slid over one another, before the fold was completed.

Between Davieau and Christie islands lies a channel nearly a mile wide, with straight walls of cliff on both sides. The cliffs lower gradually towards the western entrance of the channel where they die away in rocky points. The channel is called Tuksuit or "The Throat" by the Eskimos. It is a favourite stopping place for these people when travelling in winter owing to the number of seals frequenting the channel where they are killed with spears through holes or cracks in the ice.

Davieau is one of the larger islands of the chain, being ten miles long and in the widest part, two miles across, with an average breadth not exceeding a mile. Its longer axis, like that of the islands to the northward, lies north-northwest, or parallel to the general trend of the coast which changes from north to north-northwest at White Whale point opposite the southern end of the island.

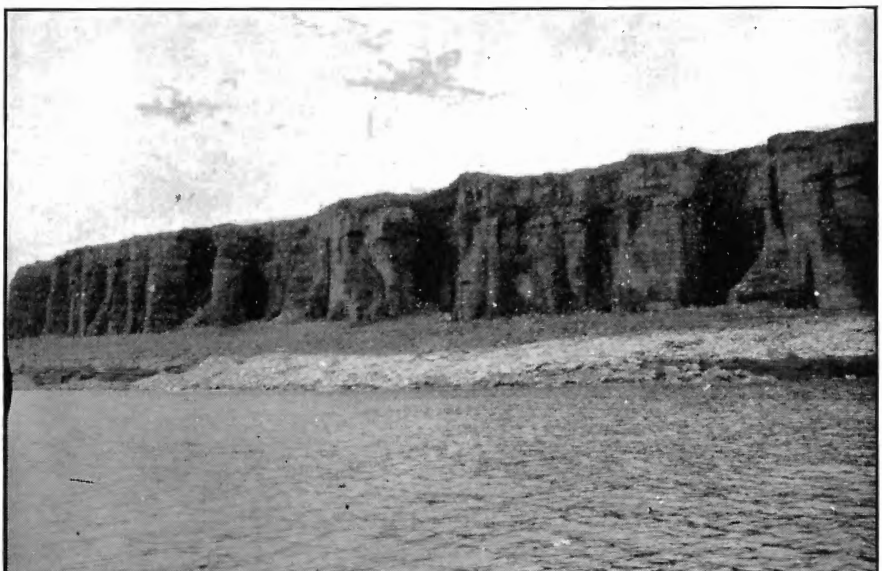
The eastern coast is rugged and broken into a number of small bays, none of which afford good harbours for easterly winds.

The interior and western portions of the island are largely covered with drift and these areas are dotted with many ponds and small lakes.

Near the south east end of the island the following section of the iron-bearing series was measured:—

	Feet.
1. Rusty weathering, dark gray chert, containing considerable ankerite	50
2. Dark gray chert, lean in magnetite, and with thin partings of magnetite ore	115
3. Red jaspilyte, poor in hematite	20
4. Impure red jasper rock	5
5. Two purplish graywacke shales, compact with green splotches, towards the upper part containing thin bands (1 in. to 5 in. thick) rich in hematite, which stains the shales and gives them the appearance of polished metallic iron.	

CLIFFS ON EASTERN SIDE OF BROUGHTON ISLAND.



CLIFFS OF LIMESTONE AND SANDSTONE ON COTTER ISLAND.

Towards the northern end of the island the dark gray cherts become thicker, especially the upper rusty portion carrying ankerite, while the underlying jaspilyte contains less hematite, and gradually thins out. The total amount of iron ore in these rocks appears to be less than in those of the southern islands and to be more evenly distributed through the measures, so that no part is sufficiently rich and concentrated to permit of the ore being mined profitably.

Nicholson island is separated from Davieau by a channel only a quarter of a mile across at its narrowest part. It is two miles and a quarter long, by nearly a mile across at its widest part. The southern third of the island forms a long narrow point, largely covered with drift. Lying off this portion are three small rocky islands. The cliffs begin on the east side near the northern end of this point and continue to the north end of the island. The interior is largely drift-covered and dotted with ponds, and the western shore is low. A very good boat harbour is situated on the east side about a mile from the south end, in a small bay behind a rocky islet.

The rocks are displayed in the cliffs from the greywacke shales upwards. The dark gray cherts have a thickness of about two hundred feet, and the jaspilyte beds have nearly disappeared. The amount of iron in the measures has decreased and is nowhere sufficiently concentrated to afford workable deposits. The carbonate ores descend much lower in the measures than they do to the southward and there appears to have been but little redistribution and concentration of the iron. The summit beds of the dark gray chert contain considerable light green chert in lenticular masses. They are overlaid by ten feet of a reddish-weathering basic rock of a greenish colour, arranged in thin horizontal layers. It is usually fine-grained, but sometimes is sufficiently coarse to show crystalline faces of plagioclase, of which it is largely composed. The rock appears to be a very fine-grained trap injected between beds and foliated by vertical pressure.

Broughton island is the largest of the Nastapoka chain, being thirteen miles long, and upwards of two miles across, to the northward of its mid-length, where it attains its greatest breadth. High cliffs rise at its northern and southern ends with a long stretch of low sandy shore between them on the eastern side. Two good harbours are situated on the east side near the southern end of the island, where shelter is afforded in small bays covered by small islands lying a few hundred yards off shore. The northern part of the east shore is deeply indented by small bays, all of which afford excellent harbours. The interior of the island is mostly covered with drift with many lakes, some of which are fairly large, and are the breeding places of numerous ducks and geese.

The southern part of the eastern cliff is largely formed of the dark gray iron-bearing cherts resting upon a thin band of graywacke shales which in turn are underlaid by beds of sandstone. The amount of iron ore in the dark gray cherts apparently continues to decrease in quantity, the richest bands of magnetite seldom exceeding six inches and never attaining eighteen inches in thickness. They are always separated by wide beds of barren rock, so that two or more bands of ore could not be worked to advantage at the same time. The northern cliffs give a more extended section with a greater thickness of the underlying sandstone.

McTavish island lies two miles north of Broughton with a small island in the channel about midway between the large islands. McTavish is a long narrow island, its length being eight miles, while it rarely exceeds half a mile in breadth. Its eastern shore is nearly straight and consequently without harbours. The highest part of the eastern cliff does not attain an elevation of two hundred feet, and rarely rises more than one hundred feet above the sea. The interior surface is like that of all the other islands—largely drift and lakes. Low ridges of rock outcrop in places and there is a general easy slope towards the eastern shore.

The following section was measured down the eastern cliff near the middle of the island :—

	Feet.
1. Rusty-weathering, dark gray chert, holding considerable ankerite..	50
2. Red jaspilyte, poor in hematite ore....	8
3. Dark green, graywacke shale, showing, on weathered surfaces a semblance to metallic iron....	34
4. Dark purple-weathering graywacke shale containing a few thin bands or veins of bright red hematite from one to six inches wide.	50
5. Impure red jasper....	4
6. Massive, light gray sandstone....	10
7. Light gray sandstone in beds from two to six inches thick separated by much light green silicious shale, all containing a small quantity of dolomite....	50
To sea level. Total....	175

Cotter island is the most northerly of the Nastapoka chain; it lies nineteen miles beyond McTavish and is twenty-six miles south of the Hopewell chain of islands, and so constitutes an intermediate link between them. The island is four miles long and averages half a mile in breadth. It is lower than the islands to the south and its eastern cliff rarely attains an elevation of one hundred feet. The shore-lines are nearly straight and afford no harbours. The surface of the island is generally rocky with a few patches of drift towards the southern end, while the northern end is covered by a sheet of trap.

The eastern cliff is formed largely of a light bluish, calcareous sandstone which is split into huge blocks by vertical cracks; many of these cracks are wide and form deep caves near the sea level and give to the cliff a very picturesque castellated appearance.

The following section was measured down the eastern cliff at a point about one mile from the north end of the island:—

1. Highly decomposed, fine grained trap	20
2. Light greenish shales, with partings of light bluish, arenaceous limestone	35
3. Light greenish and bluish calcareous sandstones (ripple-marked). Some of these beds have on their surfaces curious irregular markings, made by very thin deposits of black carbonaceous matter which may be the fossil remains of some low organism	50
To sea level. Total	105

The measures given above appear to represent those underlying the iron-bearing series of the southern islands, the shales and sandstones being very similar to those of McTavish island, except that they contain a larger quantity of limestone, or dolomite. The overlying trap may be closely related to the graywacke shale, as the latter contains much igneous matter, and, as before stated, was probably a trap-ash. These rocks are also continued in the Hopewell islands to the northward, where the trap attains a much greater thickness and overlies sandstones almost identical in appearance with those of Cotter island. The trap caps all the Hopewell islands and consequently the iron-bearing series is not represented in the rocks of those islands.

GARDEN AT CROSS LAKE, NELSON RIVER.

FALLS OF MUHIGAN RIVER.

GEOLOGICAL SURVEY OF CANADA
ROBERT BELL, M.D., Sc.D. (Cantab.), LL.D., F.R.S.

REPORT

ON

EXPLORATIONS IN THE NORTH-EASTERN PORTION

OF THE

DISTRICT OF SASKATCHEWAN

AND ADJACENT PARTS OF THE

DISTRICT OF KEEWATIN

BY

J. Burr Tyrrell, M.A., B. Sc.

OTTAWA
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EXCELLENT MAJESTY
1902

13—F. No. 786.

To the Director,
Geological Survey of Canada.

SIR,—I have the honour to present my report on the north-eastern portion of the district of Saskatchewan, and part of the adjoining district of Keewatin.

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

J. BURR TYRRELL.

NOTE.—Mr. Tyrrell's manuscript report was accompanied by a tracing of his routes on a scale of two geographical miles to an inch. This was incorporated by Mr. Dowling in the map which illustrates the report.—R.B.

NOTE.—*The bearings given in this report refer to the true meridian throughout.*

REPORT

ON THE

NORTH-EASTERN PORTION

OF THE

DISTRICT OF SASKATCHEWAN

AND ADJACENT PARTS OF THE

DISTRICT OF KEEWATIN

BY

J. BURR TYRRELL, M.A., B. Sc.

Introduction.

The rivers and lakes described in this report form the chief canoe-routes or lines of travel at present available through a tract of country with an area of rather more than twenty-five thousand square miles, lying between north latitude 50° 40' and 56° and west longitude 97° 20' and 102° 30'; bounded on the south by Lake Winnipeg and Saskatchewan river on the east by Nelson river, and on the north and west by Burntwood and Churchill rivers. Area covered by report.

The exploration was accomplished during the summer of 1896, the writer taking a canoe and two men from Selkirk, Manitoba, and occasionally employing natives in their own canoes as guides. No surveys of the interior portion of the country having been made the routes followed were surveyed as accurately as the time and means at my disposal would permit. The distances on running water were estimated by the rate of travel, and on quiet water they were measured with a Massey floating boat-log. Where local attraction was suspected the bearings were taken with a solar compass, but where no local attraction was detected they were taken with a prismatic card compass. As often as possible observations for latitude were made with a sextant of eight inch radius.

Total length of surveys.

These surveys were for the most part carefully plotted in the field on the scale of two geographical miles to one inch, ready to be reduced to a map of any desired size. The total length of surveys thus made amounts to seven hundred miles.

The character of the rocks and soils was carefully noted on the above lines of survey, and some additional information was gained about the geology of the banks of Nelson river as far down as the outlet of Sipiwesk lake, and of the valley of the Saskatchewan river from Cumberland House up to Fort à la Corne. For assistance in the microscopical determination of some of the rocks, the writer is indebted to Dr. A. E. Barlow of this Survey.

Topography.

The general relief of the country is low and unpronounced, and the whole surface slopes somewhat evenly and regularly towards Hudson bay. The highest areas are near the Cranberry lakes, which have an elevation of about 935 feet above the sea, while the lowest are near Sipiwesk lake on Shawenan falls, with an elevation of about 565 feet above the sea. Probably the most prominent feature of the district is the limestone escarpment which runs south of Grass river and the chain of lakes into which it expands; but this escarpment though steep and persistent did not seem to average more than fifty or sixty feet in height. East of Reed lake the hard granites, traps, &c., are buried beneath a thickness of from ten to a hundred feet of soft gray stratified clay. This clay has rarely been deposited in sufficient thickness to to even up the original inequalities of the underlying rocky floor, but it commonly rises over the hills and descends into the valleys. In the bottoms of the deeper depressions are large or small lakes of slightly muddy water with rocky beaches from which the clay has been washed away, and sloping thickly wooded shores. These lakes are connected and drained by rivers which, in places, flow with a gentle current between low banks of clay, and then pitch down steep rapids or cataracts over ridges of the underlying Archæan rocks. Occasionally the streams have cut narrow valleys from ten to eighty feet in depth through the stratified clay to the highest points of the underlying rocky floor.

Timber.

The surface is generally forested, though most of the valuable timber has been destroyed by fire. On the Grass, Muhigan and Minago rivers, as well as on the shores and islands of some of the lakes, there are still some forests of excellent white spruce, but on the northern part of Burntwood river white spruce is rather scarce, and at Nelson House, timber for house logs has to be collected from scattered groves and brought several miles up or down the brooks or across the lake.

Black spruce and canoe birch grow on the more level and imperfectly drained tracts, and Banksian pine may be seen here and there on the drier hill-sides. Canoe birch grows to a good size beside the lakes and streams, but aspen (*Populus tremuloides*) is the commonest deciduous tree, as it grows on the drier uplands everywhere, occasionally forming beautiful forests, but more often, and especially towards the north, partly covering the surface with scattered groves of small trees.

Small fruits in abundance.

Among the smaller trees or shrubs, the rowan tree (*Pyrus Americana*) may be mentioned as growing freely and having an abundant crop of berries along the face of the limestone escarpment, especially around Wekusko and Reed lakes, and the wild cherry (*Prunus Virginiana*) grows besides most of the lakes. Many of the smaller fruits grow on the clay-covered country in great profusion. Among those that were especially abundant were raspberries (*Rubus strigosus*), gooseberries (*Ribes oxycanthoides*), red and black currants (*Ribes rubrum* and *floridum*), strawberries (*Fragaria Virginiana*), blueberries (*Vaccinium Canadense*), and headberries (*Rubus Chamæmorus*).

Suitable for agriculture.

Much of the land is well adapted for agriculture.* At Norway House some fine barley had been sown and ripened in the garden, and all the ordinary vegetables grown in Manitoba have been raised for many years past. At Cross lake many of the Indians had good large gardens of potatoes and other vegetables, and McLeod and McIvor, two fur traders, had excellent gardens in which were growing potatoes, turnips, carrots, parsnips, radishes, cabbages, cauliflowers, onions, lettuce, beans, peas, etc. At Nelson House in the extreme northern part of the district explored, many of the Indians regularly grow potatoes, and both the fur traders and the missionaries cultivate small patches of ground on which they raise abundant crops of all the vegetables mentioned as growing at Cross lake. It is probable that the hardier varieties of grain† would also ripen here, but at present there is no object in growing grain of any kind, for it could not readily be utilized.

Game plentiful.

The country is stocked with animals of various kinds. Moose are abundant in some of the more thickly wooded tracts. Black bears are somewhat numerous, and beaver, otters, martens, mink, musk-rats and red foxes are killed by the Indians in considerable numbers in

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*In Dr. Bell's descriptions of this region, contained in the Reports of Progress of the Geological Survey for 1878, '79 and '80, contain much information as to the soil, timber, natural products, gardening, climate, etc., being the results of his explorations and observations in the country between the Winnipeg basin and Hudson bay and around the bay in general.

† Wheat ripens well at Norway House and Cross lake, on the Nelson river.—R. B.

the aggregate every year. White fish *(Coregonus clupeiformis)* abound in most of the lakes and streams, while the lake trout *(Salvelinus namaycush)* seemed to be moderately plentiful in the clear lakes near the head of Grass river. Of the other fish the sturgeon (*Acipenser rubicundus*) and pickerel (*Stizostethium vitreum*) are the most important.

Indian inhabitants.

The region was known among the early fur traders as the Muskrat country and was then thinly peopled by Cree (or Nahathaway) Indians, who were scattered along the banks of the many lakes and streams. The descendants of these nomadic Indians are now collected on Reserves or about Missions and trading stations at the following places, viz: Pelican narrows, Cumberland House, The Pas, Grand Rapids, Rossvilla, near Norway House, Cross lake and Nelson House. At these places they spend the summer, living on the fish they may be able to catch in their nets and such supplies as they can borrow or earn from the traders. During this portion of the year the surrounding forest is entirely deserted. In the autumn the Indians scatter into the woods, each man with his family choosing a tract over which he proposes to hunt, and pitching his tent or building his little log shanty beside a lake, he endeavors to catch sufficient fish to feed his family and dogs through the winter before the lake sets fast with ice, after which he devotes his time to trapping the fur-bearing animals or hunting moose.

During the summer of 1896 no frost occurred until the 29th of August. At Nelson House we were informed that, during the preceding seven years at least, no frost that would injure garden produce had occurred at an earlier date. Footprint lake, in the extreme northern portion of the district, was stated to freeze over as a rule between the first and the middle of November, and to remain frozen until about the twenty-fourth of May.

Geological Characters.

Geological formations.

The formations met with in the area under consideration are enumerated in the following table :—

Recent.
Pleistocene.
  Agassiz clay.
  Eskers.
  Till, etc.

Silurian (Niagara.)
Cambro-Silurian (Trenton.)
Huronian.
Laurentian.

Recent.

The most interesting recent deposits in the district are thick beds of peat, which extend northward from the shore of Lake Winnipeg, past Kiskittogisu lakes, overlying the level surface of the stratified Agassiz clays, that extend from the base of the limestone escarpment. In many places swamps are growing in the hollows and filling them with mossy peat, but this swamp seemed to be much more extensive than the others and it is certainly the most easily examined in the district. On the shores of the adjoining lakes the waves are rapidly cutting away the underlying clay, and fresh sections both of the clay and of the overlying peat are constantly brought to view. Similar cliffs of clay, overlain by peat were also seen around some of the lakes on Burntwood river. Peat beds.

The shore-lines of the lakes are usually rather strongly marked. Where the lake lies in a rocky basin any clay that may have been over the rock has been washed away, and a smooth bare rocky beach is left. In other places a heavy wall of boulders has been packed back on the shore. Many of the bays have beaches of sand, or the land may descend in weedy slopes to the edge of the water. In the lower western portion of the rocky country, well defined valleys seemed to be entirely wanting, but further east, where the country has been covered by a considerable thickness of Agassiz clay, the streams have cut narrow valleys through the clay to the underlying rock, thus forming reaches of quiet river, separated by falls or short steep rocky rapids. The valleys are steep and narrow without terraces and usually without bottom-land, showing that they have been rapidly eroded in very recent times by streams of about the same size as those that now flow through them. The almost entire absence of current on Minago river from the head of Hill lake to its mouth would tend to show that the northern elevation of the land shown by the old beaches around the Winnipeg basin, and around Hudson bay, had not ceased before this valley was excavated. Shore-lines.

Pleistocene.

Pleistocene clay.

Northward and north-westward from Lake Winnipeg the surface of the Archæan peneplain is covered by a coating of clay varying from a very few feet up to a hundred or more in depth. This clay seems to follow the larger contours of the underlying rock surface, descending into the valleys and rising over the hills, but it covers and obscures most of the minor inequalities. In composition it varies from a soft impervious blue clay to a light gray fine porous clayey silt, but it is everywhere evenly stratified, the lines of stratification being often coarse, but always strongly marked. Boulders were occasionally found imbedded in the clay, but they are almost invariably found in the lower layers where they have been dropped from the ice close to the retiring face of the glacier from the east. The eastern limit of these Agassiz clays, so called on account of having been deposited in the glacial Lake Agassiz, was found to be marked more or less closely by the channel of Nelson river, that stream having chosen its course along the line where the clay slopes gently down to the bare rocky surface of the Archæan rocks. The clays attain their greatest thickness along a line from Mossy point on Lake Winnipeg, bearing about N. 15° W., to Wuskwatim lake on Burntwood river, from which line they gradually decrease in thickness westward. Around Reed lake they nearly fill the rocky hollows, while around Cranberry lakes they seem to have entirely disappeared.

Origin and deposition.

The origin and mode of deposition of these clays is quite apparent. When the Keewatin glacier in its gradual retirement towards the north was joined by the glacier flowing from the east, the water derived from their melting was held between the united ice-front and the face of the Manitoba escarpment, and Lake Agassiz, a large extra-glacial body of water was formed. The eastern glacier advanced westward to within a short distance of Wekusko, lake, and then began to retire. Streams draining the glacier carried a large quantity of sediment into the lake, and this sediment was spread over the smooth rocky bottom which had but recently been cleaned and polished by the passage over it of the two glaciers. This sediment was deposited in greatest thickness along the extreme edge of the glacier, for whatever may have been thrown down in front of the advancing glacier was again picked up by the ice, carried forward, and afterwards redistributed in the lake. Farther from the front of the glacier, the sediment became fine and smaller in amount, just as is seen to be the case on ascending Burntwood or Grass rivers. From the extreme western line to which the eastern glacier reached, the Agassiz clays were deposided eastward, as the glacier gradually retired, as long as the extra-glacial Lake Agassiz existed, and as the clays do not seem to extend any considerable di-tance east of Nelson river, Lake Agassiz was evidently drained when the eastern glacier had retired to that line.

No distinct shore lines of Lake Agassiz were definitely determined in this district, but it is probable that the sandy plain over which Cranberry portage runs, was formed at or near the shore of the lake at one of its stages. One would not expect to find the old shore lines which marked the eastern side of the lake; nevertheless the existence of an esker, such as that below the Sea River falls on the Nelson river, gives abundant evidence, if such were needed, that Lake Agassiz had almost entirely disappeared when the eastern glacier had retired east of Nelson river. This esker was formed in running water, between the icy walls of one of the streams flowing from the glacier, perhaps the one that brought down most of the sediment deposited south of the present Lake Winnipeg. If it were formed west of Playgreen lake it has doubtless been modified and spread out, perhaps to form the sand plain on the portage to Kiskittogisu river. Over the ridge at Sea falls there is no sign of the prevailing Agassiz clay, but that portion of the ridge west of the river may have been a delta formed at the mouth of the glacial river where the lake stood about forty feet above the present level of Lake Winnipeg. The sandy ridges at the south-west end of Cross and of Sipiwesk lakes are probably also combinations of kames and delta-plains at the termination of an esker, where the ancient lake stood at about the same level. Eskers.

Till is remarkably scarce throughout the entire region, the whole rocky surface having been scraped very clean by either the Keewatin or eastern glacier or by both. Where till was seen it was almost always in the form of loose fragments of rock, mixed with sand and clay, dumped into the eastern side of some steep valley, or under the lee of some rocky cliff. Boulders are almost entirely absent from the surface of the country covered by Asgassiz clay, but from Wekusko lake west to Cranberry lake they are moderately abundant on the rocky hills and on the shores of the lakes. No heavy or extensive moraines were recognised but a light moraine, consisting of a ridge of boulders of Archæan rocks runs along the brow of the limestone escarpment west of Reed lake, apparently formed when the face of the Keewatin glacier rested for a little while against the face of the escarpment. Till scarce.

Kettle holes formed by streams flowing from the Keewatin glacier occur in the gneiss on Kettle island in Playgreen lake and near the foot of a hill of massive granite on the west shore of Wintering lake. In each case the sides of the holes have been partially cut away since they were formed, perhaps in part by the Keewatin glacier itself and in part by the eastern glacier. These holes would indicate that an extra glacial lake existed in front of the Keewatin glacier where they were formed, but that the streams plunged down from the ice to the rocky floor and afterwards flowed away freely over the surface. As these holes are usually on the east or south-east sides of rocky hills, the position of the moulins into which the water plunged were doubtless determined by the existence of the hills, the ice having been more readily split or melted here than elsewhere.

Kettle holes. The surface of the Archæan rises in gentle rounded knolls and ridges, apparently emerging from beneath the Palæozoic limestone with about the same contour that the remainder of the surface has at present. The only difference remarked was that the softer, more highly altered chloritic and sericitic schists were more conspicuous along the foot of the limestone escarpment than elsewhere. Where they have been more exposed they have been eroded deeper than the surrounding rocks, and consequently occupy the beds of the lakes and other hollows. Glacial striæ. Most of the knolls are smoothed and marked with glacial striæ. The striæ in the western part of the region have been made entirely by the Keewatin glacier, which moved southward from the country west of Hudson bay, while those in the eastern part of the region have, with one or two exceptions, been made by the eastern glacier. On a belt a few miles in width, down the middle of the region both sets of striæ can be clearly seen, crossing each other at a wide angle, the rocks of the eastern glacier over-riding and rubbing out those made by the Keewatin glacier. The direction of motion for both glaciers is unmistakable. How far east the Keewatin glacier extended has not yet been determined.

In the following list of glacial striæ, the coarse of those made by the Keewatin glacier are printed in italics.

List of Glacial Striæ.

Islands off Mossy point, Lake Winnipeg	S. 40° W.
Nelson river, outlet of Lake Winnipeg	S. 36°-45° W.
" " " (earlier set)	*S. 5° E.*
Playgreen lake, Goose island	S. 45° W.
" 1 mile north of Goose island	S. 50° W.
" north-west end	S. 55° W.

Playgreen lake, east shore. 3 miles from north end	S. 50° W.
Little Playgreen lake, Rossville mission	S. 52° W.
" " Soulier point	S. 52° W.
" " mouth of Sepastic channel	S. 65° W.
" " north end	S. 40° W.
Nelson river, 2 miles above Sea River falls	S. 55° W.
" Sea River falls	S. 55° W.
" latitude 54° 22′	S. 40° W.
" first portage above Pipestone lake	S. 40° W.
" Gabbro island, Pipestone lake	S. 50° W.
" island below Pipestone lake	S. 50° W.
" " " (earliest)	*S. 15° W.*
Cross lake, near south-west end	S. 56° W.
" south-west corner of Indian Reserve	S. 54° W.
" island north of Indian Reserve	S. 53° W.
" 7 miles north-east of the H. B. Post	S. 65° W.
" 10 " " "	S. 65° W.
" near north-eastern end	S. 63° W.
Nelson river, above Duck lake	S. 61° W.
" entrance to Duck lake	S. 66° W.
Sipiwesk lake, south-western end	S. 60° W.
" Old Fort point	S. 65° W.
" Cross portage	S. 69° W.
Island in Kiskittogisu lake	S. 57° W.
" Kiskittogisu river	S. 60° W.
Kiskittogisu lake, north end	S. 45°-50° W.
" " east shore	S. 44° W.
" " south-east shore (second)	S. 45° W.
" " " (first)	S. 65° W.
" " south-west side (second)	S. 66° W.
" " " (first)	S. 41° W.
Minago river, 5 miles below the Painted Moose	S. 50° W.
" " 2½ " "	S. 46° W.
" " north end of Hill lake	S. 45° W.
Water-lily lake	S. 55° W.
Muhigan river, near Duck lake portage	S. 68° W.
Landing lake, 4 miles from Cross portage	S. 80° W.
" " 6 " west end	W.
" " 3 " "	S. 85° W.
Wintering lake, 1 mile north of Old Post	W.
" " granite hill, west shore	S. 87° W.
Paint lake, south-east end	N. 75° W.
" " (earlier set)	*S. 42° W.*
Lake east of Ospwagan lake	N. 80° W.
Pipe lake, south end of northern half	N. 82° W.
" south point on west shore	N. 87° W.
" " " (earlier set)	*S. 20° W.*
" two miles north on west shore	N. 89° W.
" near north end	N. 84° W.
Burntwood river, above Manasan falls	S. 88° W.
" 2 miles above Manasan falls	S. 86° W.
" Kepuche falls	N. 77° W.
" island in Opegano lake	N. 87° W.
" Taskinigup portage	N. 72° W.

Burntwood river, Taskinigup (earlier set)	*S.* 43° *W.*
〃 Wuskwatim portage	N. 83° W.
〃 〃 〃 (earlier set)	*S.* 37° *W.*
〃 Wuskwatim lake	N. 78° W.
〃 〃 〃 (earlier set)	*S.* 37° *W.*
〃 10 miles above Wuskwatim lake	*S.* 38° *W.*
〃 11½ 〃 〃	*S.* 37° *W.*
〃 Limestone Point lake	*S.* 20° *W.*
Footprint lake } near north-west end	*S.* 16° *W.*
〃 } near north-west end	*S.* 14° *W.*
〃 Nelson House	*S.* 26° *W.*
Grass river, 12 miles above Paint lake	W.
〃 〃 〃 〃 (earlier set)	*S.* 41° *W.*
〃 〃 2½ miles below Pisew falls	S. 87° W.
〃 〃 Pisew falls	S. 87° W.
Setting lake, 4 miles from north end	S. 70° W.
〃 5 〃 〃	S. 70° W.
〃 3 〃 mouth of Grass river	S. 80° W.
〃 3 〃 〃 〃 (earlier set)	*S.* 44° *W.*
Pakwahigan lake, north end	S. 85° *W.*
Grass river, Wapichtigow falls	S. 86° *W.*
〃 〃 〃 (earlier set)	*S.* 42° *W.*
〃 〃 Sasago rapid	*S.* 40° *W.*
Wekusko lake, north end	*S.* 20°-23° *W.*
〃 〃 island near north end	*S.* 30° *W.*
〃 〃 mouth of Notaminihewi creek	*S.* 15° *W.*
Reed lake, island off point on east shore	*S.* 36° *W.*
〃 island in south-east bay	*S.* 36° *W.*
Cranberry lakes, north division	*S.* 28° *W.*
Athapapuskow lake	*S.* 37° *W.*
Goose lake, north end	*S.* 33° *W.*
Namew lake, south-east shore	*S.* 17° *W.*
Namew river, Rat Portage	*S.* 24° *W.*
Beaver lake, island in	*S.* 17° *W.*
Sturgeon-weir river, 15 miles above Beaver lake	*S.* 7° *W.*
〃 Leaf portage	*S.* 12° *W.*
〃 Birch portage	*S.* 12° *W.*
〃 Dog portage	*S.* 7° *W.*
〃 Pot-hole portage	*S.* 12°-27° *W.*
Outlet of Wabishtock lake, Pine-root river	*S.* 18° *W.*
Beaver fall, Kississing river	*S.* 39° *W.*
Churchill river, below Pukkatawagan fall	*S.* 45° *W.*
〃 Loon fall	*S.* 40. *W.*

SILURIAN.

Undisturbed horizontal limestone, of about the age of the Niagara formation of New York and Eastern Canada, was seen at several low outcrops on the south shore of Pine Island lake. On page 36 a list of fossils is given, collected from a point of this limestone seven miles east of Cumberland House.

CAMBRO-SILURIAN.

Undisturbed flat-lying limestone, similar to the Galena limestone of Lake Winnipeg, underlies the southern portion of the region as far north as Grass river. Towards the north it terminates in a steep escarpment from fifty to one hundred feet in height. This escarpment runs north-westward from the north end of Lake Winnipeg, crosses Minago river at the head of Hill lake, probably passes the south end of Setting lake, though this was not determined, and reaches Grass river at the south end of Wekusko lake. Then it turns westward forming a steep wooded hill or abrupt rocky cliff along the south side of Reed lake. It strikes the east side of the middle sub-division of Cranberry lakes and then turns southward, forming a deep rounded bay in which lie Goose and Athapapuskow lakes. Cambro-Silurian limestone.

The examination of the rock was confined to places on the face of the escarpment convenient to the lakes and rivers traversed, and to some points on the shore of Namew lake. The limestone is for the most part thick-bedded and of a yellowish gray colour, but some of the lower beds, south of Wekusko lake, have a distinctly reddish colour, which, however, is sometimes rather blotchy. The limestone is underlain by from ten to twenty feet or more of soft and rather coarse sandstone, deposited in shallow water in the gradually sinking floor of the Trenton sea.

In one place where the sandstone was well shown, one band was fairly rich in fossils, but the rock was so friable that it was very difficult to get them out, or to save them after they had been obtained. The limestone was remarkably poor in fossils, and in many places none at all could be found in the time at our disposal. The following is a list of the recognizable forms obtained :— Fossils difficult to obtain.

Receptaculites Oweni.
Crinoid stems.
Columnaria alveolata.
Columnaria (Palæophyllum) rugosa.
Streptelasma robustum.
Calapœcia Canadensis.
Stictopora acuta.
Orthis testudinaria.
Leptæna unicostata.
Plectambonites sericea.
Dinobolus parvus ?

Cyrtodonta, sp.
Maclurea Manitobensis.
Liospira, sp.
Murchisonia or *Loxonema*, sp.
Trochonema or *Pleurotomaria*, sp.
Orthoceras, sp.
Endoceras subannulatum ?
Tripteroceras Lambii.
Gyroceras submamillatum ?
Bumastes Trentonensis.
Cheirurus pleurexanthemus.

In the underlying sandstone the following species were found:—

Ctenodonta subnasuta ?
Pleurotomaria, sp.
Murchisonia or *Loxonema*, large sp.
Helicotoma, sp.
Bucania Buellii ?
Bellerophon, sp.
Orthoceras semiplanatum or *planoconvexum.*
Endoceras (Narthecoceras) crassisiphonatum.

HURONIAN.

Huronian areas.

The existence of the following areas of Huronian rocks was determined, viz: at Cross lake, Pipe lake, and the large area extending from Wekusko to Athapapuskow lake. The first is separated from the others, but further exploration may show that the last two are connected.

The Cross lake area consists of two bands of micaceous schist or schistose conglomerate, one striking westward across Pipestone lake and the other south-westward along Cross lake, the two joining towards the north-west end of Cross lake. In places this schist is altered into a rusty gneiss very similar to the rusty Sillimanite gneiss of the Grenville series, but whether it has precisely the same composition has not yet been determined. The schist is in more or less vertical attitude, apparently squeezed between the Laurentian gneiss on each side. It is cut by many irregular veins of white quartz and in some places is highly charged with mispickel. Towards the south-west it is cut by wide veins and bands of coarse white pegmatitic granite containing large crystals of tourmaline and muscovite.

Muscovite of probable economic value.

Crystals of the latter could probably be obtained of sufficient size to be of economic value.

The schist is also cut by dykes of dark-gray gabbro, and in the contact zone between the two rocks there is often a considerable quantity of iron- and copper-pyrites. On the south side of the southern band of schist is a mass of coarsely crystalline light greenish-grey anorthosite, consisting almost entirely of plagioclase. The Pipe lake area consists of a band of fine-grained green schist, striking north-east and south-west, and lying in a trough in the surrounding gneiss.

The Cross river area is very much more complex in its character, and as it was not discovered until rather late in the autumn it was impossible in the remaining few days of the season to do more than obtain a rough idea of its structure and of the nature of some of its more typical rocks, the details of which will be found in the descriptions of the localities. A thinly foliated staurolite schist, doubtless an altered clastic rock, strikes down the northern arm of Wekusko lake, and down the river for a short distance below it. Further south on Wekusko lake the staurolite-schist is represented by a fine-grained green chloritic schist. Further down the river is another newer band of staurolite schist, and east of that is a ridge of light-green diabase. On the east side of Wekusko lake the schist is in contact with reddish gneiss and light-gray massive granite, while on the west side of the northern portion of the lake it is in eruptive contact with a coarse massive gabbro, which extends southwards as far as Wekusko point. Further north a diorite underlies the rounded peninsula extending into the west side of the lake, north of which is an extensive area of massive, medium-grained red granite, also apparently erupted through the schist. Above the lake the river runs along the contact of the red granite, and the clastic rocks, which have here the form of a highly altered green schistose conglomerate. At one point is a boss of massive red quartz-porphyry, very similar to the quartz-porphyry of the Keewenawan rocks of Lake Superior. Above this is an area of coarse dark-green gabbro, and then a reddish massive granite-gabbro extends up to Reed lake. For the rest of the distance up to Cranberry lakes and over to Athapapuskow lake, the prevailing rocks are chloritic or sericitic schists, altered from diabases or clastic slates, cut by massive diorites and gabbro. Along the lines of contact with these rocks and with the surrounding gneiss, quartz veins occur, usually highly charged with pyrites.

Rocks on Wekusko lake.

LAURENTIAN.

Laurentian type of rocks.

Granites and granitoid gneisses of Laurentian type underlie the greater portion of the country here reported on. As a rule, they seem to have the same general strike as the adjoining Huronian rocks, giving the two formations the appearance of having been disturbed, altered and reduced to their present condition at the same time.

KISKITTOGISU RIVER.

Kiskittogisu river was reached by a portage two miles and a half long, from the west side of Playgreen lake. The portage has a general direction a little north of west. For about half of its length it crosses a sandy plain, after which it passes through a wet tamarac swamp. At the portage the river is a hundred yards wide and without current, with a wide marsh stretching out on each side. The water is dark-brown in colour. The river maintains this character for six miles until it reaches the south side of Kiskittogisu lake. The south and west shores of this lake were explored for nineteen miles, but its total extent was not determined. The south shore is at first low and marshy, and then to a point nine miles from the river, it has a sandy beach strewn with whitened tree trunks, behind which is a cliff from ten to twenty feet high, composed at the top of six or eight feet of peat, under which is a bed of stratified clay, evidently a northward continuation of the clay and peat deposits at the north end of Lake Winnipeg. At the above distance where the shore begins to bend towards the north-east, boulders begin to make their appearance, and a little island off the shore is composed entirely of well-rounded boulders.

First outcrop

A mile and a quarter further towards the north-east, the underlying Laurentian rock first outcrops on a small island, as a somewhat thinly foliated dark-gray hornblende-gneiss striking N. 35° E. It is interfoliated with bands of rather coarse-grained gray granite. The surface is strongly scored by glacial markings trending S. 58° W.

For the remaining eight and three-quarter miles the shore and the islands lying off it seem to be composed of massive or heavily foliated light-gray medium-grained biotite-granite. Except along the shore, the rock is everywhere covered by a few feet of stratified clay bearing a forest of spruce. The Kisipatchewuck falls are just at the point of discharge of the lake. They have a width of about 80 yards and a drop of ten feet. Past them is a portage three hundred yards long on the west side over clay. For four miles below the falls the river has a strong current between rocky banks to the point where Kiskitto lake opens into it from the west. The water is white with suspended clay. At its south-west end are cliffs twenty feet high of horizontally and evenly stratified white or light-yellow clay without pebbles or boulders. The first rock outcropping on the north-west shore is a very irregularly foliated light-gray gneiss. Its surface is beautifully smoothed and the north-east sides of the little knolls are well rounded, while the south-west sides are rough and broken. Three sets of striæ can be clearly distinguished. The earliest, seen in a few protected spots, trends S. 41° W. The second and most conspicuous, forming most of the coarse grooves on the level surfaces, S. 66° W. The latest, rubbing out the previous one on many of the north-westerly slopes and represented by fine grooves and scratches on the level surface, trending S. 52° W.

Three sets of glacial striæ.

Three-quarters of a mile further towards the north-east there is a small island of greenish-gray hornblende-gneiss, composed of quartz, orthoclase, plagioclase, hornblende of a rather pale green colour, garnets formed after the hornblende and containing it, and some small particles of iron ore. Most of the remainder of the north shore seems to be composed of moderately dark-gray well foliated biotite gneiss, striking about N. 55° E., and with more or less vertical dip. A large dyke of dark-green coarse-grained diabase, about sixty yards wide, extends in a direction S. 45° W., down through the north-east side of the lake and outcrops on a number of islands.

On one of the adjoining islands, where the gneiss is overlain by two or three feet of light-yellow stratified clay without pebbles, the bedding is a good deal disturbed. On the south side of the same island a scarped bank shows two feet of unstratified till with pebbles and boulders overlying the stratified clay. The matrix of the till is clearly the same as the stratified clay, but it has been kneaded together and mixed with some foreign material. It was probably formed by a slight re-advance of the Labradorian glacier from the east, after the clay had been deposited in the water in front of it. For seven miles below this lake the banks of the river are composed of red and gray gneiss, with occasional narrow bands of darker hornblende or mica schist. The gneiss and schist are overlain by stratified clay which extends on both sides as a plain from ten to twenty feet above the river. Towards the end of the above distance a few boulders are scattered along the banks. As the Nelson river is approached the

Readvance of Labradorian glacier.

Lake Agassiz clays are left behind, and the country becomes bare and rocky and the surface of the rock is rough and weathered, not smooth and polished like that which has been protected by the impervious stratified clays. The rock at the mouth of Kiskittogisu river, not far from the upper end of Whisky Jack portage, is a light-gray gneiss, including many strings and broken bands of rounded or angular fragments of dark-gray gneiss or altered diorite. The foliation runs N. 60° E., but is wavy, and flows around the darker inclusions. A better example of flow structure in the gneiss on a large scale is seldom seen.

MINAGO RIVER.

Section on Minago river.

Minago river rises on the limestone plateau near the north shore of Moose lake, and flowing in an east-north-easterly direction, empties into the west end of Cross lake. At the south end of Hill lake in approximately north latitude 54° 15′ it leaves the limestone. In a cliff fifty feet high the following descending section is here seen :—

	Feet.
Fine light-gray horizontally stratified Agassiz clay without pebbles or boulders	25
Light-yellow thick-bedded Trenton limestone with rather fine porous texture and breaking readily in any direction.....	15

Fossils were very scarce but the following were found :

Columnaria alveolata.
Streptelasma robustum.
Endoceras subannulatum ?

	Feet.
Light-gray, brownish-weathering sandstone, thick-bedded, and rather fine-grained.	10

Fossils.

A foot below the top there is a fossiliferous band but the fossils were very difficult to extract. However, the following were obtained and are sufficient to determine the rock as being clearly of Trenton age :

Ctenodonta subnasuta.
Pleurotomaria, sp.
Murchisonia or *Loxonema*, large sp.
Helicotoma, sp.
Bucania Buelli ?
Orthoceras either *semiplanatum* or *planoconvexum.*
Endoceras (*Narthecoceras*) *crassiphonatum.*

Under the clay the surface of the limestone is smoothed and strongly marked by glacial grooves as is shown on large masses fallen down the cliff. Eight miles north-east from the cliff of Trenton limestone low outcrops of gray Laurentian gneiss begin to appear at the water's edge, cut by one or more dykes of dark-green diabase. The river below Hill lake is thirty-three miles long and at only one place near its mouth is there any current. Drunken lake is an expansion of the river twenty miles below Hill lake, and between the two lakes the banks are at first marshy and then rise to a clay plain three or four feet above the water. Here and there are low glaciated knolls of gray gneiss, striking more or less parallel with the river banks. The shores of Drunken lake are generally low and moderately well wooded, with rocky knolls here and there on the south side.

Below Drunken lake the banks are much more rocky, with little or no covering of clay. The rock is generally a dark-gray hornblendic gneiss, cut in two places by dykes of dark-green amphibolite. Eight miles below Drunken lake the gneiss is cut by the Cross Lake white granite, and thence to the mouth of the river this granite forms a conspicuous feature along the banks. Near the mouth an esker twenty-five feet high composed of fine sand without pebbles or boulders rises close to the west bank. **Esker near mouth of river.**

Seven miles below Hill lake a small brook flows into the river from the west, and half a mile up this brook is the beginning of a portage path, which the Indians occasionally make use of to reach Wolf river. The portage is three miles and three-quarters long, and for most of the distance is through a mossy swamp, or over a reedy marsh supporting a few small scattered tamarac trees. Several low bosses of gray gneiss run through the swamp, and about the middle of the portage for half a mile is a dry clay plain, wooded with spruce and Banksian pine. At its north-west end the portage reaches the shore of Waskik lake.

Muhigan River.

A quarter of a mile S. 80° W. from the end of the portage is a point of grey gneiss striking N. 35° E. 50° E. The east shore of Waskik lake is generally swampy, while the west shore is broken by low rounded rocky points. Near the north-west angle of the lake the rock is a medium-grained irregularly foliated gray gneiss, cut by heavy veins of coarse red pegmatite and one or more narrow dykes of diabase. The shore and islands are covered with from three to six feet of soft Agassiz clay. From the north-west angle of this lake a marshy creek **Muhigan river.**

a quarter of a mile long runs to another similar lake about a mile and a half long, from the north-east end of which the river winds through a marsh between tamarac swamp for three miles and a half to the south end of a third lake, very similar in character to the other two, with low, thickly wooded shores and rocky points of light-grey gneiss.

The river flows from the north-east side of this third little weedy lake and has marshy banks for three miles to a rapid with a descent of eight feet, past which is a portage 140 yards long on the east side over a hill of clay. For the next three-quarters of a mile the stream is fifty feet wide and well defined between clay banks ten feet high, from which little rills are washing out bars of sand. Then there is a fall of ten feet, opposite which the stratified clay rises thirty feet above the river to the top of a knoll of gneiss and whitish pegmatite.

For the next six miles the river is thirty to forty feet wide, with a moderate current and continues N. 15° E., in the bottom of a narrow valley thirty-five feet deep, from the sides of which many trees had fallen and had to be cut away before our canoes could pass. On the top of the bank is an extensive undulating clay plain. This country has all been burnt over and much of it is now almost treeless, like partly open prairie, with scattered grooves of small poplars and alders. Strawberries were growing on the ground in great profusion. At the end of this six mile stretch the river turns sharply eastward, and within a mile and a half is obstructed by four rapids, the Muhigan rapids, with descents respectively of two, four, six and fifty feet. Above the upper rapid the river bank, twenty feet high, is composed of fine brown sand. At the lower rapid the water rushes through a narrow gorge along the strike of the gneiss, at first dropping as a mass of fleecy spray and foam over the jagged rocks, and then hurrying along between steep rocky walls.

Country burnt over.

At the foot of the gorge on the south bank a huge sub-angular mass of gneiss is perched on the side of the hill, rising much higher than the top of the hill, and is supported in its present position by smaller masses of rock. This great perched block is known as "The Wolf stand" and from it the river is also called Wolf river. The country here seems to descend from sixty to eighty feet, and the river winds through an extensive willow-covered flat, apparently encircled by hills, those to the south being rocky and bare. For fifteen miles the river winds through this country. The banks are low and reedy. Behind the reeds there is a belt of willows and behind the willows are the sloping banks of the valley rising to a white silt plain wooded with Banksian pine, or to the low ridges of gneiss wooded with spruce and poplar. In this vicinity large game was very plentiful, eleven moose having been seen by the writer in one day. For two miles above the junction of the west branch the valley is narrow and about fifty feet deep with steep sloping sides of light-gray clay, rising to a clay plain. The river was very much obstructed by fallen timber. Large game plentiful.

At the Forks the banks become lower and the river is wider and less rapid. For three miles and a half it flows between clay banks from fifteen to twenty feet in height, the easy current being broken by three short rapids. There it opens into a small lake a mile and a quarter long, the banks of which are overlain to a height of twenty-five feet, with light-gray stratified clay. From this lake Muhigan river is said to continue northward and to empty into Nelson river, near Sipiwesk lake. But the canoe route commonly used by the Indians leaves the east side of the lake, and ascending a little brook for half a mile, reaches the end of a portage. This portage is a mile and a third in length, and crosses a wooded clay ridge a hundred feet high, to the west side of Duck lake, one of the expansions of Nelson river.

Nelson River.*

The Nelson river in its northerly course of 230 miles, from Lake Winnipeg to Split lake flows in one or more rather shallow and often ill-defined channels for the most part through a country underlain by Laurentian granite and gneiss. At Pipestone and Cross lakes it passes over an area of horneblende and mica-schists and highly altered conglomerates. Nelson river.

Playgreen lake into which the river expands shortly after it leaves Lake Winnipeg, lies along the south-western edge of the Archæan nucleus. While its south-western shore is for the most part composed of clay and peat, its north-eastern shore consists of low rounded bosses of granite or more or less distinctly foliated gneiss. At one point a scarped bank of sand and pebbles, thirty-five feet high, rises from the edge of the water to a narrow sandy plain, probably an esker, extending into the country to the north-east.

From Playgreen lake the river flows by several streams, the more easterly of which pass through Little Playgreen lake on their

* A survey of the whole course of this great river from Lake Winnipeg to Hudson bay was made by Dr. R. Bell in 1878 and 1879 and a description of its topography, geology, etc., is contained in the reports of progress of the Geological Survey of Canada for these years. A map accompanies the report of 1878.

way to Cross lake. Little Playgreen lake lies entirely within the country underlain by Archæan rocks. The banks are rocky, with marshy bays on the east side and long sandy beaches in front of thick woods on the west side. The rock is still a rather irregularly foliated gray gneiss, associated with which, near the south end of the lake, is a rather coarse-grained massive diorite. Near the north end of the lake is a light reddish-gray massive biotite-granite cut by veins, a foot or more in width, of red pegmatite containing crystalline masses of molybdenite, with occasional crystals of pyrite and magnetite. In the bank of the river, seven miles below Little Playgreen lake, opposite the mouth of Pine creek, is a dark-gray rather fine-grained diorite or uralitic diabase, probably forming part of a large dyke cutting the gneiss. A few transported boulders are scattered along the banks in this vicinity, but they become rare as the river is descended.

Pegmatite veins holding minerals.

A mile below Sea-river falls, on the north-west side of a rather wide stretch of quiet water, is an esker or ridge of sand forty feet high. It runs steeply from the water and as far as one can see into the rather scattered forest of Banksian pine; its summit is a plain of sand and gravel. It runs about S. 50° W., and the Indians assert that it is continuous with the sand ridge on the south-east side of Playgreen lake. In the opposite direction it can be readily recognized on the east side of the Nelson river as far north as the Etoimami river. Below this the banks are of gneiss, usually covered with a few feet of clay to within a short distance of Pipestone lake. At the lowest portage the gneiss is cut by a dyke striking S. 10° E. of fine-grained dark-green diabase, consisting of plagioclase in numerous interlocking lath-shaped crystals, the intervals between which are largely filled with augite, some of the crystals of which have been altered around the edge to hornblende. A little biotite is present, and ilmenite surrounded by leucoxene. As Pipestone lake is approached the gneiss contains many dark, often angular, inclusions around which the foliation flows. In places the inclusions are so numerous and distinct as to give the gneiss the appearance of a conglomerate.

Inclusions in gneiss.

About three-quarters of a mile from Pipestone lake the bank is composed of a massive greenish-gray anorthosite, containing small irregular patches of biotite and grains of copper-pyrites. In places it is coarsely crystalline, a fresh fracture showing large cleavage surfaces of plagioclase, while in other places it is finer-grained and breaks with an irregular greasy fracture. At the principal outcrop visited it is in contact with a dark-gray finely crushed diabase in which the pyroxene is altered to hornblende which sends off a narrow dyke into the anorthosite. The diabase is cut by a vein of pegmatitic granite.

The anorthosite is here a comparatively narrow band, and just north of it is a thinly foliated green garnetiferous chloritic schist composed of biotite largely altered to chlorite, quartz very much shattered, small rounded garnets, arsenopyrite, epidote and zoisite. It strikes S. 57° E. and has an almost vertical dip. The south shore of Pipestone lake, west of the mouth of the river is composed of similar chloritic schist, in places varying to a conglomerate and holding well rounded pebbles of gneiss.

An island out in the lake two miles and a quarter from the mouth of the river is crossed by a dyke of squeezed diabase in which the augite is almost entirely altered to a light-green hornblende, and contains numerous flakes of biotite, consisting of thinly foliated light-green chloritic schist. The diabase contains also a large quantity of copper and arsenical-pyrites. Just to the west of this island is a chain of islands extending N. 25° E. composed of a dyke of massive coarse or medium-grained sausurite gabbro which becomes finer-grained as it reaches the north shore of the lake. On the shore no rock was seen close to the dyke, but a few yards distant there are low cliffs of dark green chloritic schist very much crumpled and altered. This gradually changes into a soft sericitic schist, which is cut by wide veins of white milky quartz.

Copper and arsenical pyrites in diabase dyke.

The beach along the north side of the lake is strewn with boulders. On an island in the river, half a mile below the lake, the surface is strongly marked by glacial grooves trending S. 50° W. while in a protected spot a few earlier grooves were found trending S. 15° W. The clay overlying the chlorite schist in the middle of the island is a fine white incoherent silt, without boulders.

On the point of an island two miles and a half below the lake the rock is a conglomerate filled with rounded pebbles of white quartz, etc., and darker and more angular pebbles of schist or diorite. The bedding is very irregularly broken, but seems to strike northward in line with the bands of pebbles, while the schistosity strikes S. 75° E. with nearly vertical dip. At the point of entrance with Cross lake the rock is a dark greenish-gray schistose conglomerate with pebbles similar to those last mentioned, most of which are rounded or oval, as seen on the surface, while they are often greatly elongated vertically. The matrix is a thinly foliated garnetiferous biotite schist, striking S. 55° E. and with vertical dip. On the beach are lying some large masses of light-green sericitic schist, the pipestone of the Indians.

Cross lake lies along a band of chloritic schists, schistose conglomerate and fine-grained gneisses, and the islands and the more prominent points are for the most part composed of these rocks, while the surrounding country is composed of gray, more or less distinctly foliated Laurentian gneiss. On the south shore dark-green garnetiferous hornblende schist, continuing across from Pipestone lake, was seen almost in contact with the gneiss, and the two rocks have the same dip and strike. On the south side of the Indian Reserve island this hornblende-schist was cut by large dykes or masses of very coarse white pegmatite granite containing large crystals of tourmaline, biotite and muscovite. Some of the latter were as much as nine inches and a half in length, and some smaller ones which were extracted were of excellent quality. This white pegmatite, which we may call the Cross lake granite, extends south-westward to the end of the lake and for several miles up Minago river, forming low but conspicuous rounded white hills.

Large crystals of muscovite.

On the south-east shore of the Indian Reserve island, the rock is a fine-grained green schist or squeezed greywacke, weathering into indistinct oval masses and with a general strike about N. 55° E., while Otter island between it and the east shore is a thinly foliated green porphyritic schist. Gray Laurentian gneiss was found on the south-east side of the Indian Reserve island, and the east shore opposite is also composed of similar gneiss. East-north-east from the Indian Reserve, the lake lies in a trough excavated along a band of dark hornblendic and micaceous schists and rusty gneisses, with more or less vertical dip and often highly charged with arsenical pyrites. A thin section of rock from an island north of the Indian Reserve consists of hornblende in large amount, quartz very much crushed and shattered, orthoclase, plagioclase, a few scales of biotite, calcite in large quantity, apparently primary, and many small patches of ilmenite altering to leucoxene. Another specimen collected near the north-eastern end of the lake was found to have almost precisely similar character. In the northern part of this portion of the lake some of the islands, probably along the line of a dyke, were composed of a coarse or medium-grained gabbro often with indistinct diabase structure.

Post-glacial deposits.

Towards the north-eastern end of the lake the surface of the rock is quite free from any covering of stratified sand, clay or silt, but as the Nelson river is approached these post-glacial stratified deposits begin to make their appearance, and they gradually become heavier towards the south-west, where they have an average thickness of ten feet or more. The Indian Reserve island and the adjoining smaller islands are covered with a light rather friable stratified clay, which makes an excellent soil for the growth of all the vegetables and garden produce common in Manitoba. The eastern limit of these stratified deposits marks the line of the greatest easterly extensions of Lake Agassiz as shown on a preceding page.

Nelson river flows from Cross lake by several channels and the one we followed was that commonly used by the inland freighting boats of the fur traders descending the river. The banks are exceedingly monotonous, being everywhere composed of red and gray gneiss more or less regularly foliated, occasionally cut by dykes of diabase or gabbro. This rock is covered by from five to twenty feet of soft gray clay. Pebbles and boulders are conspicuously rare except in the straight narrow reach below White Mud falls. Here the gneiss strikes along the river and dips at a low angle (15°–25°) north-eastward. On this account the rocky bank on the north-west side rises in an easy slope and as the glaciation was from the north-east the surface has been smoothed and well rounded. The north-east bank having broken across the lamination of the rock and also having been protected from glacial abrasion, is particularly ragged and abrupt. On this bank in the hollows between the cliffs of gneiss, and underlying the stratified Lake Agassiz clays, are banks up to forty feet in height, of a mixture of sand, pebbles and well rounded boulders. The material is very loose and it had evidently been deposited in rapid water. This coarse gravel is of early glacial age and is the remains of a bed of gravel that has filled this portion of the valley from side to side. This bed of gravel may have been laid down in the valley near the face of the Keewatin glacier, as that glacier was advancing southward, and the fragments of the bed that still remain are in such positions that they would have been protected from the Keewatin glacier from the north and the Labradorian glacier from the west. As the Labradorian glacier retired these fragments were buried under the clay deposited in the bottom of Lake Agassiz.

Banks of glacial gravel.

At Masuto falls, a mile and a half below where the two branches of the river diverge, the west branch is crossed by a dyke between two hundred and three hundred feet wide, striking S. 33° W. of a rather coarse dark-gray diabase, composed of plagioclase in stout lath-shaped crystals, augite, hornblende around the edges of some of the crystals of augite, and a considerable amount of iron ore. The surrounding rock is a rather fine-grained red lightly foliated granite gneiss. Near the foot of the rapid is a cliff of coarse-grained light-gray norite or gabbro.

At the point of discharge of the river into Duck lake is an outcrop of dark-gray hornblende-schist cut by heavy veins of white pegmatite. The imperfect character of the drainage of the Nelson river is very clearly shown at Over-the-hill rapid, where the great river falls several feet over hard Laurentian rock, while a short distance to the west there is a narrow neck of soft gray clay a hundred yards in width, without any sign of the underlying rock, between the quiet water above and that below the fall. When this neck of clay is cut through or is worn down by atmospheric agencies the fall will disappear.

Imperfect drainage of Nelson river.

A heavy diabase dyke crosses the river a mile below this rapid, and three-quarters of a mile lower is a rapid caused by a band of dark-gray hornblende schist crossing the river. The schist is highly garnetiferous and in places is porphyritic from the presence of elongated masses of quartz. It is cut by many narrow stringers of white opaque quartz. The strike of the schist is S. 50° W. 75° N.W. The banks of the river for a mile and a half continue to be formed of this garnetiferous hornblende schist, which is often cut and broken by dykes and masses of red and gray granite. Below this the country is again underlain by gray gneiss.

A mile and a half below Red Rock falls is a small island, the east side of which is cut by a dyke of a medium-grained olivene norite composed of plagioclase, monoclinic pyroxene, strongly pleochroic orthorhombic pyroxene, probably hypersthene, hornblende, around the edge of the crystals of monoclinic pyroxene and serpentine, apparently altered from olivene running N. 25° E. towards a point on the east shore. This point is overlain by a fine white silt, rising to a moderately level plain from thirty to forty feet above the river.

Dyke of olivene norite.

At Chain-of-rocks rapids a dyke of dark-green medium-grained olivene norite very similar to the above except that the orthorhombic pyroxene is not so highly pleochroic and some of the olivene is rather fresh, perhaps a continuation of the last mentioned dyke, crosses the river. It is horizontally and vertically jointed into squarish blocks, giving it the appearance of a heavy broken wall or dam of rude masonry.

A mile and a quarter below this rapid, on the south-east side of the river, is a cliff seventy-five feet high, of moderately coarse light-brown stratified sand, mixed with a very few pebbles, overlain by three feet of thinly stratified clay. The surface rises slightly for a short distance as it recedes from the bank, and extends for several miles in a north-easterly direction as a broad kame or eskar.

Four miles further north and near the upper end of Sipiwesk lake is Mittonegesik hill, a ridge 150 feet high, extending N. 35° W. and S. 35° E. Its sides are rounded and covered with small poplars, while its summit rises in three more or less conspicuous knobs. The most southerly of these knobs was ascended and was found to consist of transported boulders embedded in a matrix of sand. This ridge is one of the moraines of the Laurentide glacier, and it would seem to have been formed before Lake Agassiz had entirely disappeared, for its lower portion has been to a certain extent worn and modified by the water of this lake. Moraine of Laurentide glacier.

Boulders, which have not been at all common along the banks of the river to here, now begin to occur in considerable abundance, and at the south-west end of Sipiwesk lake and for at least four miles down both shores of the lake they cover the beach. At a conspicuous point on the north-west shore the bank is composed of a white, well-stratified clay in clearly marked horizontal layers from half to three-quarters of an inch thick. The clay itself is quite free from pebbles or boulders, but its surface seems to be scattered over and studded with boulders of gneiss, diabase and Palæozoic limestone.

At Old Fort point, on the same side of the lake the rocky shore is composed of thinly foliated hornblende gneiss, striking S. 50° E. $<$ 45° N.E., overlain by a little brownish-gray clay without boulders. A third of a mile to the east are two small bare islands of coarse dark-green gabbro, forming part of a dyke running N. 24° E., as at the Chain-of-rock rapids the gabbro is cut by joints into more or less rectangular blocks. The islands are composed of gneiss overlain by a little clay. Boulders are not plentiful, except on the western points. A conspicuous ridge rises behind the north-western shore.

Cross portage is a mile and a half long, through woods of spruce and poplar and over a ridge of clay fifty feet high. Its north end is on a level clay flat on the south side of a small lake tributary to Landing lake, which lies about thirty feet higher than Sipiwesk lake. The shores of Landing lake are of reddish-grey gneiss striking with the long axis of the lake, cut by dykes of coarse dark-green gabbro. Boulders are not at all numerous, but the rock is generally overlain by a few feet of stratified clay. The surrounding country is rather thickly wooded with poplar, birch and spruce.

Near the western end of the lake, Thicket portage leaves its northern shore and crosses to Wintering lake. The portage is a mile and a quarter long, quite dry, and almost entirely through woods of small poplar. It is over a brownish-gray clay or silt, through which a few low bosses of gneiss scarcely show. At its northern end it has an easy slope of fifty feet to Wintering lake. This slope is underlain by small boulders, but the rest of the portage is quite free from boulders. The crest of the ridge crossed by the portage is sixty feet above Landing lake while Wintering lake lies fifty feet below it.

Site of old fur-trading post.

The shores of the latter are chiefly composed of grey gneiss, cut by at least one dyke of dark-green gabbro extending N. 60° E. A mile above the point between the two rivers is the site of an ancient fur-trading post of the North West Company. A gray line of gneiss runs along the edge of the water, above which is a thick growth of small poplar and underbrush, and in the background is a forest of spruce. The surrounding shores rise gently from the water, and are densely wooded with a close forest of white spruce, growing on the rich clay soil.

Pot-holes.

The south-west shore of the lake is largely composed of a rather high steep ridge of massive red granite either bare or thinly wooded with Banksian pine. Near the northern end of the lake and at the foot of the granite hill which is here sloping towards the east, is a large pot-hole probably formed by a stream from the face of the Keewatin glacier. The pot-hole was $4\frac{1}{2}$ to $5\frac{1}{2}$ feet in diameter at its mouth, which was just on a level with the water of the lake, and it was certainly three feet deep, but how much more could not be determined, for it was nearly full of sand and gravel. Half a mile further up the shore, where the granite hill descends into the lake at an angle of about 30° two large pot-holes were seen at the edge of the water. One of them, five feet deep, has had the side worn out of it by subsequent erosion.

Towards the western end of the lake the granite comes in contact with a dark hornblende gneiss or schist striking along the shore. A narrow sluggish brook enters the west end of the lake in a wide straight marshy valley. The canoe route ascends this brook for a mile and a quarter, and then leaves it and crosses a portage two-thirds of a mile long, half of which is over dry clay through poplar woods, while the other half is chiefly through a mossy swamp. At its northern end it reaches a small lake three-quarters of a mile long and thirty-five feet above Wintering lake.

On the opposite side of this lakelet is another portage a mile and a quarter long. In the first quarter of a mile it rises up a rocky slope seventy-five feet high to a plain of gray clay wooded with small poplars ; in the next half mile it crosses a rich valley the bottom of which is a deep spruce and tamarac swamp, while in the remaining half mile it ascends a gentle rise and crosses a dry plain that has once been wooded with spruce but is now covered with small poplar and alder. On its northern side this plain drops suddenly forty feet to Paint lake. On the brow of the slope is an outcrop of medium-grained gray gneiss striking N. 75° E.

Paint lake is much broken by many points and islands, and its shores for the most part rise in rounded clayey slopes to heights of from fifty to a hundred feet. At the edge of the water the underlying rock is almost everywhere exposed. It consists of medium gray gneiss with fairly distinct foliation and rather persistent strike N. 45° E., cut by larger and smaller veins of coarse white biotite granite. The country appears to maintain the contour of the surface of the underlying gneiss, but it does not present the rugged barren appearance so common to the districts underlain by Laurentian rocks. Not long ago both the hills and valleys have been covered with a forest of spruce, but almost all of this timber has been destroyed by fire, and has been replaced by a thicket of small poplar, through and above which tall whitened tree-trunks rise here and there. A few green islands, isolated and cut off from the risk of fire are now thickly covered with large white spruce, showing what would have been the general state of the country if it had not been ravaged by fire. Pain lake.

Two hundred yards west of Paint lake, across a ridge of clay thirty feet high, is a small lake a mile long, the east shore of which is an even clay-covered ridge, while the west shore is much more rugged, in places showing steep slopes of bare gray gneiss. Near the south end is a steep rounded hill of white granite. From this lake is a portage two thousand yards long over a diffuse clay-covered ridge, overgrown with small poplars, alders, etc. The ground is dry and is covered with grass, vetches, strawberry plants, trailing raspberry vines, raspberry bushes, pembina currant and red cherry bushes. At the highest point of the portage a low knoll of light-gray gneiss peeps up through the turf. From this knoll the surrounding country may be seen to consist of low gently sloping ridges, all wooded with small poplar, or covered with grass and vetches. Here and there, on a few of the steeper hill-sides, the underlying rock shows itself in little patches.

Another small lake, about the same size as the last, lies west of this portage, and from its western end is another portage six hundred and fifty yards long, over a level clay plain to the top of the bank over-

Pipe lake.

looking Pipe lake, which lies eighty feet below. Pipe lake consists of two more or less oval bodies of water connected by a short almost currentless river. The upper and most southerly division is a little basin about five miles long, surrounded by steep and almost bare rocky hills a hundred feet in height. It holds a few small islands of almost bare rock without any covering of clay. The water is clear and transparent, very different from the muddy water of all the surrounding lakes and streams. The rock of the islands and the south-east shore seems to be generally a more or less massive light-gray gneiss, while the north-west shore is composed of thinly foliated fine-grained green Huronian schist, striking N. 55° E. $<$ 60° N.

Syncline in Huronian rocks.

The northern expansion of Pipe lake is somewhat larger than the southern, and its shores are composed almost entirely of fine-grained green schist still striking in a north-easterly direction, but apparently dipping inwards from both sides, thus forming a synclinal trough in the middle of the surrounding Laurentian gneiss. The rocky shores are more or less thickly covered with stratified Agassiz clay, and the water is white and opaque from suspended clay.

The schist has been smoothed and scored by the glaciers from the north and from the east, though the striæ made by the former have been for the most part obliterated. In one protected spot striæ of the Keewatin glacier from the north were observed trending S. 20° W. while striæ of the Labradorian glacier were common everywhere, trending N. 82°-89° W. Since leaving Cross portage on Nelson river, the variation of the compass had been very irregular, so that it was for the most part impossible to make a survey with the ordinary magnetic compass, and it was necessary to use a solar compass in order to obtain the direction of the course travelled.

Manasan river flows from the north end of Pipe lake, and after a course of seven miles and three-quarters, empties into Burntwood river. It winds gently between clay banks from ten to thirty feet in height, and the underlying rock is but seldom exposed. Where seen, it was a grey gneiss occasionally garnetiferous, and with a general north-easterly strike.

Lower part of Burntwood river.

Burntwood river.

Burntwood river was ascended from Manasan river to the mouth of Footprint river, a distance of about fifty-five miles. At Manasan falls, just above the mouth of Manasan river the water tumbles about twenty feet in a fine cataract over a band of thinly foliated, dark-gray hornblendic gneiss, striking N. 38° E. and with vertical dip. About two miles above these falls the river opens out into Birch lake, which is merely a long and rather wide currentless part of the river. The underlying gneiss is exposed at some of the points close to the edge of the water, but the banks are otherwise composed of stratified white or light-gray clay or silt, more porous and less adhesive than the clay of Manitoba, and are generally about thirty feet in height. The surrounding country has all been burnt over and now there is very little timber standing on it, the undulating surface being grassy or thinly covered with small poplar scrub. In places, the surface, though now dry, is lumpy as if it had been an old swamp.

Where Birch lake again narrows into the river is a point on the west shore of whitish, medium-grained, very slightly foliated granite, containing a small amount of mica. Three-quarters of a mile higher up is the mouth of Wapichtigow creek, from which there is said to be a long swampy portage to the west shore of Pipe lake. A mile further up the river are Wapichtigow falls, fifteen feet high, where the stream is crossed by a ridge of rather irregularly foliated, dark-gray gneiss, with lighter bands, striking N. 50° E., 60° N.W. Ascending the river for about a mile and a half between steep, wooded banks either of clay or gneiss, Kepuche rapid is reached. Here the water descends three feet in a narrow channel over a ridge of nearly horizontal biotite gneiss, interlaminated with heavy bands of rather coarse, whitish granite.

Wapichtigow creek and falls.

For the next mile the river has steep, clay-covered banks, sixty feet high, burnt and wooded with scrub. Then there is a rapid descent of thirty feet, part of which is a portage, known as Waskatigow portage, four hundred yards long on the east side. At the foot of the portage and protected by a cliff of gneiss is a bank of till, composed of light-brownish clay filled with somewhat rounded and striated pebbles and small boulders. Most of the surrounding country is, however, covered with soft gray stratified clay without pebbles, while on the portage is an exposure of dark-gray, highly garnetiferous gneiss, striking N. 40° E. and dipping eastward at a low angle.

Bank of till.

For a couple of miles above this rapid the river flows between steep clay banks which appear to rise to a terrace thirty feet above the water, and then it opens out into Opegano lake which lies between low clay-covered hills and on the west side of which are cliffs of well stratified clay, occasionally overlain by a small thickness of peat. Under the clay is an undulating floor of gray Laurentian gneiss.

Above Opegano lake the river flows for nine miles from a W.S.W. direction. The banks usually descend in easy slopes, though here and there bold rocky cliffs overlook the water, and ridges of gneiss cross the channel, forming rapids, past some of which it is necessary to portage. At the heaviest of these rapids the water plunges for fifty feet over a ridge of gray garnetiferous gneiss, striking N. 48° E. <45° S.E. A portage three hundred and twenty yards long and known to the Indians as Taskinigup portage, is here made on the north side of the river. Three-quarters of a mile above Taskinigup, over rather quiet water, are Wuskwatin falls, which have a descent of twenty feet over a ridge of coarse gray garnetiferous gneiss, striking N. 40° E. There is a portage on the north side two hundred and twenty yards long over a hill covered with soft gray clay from the foot of the falls to the shore of Wuskwatim lake, from which the river here issued.

Taskinigup portage.

As far up the river as Opagano lake the surface of the gneiss had been generally marked by glacial grooves and striæ made by the Labradorian? glacier from the east, and striæ of the Keewatin glacier were seen only in protected and favourable spots. Above that lake striæ of the Keewatin glacier trending in a S.S.W. direction prevail over the surface of the rock, while striæ of the Labradorian? glacier were but seldom seen, for we were now approaching the extreme western limit to which this latter glacier bed was extended, and it would seem that the waters of Lake Agassiz which lay immediately in front of it bore up its attenuated edge. On the shores of Wuskwatim lake the last of these eastern striæ were observed, and the extreme extension westward of the Laurentide glacier was but a few miles west of this lake.

Wuskwatim lake.

Wuskwatim lake is a very pretty sheet of slightly murky water, six or seven miles long and three miles wide, surrounded by sloping clay-covered hills wooded with white spruce and poplar. Its surface is varied by a few islands composed of clay overlying a floor of gneiss. The two falls above mentioned, at and near its outlet, would furnish a large amount of power for driving mills or machinery of any kind, while a supply of timber for building and fuel could be obtained from the surrounding country, and the soil would grow any of the ordinary roots or more hardy cereals, so that it is not improbable that before long when this fertile country is made accessible by the advent of a railroad from the south, one of the most prosperous towns in the district may grow up on the shore of this now secluded lake.

Above Wuskwatim lake the river is wide and sluggish with low banks covered with poplar and willow. Then it turns sharply and flows for seven miles from a little west of north in a valley from sixty to eighty feet deep, through a ridge of well stratified clay that has been deposited on the floor of Lake Agassiz along the face of the Labradorian? glacier. If there had been free drainage from the face of the glacier the position of this ridge would doubtless have been occupied by a terminal moraine of boulders and unassorted till. Looking from the top of the bank on this ridge the country seems to be a great clay plain, cut through by the sloping trough of the river, and trenched by wide lateral gulleys. The surface is generally covered with small poplar, with some spruce in the valleys, and there are no signs of rocky hills, or of rock except here and there at the water's edge. Where the rock appears it is a medium-grained dark gray gneiss often studded with garnets, some of which were found as much as 1·4 inches in diameter.

Country a clay plain.

Above the clay ridge the course of the river again changes, and for five miles it flows from the west between banks eight or ten feet high, covered with scrub poplar and willow. Very little spruce of any value was seen. The character of the country now begins to change, and instead of regular clay-covered slopes and plains, rocky hills rise from one to two hundred feet above the general level, their hard dark sides being but scantily covered with small Banksian pine, while small lakes occupy the deeper depressions.

At a place called the Atwawin, where there are a few Indian houses and a Roman Catholic mission church, the Burntwood river was left and we turned northward into a small stream called Footprint river, which, two miles further up, flows from the south side of Footprint lake. It flows in a valley with steep rocky banks, cutting across the strike of the gneiss. Footprint lake, on the northern shore of which the Hudson's Bay Company have had a trading post for a number of years, and the Methodists have a small church and mission house, has somewhat the shape of a rude cross, seven miles long from east to west, and six miles from north to south. The latitude of the trading post was found to be 55° 48' 26" N. The lake is surrounded by banks of light gray friable clay from thirty to forty feet high, through which rise rounded hills of gneiss up to two hundred feet or more in height. The clay extends over the lower portions of these hills, but some of the higher summits appear to rise above it, possibly having risen above the surface of Lake Agassiz where the surrounding clay was deposited on its floor. When the lake was visited in August last both the

Footprint lake.

Vegetables grown.

trader and the missionary had excellent gardens in which they were successfully growing potatoes, cabbages, cauliflowers, onions, radishes, lettuce, peas, beans, turnips, carrots and other vegetables, and many of the Indians had patches of potatoes sufficiently large to assist materially in the support of their families throughout the winter.

I inquired from the Indians who were living around the lake, how far the fertile clay-covered country extended towards the north, and they told me that it extended as far as Indian lake on Churchill river, north of which the surface is either of sand or rock.

Cumberland and Namew Lakes.

Cumberland lake.

The shores of Cumberland lake, in the vicinity of Cumberland House, are underlain by horizontal thick-bedded white Silurian limestone in places cherty, and in other places weathering into a rather soft sponge-like or vesicular mass. In places it contains fossils, but unfortunately for the exact determination of the horizon, most of the specimens collected seem to belong to undescribed species. Dr. Whiteaves supplies the following list of a collection made on the north shore seven miles east of Cumberland House:—*Rhynchonella?* sp., *Obolus* or *Dinobolus* sp., Strophomenoid-like brachiopod with sculpture like *Rafinesquina alternata*, *Euomphalus*, n. sp., *Murchisonia* or *Loxonema*, sp., *Platyostoma* or *Platyceras*, probably undescribed, *Gomphoceras* or *Cyrtoceras*, sp. undescribed, *Orthoceras*, transversely annulated species.

Above the limestone is a covering of light gray calcareous till, filled with boulders, with a thickness of from one to thirty or more feet, and the shores are almost everywhere more or less thickly strewn with boulders.

The point on the north shore, almost opposite that from which the above fossils were collected, is composed of light-gray pebbly till, and is surrounded by a large number of boulders. These are chiefly of limestone, white, reddish and yellow and for the most part are well glaciated. There are also a few of green amphibolite, red, gray and green gneiss, dark mica schist, etc. At a point three miles north of Whitways narrows on the east shore of Sturgeon lake, a light-gray fine-grained limestone, probably of Trenton age, outcrops near the edge of the water. No fossils were found in place in the rock, but the shore is strewn with large angular masses of yellow porous dolomite, which has doubtless been broken off and shoved up by the ice, from some bed in the immediate vicinity. It contains such typical Galena fossils as *Receptaculites Oweni*, *Maclurea Manitobensis*, *Orthoceras*, with large beaded siphuncle, *Bumastes Trentonensis* and *Cheirurus pleurexanthemus*. Among these names of rock are also a few boulders of soft yellow fossiliferous sandstone, containing, besides some of the species of fossils mentioned above, an apparently undescribed species of *Bellerophon*. The surface of the limestone is well smoothed, and scored by glacial grooves and striae pointing S. 17° W., many of the grooves being crossed by curved transverse fractures opening southward. Fossils.

On the north shore of Namew lake, at a point four miles west of the mouth of Sturgeon-weir river, the rock is a white or salmon-coloured fine-grained thick-bedded limestone of Trenton age. Dr. Whiteaves has furnished the following list of fossils obtained from it :—*Leptaena*, like *L. unicostata*, *Plectambonites sericea*, *Dinobolus parvus?* *Cyrtodonta* sp., fragments of three species of Lamellibranchs, *Liospira* sp., *Murchisonia* or *Loxonema* sp., *Trochonema* or *Pleurotomaria* sp., and a *Gyroceras*, which is very much like *G. submamillatum* of the Devonian of the adjoining area to the south.

Goose and Grass Rivers.

Goose and Grass rivers together form an almost complete water communication between the Saskatchewan and the Nelson rivers, broken only by Cranberry portage, which is rather less than a mile and a half in length, the former discharging into Sturgeon river a short distance above Namew lake and the latter into Nelson river, a short distance above Split lake. Three miles above the mouth of Sturgeon river, Goose river joins it from the east. For two miles and a half this stream is from fifty to sixty yards wide and has sloping clayey banks ten feet high, which rise to a clay plain wooded with poplar and a little spruce. Above this quiet part of the river is a long rapid full of boulders, overlying a bed of limestone, past which is a portage half a mile long on the north-west bank, over level clayey ground through woods of small poplar. Goose and Grass rivers.

For three miles above the portage the river is a series of shallow rapids over a bed of limestone, and then for another three miles to the south end of Goose lake, it is wide with marshy banks that extend back to low land covered with a forest of poplar.

Goose lake.

Goose lake lies in a bay in the edge of the limestone along the contact of the unaltered Palæozoic limestone or sandstone with the highly altered Archæan gneisses and schists. The west shore, along which we travelled, is low at the south end, but towards the north it gradually rises until it forms a high steep limestone escarpment overlooking the lake. This escarpment is immediately underlain by gneiss, and from its base long low points of gneiss extend towards the north-east, beyond which are low rocky islands. One of these islands towards the north end of the lake was found to be a fine-grained dark-gray hornblendic gneiss striking S. 75° W. and with vertical dip. Its surface is well smoothed and marked by glacial striæ pointing S. 35° W. In the stream coming from Athapapuskow lake, at the lower rapid, is a light gray rather fine-grained gneiss striking S. 30° E., 60° N., while the upper ones are over a massive dark-gray rather coarse quartz-mica diorite, consisting of hornblende showing pale interior, suggestive of alteration from augite, biotite, considerably bleached, rather fresh plagioclase and orthoclase, the former being rather more abundant, much epidote derived from the decomposition of the bisilicates, quartz very much broken up and filling many of the irregular spaces between the other minerals. Above the rapids the river has low clay banks wooded to the water's edge, and flows quietly over a bed of sand or boulders.

Athapapuskow lake.

Athapapuskow lake, from which Goose river flows, is an elongated oval body of beautifully clear transparent water, lying in a general north-easterly and south-westerly direction. The shores and islands in the north-eastern portion of the lake consist of green Huronian schists and fine-grained massive gabbro. About five miles south-west of the head of the river this greenstone is overlain by Trenton limestone, which soon forms a low escarpment a short distance back from the beach. The southern end of the lake and most of its north-western shore were not visited. On the south-eastern shore considerable areas are covered with large white spruce. At a low sandy spot overshadowed with tall white spruce trees near the north-east end of Athapapuskow lake, Cranberry portage begins, and from there it runs in a general north-easterly direction for a mile and a third, to the south end of Cranberry lake, crossing the watershed between the streams flowing southward to the Saskatchewan and those flowing northward to the Nelson.

White spruce.

The portage is over an almost level plain of light-gray clay or reddish sand, wooded respectively with small poplar and Banksian pine, beneath which the ground is covered with bearberries (*Arctosta-*

phylos Uva-ursi), blueberries (*Vaccinium*), and cranberries (*Vaccinium Vitis-Idæa*). Towards the north end of the portage some boulders are scattered over the surface, and some low bosses of green Huronian schist rise through the overlying clay. The lakes at both ends of the portage have about the same level. East of the portage there seemed to be a shallow dry channel connecting the two lakes.

The Cranberry lakes form an irregular body of water broken by two narrow straits and indented by deep bays. At the southern end the shores are generally low, but they become higher and more rocky towards the north. Almost all the surrounding country has been swept by fire, but many of the islands are still wooded with white spruce of fair size. Cranberry lakes.

At the north end of Cranberry portage there is a low knoll of light-green chloritic schist, rather irregularly foliated, but generally striking about N. 35° E. The southern and eastern shores south of the first strait are mostly composed of similar green schist, but a mile east of the portage is a low cliff of reddish nodular Trenton sandstone, overlain by nodular Trenton limestone, while a mile and a quarter further east low cliffs of similar limestone skirt the edge of the water. At the first narrows a rounded hill, probably of green schist, runs on the west side, while opposite it on the east side, is a rather high bluff of horizontally stratified limestone. For the next two miles the south-eastern shore is underlain by green chlorite and silvery sericitic schists, and then these schists are overlain by light-gray horizontally stratified Trenton limestone rising into high bare rocky cliffs. Cliffs of Trenton limestone.

The remaining portion of the eastern shore up to the second strait, is composed of a massive medium-grained reddish intrusive granite, while most of the islands are composed of schist. Near the contact the granite often contains angular inclusions of the schist.

At the second strait the rock is a green schist, similar to that seen further south. Just north of the strait a sandy terrace, fifteen feet above the water is a conspicuous feature along the shore. The rocks seen around the most northerly expansion of the lake were all green Huronian schists or slates, very similar to those further south. The level surfaces are strongly marked by glacial striæ running S. 28° W.

From the northern end of the lake the river winds through an extensive marsh in the bottom of a wide valley. On the western side of this valley is a rather bare red granite while the eastern side is a ridge of green slaty chloritic schist or greywacke with a general north-and-south strike. Most of the rocky knolls that rise through the marsh in the bottom of the valley seem to be also composed of this schist, traversed by wide dykes generally parallel with the foliation of the schist, of medium-grained light-gray porphyritic gabbro.

Boulders are scattered rather freely over the southern slopes of some of the hills, but there is little clay except in the bottoms of the valleys.

Elbow lake.

Elbow lake is simply a very irregular set of long lanes of water, stretching out between the rocky ridges, where the granite or gneiss closes in on both sides of the green schist. At one high point on the west shore of the lake the green chloritic schist has a strongly marked slaty cleavage striking N. 5° W. At Elbow lake the river turns abruptly southward, and for several miles runs along the east side of the same rocky ridge to the west of which is the valley of that portion of the river just described. Four miles down this portion of the river is a rapid with a descent of fifteen feet, past which is a portage one hundred and sixty yards long on the west bank, over a light-green chloritic and epidotic schist or greywacke, cut by wide veins of white quartz. To the east are rounded hills of greenish, red-weathering hornblende gneiss, with vertical dip, and striking east-and-west, and the river lies in the valley along the line of contact between these two rocks.

Schist cut by quartz veins.

At the next rapid, a few hundred yards further down the stream, the schist is cut by a large number of veins of white quartz, most of which are studded with crystals of pyrite. Three-quarters of a mile lower down stream is another rapid with a descent of six feet, behind which is a rocky hill of light-green massive gabbro with well marked concretionary striation. It runs in ridges trending N. 35° E. The surrounding country is now exceedingly rugged and barren, and the rocky hills are either bare or are sparsely covered with stunted poplar or Banksian pine.

Three miles further down the river the bare hills were found to be of a fine-grained squeezed diabase with slaty structure, with vertical dip and striking N. 35° E, cut by many quartz veins. Two miles further is a little rapid between the steep banks of coarse massive diorite. A mile below this rapid the river opens out into a small lake, just below which it strikes against the foot of the limestone escarpment. The escarpment is here sixty feet high, and for the upper twenty-five feet at least is composed of a white or light-yellowish, compact, semi-crystalline limestone in thick horizontal bed. It is doubtless of Trenton age, but I could not find any fossils, except a few obscure fragments of crinoid stems. The sloping face of the escarpment is densely wooded, and the rock in most places is covered by a deep coating of moss. The surfaces facing the north are all well rounded. Along the coast of the escarpment, and extending back from fifty to one hundred yards, is a low moraine ridge from six to eight feet high of rounded boulders of Archæan rock, chiefly granite and gneiss, derived from the lower area to the north, and had it been a beach it would most undoubtedly have been formed largely of boulders and pebbles from the underlying limestone. It would clearly seem to have been formed when the front of the Keewatin glacier rested against the face of the escarpment. South of the moraine is a level, almost bare surface of limestone, thinly wooded with stunted Banksian pine. Moraine ridge.

For the next eight miles the river flows eastward, within sight of the limestone escarpment, until it empties into the west end of Reed lake. For four miles of this distance the underlying rock is a light-greenish, rather fine-grained crushed hornblende granite, consisting of quartz, orthoclase, plagioclase, hornblende, altered to chlorite, epidote, zoisite and calcite, with a northerly or north-easterly strike, below which any rock seen was massive green diabase.

Reed lake. Reed lake is a large body of clear water lying along the line of contact of the horizontal Trenton limestones to the south, and the highly altered Archæan rocks to the north. The shores are generally rocky, though here and there are long stretches of sandy beach, while some of the adjoining low land is covered with clay. The surrounding forests are mostly of poplar, but there are some good groves of fine large spruce up to twenty-five inches in diameter. Trout and white-fish are said to abound in the lake. The south shore of the lake and the adjoining islands were also examined, and the rock seen, other than the limestone, consisted chiefly of a fine-grained diabase or a fine-grained chloritic-epidote schist or greywacke. Towards the north-eastern end of the lake these rocks are replaced by a red and green hornblende gneiss, more or less definitely foliated about N. 60° E. A mile down the river below Reed lake is a rapid with a descent of three feet over a point of soft gray clay. The rapid is over a ridge of massive reddish granite.

This granite extends down the river for nearly half a mile to the next rapid in latitude 54° 38′ 30″ where it is succeeded by a coarse red and green quartz gabbro, which comes in vertical contact with a massive dark-green gabbro, the line of contact running N. 85° E.

Close to the contact the latter is altered into a chloritic schist, which is cut by veins and irregular masses of white quartz. Four other rapids occur in quick succession, and all are over the dark-green coarse gabbro. Then for three-quarters of a mile the river flows between level clay banks, after which the gabbro outcrops for about half a mile as far as a little rapid.

Below this rapid the stream winds for nearly two miles between low reedy banks, until it falls over a ridge of gray granite into the west side of a long narrow lake. This lake is about fourteen miles long, extending N. 35° E. from the foot of the limestone escarpment. As far as seen it occupies the valley along the line of contact between massive granite and clastic Huronian schists, thus holding a position somewhat similar to the valley of Grass river above and below Elbow lake. East-north-eastward from the rapid at the discharge of the river, on the eastern shore, is a point composed of green slate conglomerate, containing many small irregular pebbles of similar green rock with others well rounded of granite, jasper, etc. The beds strike N. 30° E. 70° E. In irregular contact with the conglomerate is a fine-grained red thinly foliated quartzose rock, the foliation being parallel to that of the conglomerate. However, it runs very irregularly into the conglomerate, sending arms into it and inclosing or almost inclosing masses of it.

Lake occupies valley along line of contact.

Quartz-porphyry.

A mile further north-eastward, on the same shore, is a low rounded point of a massive red and green rather coarse quartz-porphyry having a fine-grained microcrystalline groundmass composed chiefly of felspar coloured by particles of iron ore, inclosing rounded grains of quartz, which are much crowded and penetrated by tongues of the matrix, plagioclase in large crystals much decomposed and fractured, the lines of fracture being marked by little strings of epidote, while the surfaces of the crystals are much corroded, small sharply defined crystals of colourless pyroxene, irregular areas or amygdules composed of aggregations of the following minerals: ilmenite altering to leucoxene, chlorite, calcite, zoisite and epidote. A third of a mile further in the same direction is a small island of hard dark-green chloritic schist, or greywacke, while the opposite point on the west shore is of lightly foliated red granite. North-east of this island is the widest and clearest part of the lake. A landing was made at but one place on its eastern shore, and there the rock was a fine-grained light-green agglomerate or slate conglomerate, the pebbles being of very much the same character as the matrix associated with a fine quartz porphyry somewhat similar to that described above, though the phenocrysts are smaller and composed almost entirely of corroded crystals of quartz and felspar. It also contains a large quantity of mispickel. North-east of this point the east shore was seen to be all composed of this agglomerate, either schistose or massive, while the opposite shore was of massive medium-grained red granite. At its north-eastern end the long lake or wide river expands into an oval sheet of water about a mile in diameter, the northern side of which is formed by high bare rounded hills of granite, while most of those on the south-east side appear to be of similar character. An island near the south side of the lake is composed of fine-grained greywacke, highly charged with pyrites, the surface being in places weathered to a rusty porous mass. Mispickel.

From the eastern side of this little lake the river flows with moderate current, between granite hills for three-quarters of a mile, and then it leaves the granite and for another three quarters of a mile to Wekusko falls flows over a country underlain by a fine-grained green schist, probably a squeezed and altered gabbro, though the surface is generally overlain by a thin coating of clay.

Wekusko falls have a total descent of forty-five feet, over green altered gabbro. Wekusko lake, which extends eastwards from the foot of the falls, is a beautiful expanse of moderately clear water with bold rocky shores. At its southern end the escarpment of Trenton rocks rises to a height of fifty feet. The upper twenty-five feet of this escarpment consists of mottled salmon-coloured and yellow Trenton limestone, weathering to a light red, heavily and horizontally bedded. It is very much fractured along numerons jointage planes, and large angular masses have slid forward or have pulled down the face of the cliff, so that the limestone is evidently underlain by a more friable layer, doubtless the basal sandstone. Wekusko lake.

Fossils are scarce and badly preserved, but the following were collected or recognized in place:—*Receptaculites Oweni*, small crinoid stems, *Columnaria alveolata*, *Palaeophyllum rugosum*, *Calapœcia Canadensis*, *Stictopora acuta*, *Orthis testudinaria*, *Maclurea Manitobensis*, and a large form of *Tripteroceras Lambii*. The limestone skirts the shore for four miles, but some low points and outlying islands are composed of massive or schistose green chloritic rock, probably a squeezed and highly altered diabase. The schistose portions are more or less vertical and strike northwards. On the eastern shore of the lake for four miles north of the limestone escarpment, the points and adjoining islands consist of similar green chloritic schist cut by many quartz veins, behind which is a massive even-grained red granite, that occa- Fossils.

sionally shows traces of foliation near the line of contact with the schist. North of this for seven miles this shore was not examined.

On the western shore north of the limestone escarpment is a terrace twenty feet high, of sand and boulders, from beneath which crop out low bosses of chloritic and sericitic schist. A mile and a half from the limestone the schist comes in contact with a massive rather fine-grained diorite. Close to the contact the diorite contains such a large number of angular fragments of schist as to give it a definitely schistose character. From there northward to the next deep bay the shore is composed of bold cliffs from twenty to fifty feet high, of massive diorite, consisting of plagioclase in large amount, hornblende, a light-green variety, very slightly pleochroic; a few scales of biotite in which is included a small amount of iron ore; the principal jointage planes always dipping towards the lake at a high angle. In places the diorite is highly charged with pyrite.

North of the deep bay the shore is not so high and in many places the twenty feet clay terrace is quite clearly defined. On the lee sides of the rocky hills there is often a little till, consisting of a mixture of sand and clay. The rock is generally a compact. much jointed, thinly foliated green schist.

Contact forms northern terminations of granite mass.

This schist extends northward along the shore, past the mouth of Grass river, to the mouth of Notaminihewi or Berry-hunting river, where it comes in vertical contact with a massive coarse-grained red hornblende granite. Along the line of contact the schist is baked into a very hard light-gray quartzitic schist. This would seem to be the northern termination of the granite mass that has been described as extending for a considerable distance along the west side of Grass river. Here glacial striæ may be distinctly seen running S. 15° W. North-eastward from Berry river for five miles down the shore, the rock seems to be everywhere either an altered schistose diabase, or a fine-grained green clastic schist or greywacke.

The islands in the bay off the mouth of Wekusko brook seem to be of altered diabase, while the points on the adjoining east shore are composed of a fine-grained slightly foliated rock, probably an altered diabase or feldspathic sandstone. Off Wekusko point are some small islands apparently on the line of a dyke of coarse diabase, while the shore is composed of a light-green chloritic schist. Two miles east of Wekusko point, where the lake contracts to half a mile in width, the shore is composed of a dark-gray staurolite schist, with vertical dip and striking N. 45° E. Behind it are steep cliffs of coarse gabbro, approaching a diabase in structure. This gabbro contains large idiomorphic crystals of plagioclase up to about two inches in length with allotriomorphic crystals of plagioclase, perhaps of slightly different composition in the groundmass. On the eastern shore are steep cliffs of a schistose or massive dark-green squeezed diabase.

For three miles and a half north-eastward, the coarse porphyritic gabbro continues to form a steep bare cliff along the north-western shore, while at the foot of the cliff the staurolite schist may be seen here and there near the edge of the water. In places near the contact of these two rocks, fragments of the schist are included in the gabbro, showing clearly the irruptive nature of the contact. Irruptive nature of contact evident.

The cliff of coarse gabbro then recedes from the west shore, and a sandy terrace takes its place. The low points and islands are of staurolite schist cut by wide dykes of coarse red and white pegmatitic granite. At one point the red granite was found to contain large crystals of tourmaline and muscovite, and a considerable quantity of arsenical pyrites.

Nine miles below the main body of Wekusko lake are several small houses on the east shore, where some families of Indians usually pass the winter. Behind this winter village is a steep ridge one hundred and twenty feet high, consisting of thinly foliated gray micaceous gneiss striking N. 45° E. and dipping more or less vertically. It is cut by many irregular veins of white quartz, and by wide veins, running nearly along the strike of the gneiss of a coarse white or reddish granite, containing large idiomorphic crystals of orthoclase, and also crystals of white and black mica.

The surface on the summit of this ridge is scored by parallel glacial grooves running S. 18° W. All the hollows on the summits are filled with soft brownish clay. The thinly foliated micaceous, often staurolitic, schist, seemed to strike N.N.E. down the middle of the straight valley occupied by the river, but its exact relationship to the surrounding gneiss was not determined.

At the mouth of Wuskatasko (or Carrot) creek, Grass river turns sharply eastward for two miles, measured in a straight line, passing through a low ridge of evenly foliated gray gneiss striking N. 15° E., 40° E. At the end of the two miles the river strikes the foot of a high bare ridge of thinly foliated fine-grained biotite schist, with crystals of staurolite striking N. 30° E., 75° E. It is not improbable that this ridge of schist forms the eastern side of an anticlinal fold, and that the band of schist followed a short distance further up the Anticlinal fold.

river forms its western side, while the central portion overlying the gneiss has been denuded away. Where the river breaks through this ridge of schist it forms three heavy rapids, past the upper two of which are portages, respectively ninety and seventy yards in length.

Below these rapids the banks for a mile and a half are formed of a more or less open terrace from ten to fifteen feet above the water. Then the river turns sharply and flows for five miles southward on the east side of a high ridge of dark-green schist, probably altered diabase. From the foot of the ridge it swings round again in an easy curve towards the north-east, passing some hills of dark-green highly altered diabase which rise in the middle of a wooded valley.

River leaves Huronian area.

At or near these hills the river leaves the Huronian area, through which it has flowed all the way from its source, and enters a country of lower surface contour, underlain by Laurentian granites and gneiss, though these rocks are usually hidden by stratified Lake Agassiz clays. From the bend the river winds between low reedy clay banks for seven miles to a series of three rapids with descents of twelve, fifteen and eight feet respectively, over gray or reddish gneiss with a strike N. 50° E., and a dip approaching more or less nearly to the vertical. The second and third of these rapids are known to the Indians as Kanisota (or the Two) rapids.

For ten miles below Kanisota rapids, the river has a gentle current and flows between sloping banks of light-gray clay wooded with white and black spruce and Banksian pine. The surrounding country seemed to be a level clay plain, more or less completely covered with swamp.

At Wapikwachew (or White Forest) rapid is a barrier of medium-grained light-gray garnetiferous granite, and a similar, though lighter coloured granite again outcrops at Stickago (Skunk) rapid, three miles and a half further down the stream. The surface of the rock here is strongly marked by striæ and grooves of the Keewatin glacier trending S. 40° W. A mile and a half down stream is Wapichtigow (Whitewood) falls, one of the highest on the river, where the water tumbles forty feet over a ridge of evenly foliated dark-gray hornblende gneiss striking N. 5° E. and with vertical dip. In places the gneiss is highly garnetiferous, some of the garnets being very clear and bright. The general surface of the gneiss is strongly scored by striæ of the Keewatin glacier trending S. 42° W., but some of the more prominent faces sloping eastward show the later grooves and striæ of the Labradorian glacier trending S. 88° W., clearly marking a point near the extreme western limit of this latter glacier.

Western limit of Labradorian glacier.

For three miles further to the mouth of Metishto river, the river continues to flow with decreasing current which is interrupted by two slight rapids over reddish or gray gneiss. Metishto (Sweat tent) river is stated to rise within a short distance of the north-west arm of Moose lake, and to flow northward with a gentle current to within a few miles of Wekusko lake, below which it is a narrow rapid stream difficult to navigate with canoes. From here to Setting lake, Grass river is wide and currentless with greenish milky water. A short distance below the mouth of Metishto river it crosses the end of Metishto lake, which has rocky shores, and then it continues north-north-eastward for seven miles in a straight valley a quarter of a mile wide between wooded ridges of gneiss, the banks of the channel being everywhere low and marshy. It then turns eastward and cuts across the north end of Pakwahigan lake. Where the river leaves this lake is a low rocky point composed of gray regularly foliated gneiss striking N. 50° E., and with vertical dip. Some of the thicker bands are cut by veins of red pegmatite in which are large crystals of hematite. The surface is generally scored by grooves of the Labradorian glacier running S. 83° W.

Metishto river.

A similar gneiss, but striking N. 15° E. outcrops at the point of discharge of the river into Setting lake.

Setting lake, or as it is locally known John Scotts' lake, is a long and comparatively narrow body of light-brownish water, extending in a north-easterly and south-westerly direction. Its south-western end was not examined. The widest portion of its northern end is divided longitudinally by a chain of gneissic islands. The shores are for the most part composed of a beach of smooth grey gneiss striking with the long axis of the lake, overlain by a few feet of clay, which is wooded with a forest of small poplar or spruce and larch, much of which has been destroyed by fire.

Setting lake.

Near the end of a long point on a sandy delta-like terrace, ten feet above the water, stands an old double chimney of mud and stones, still in a very perfect condition, marking the site of an old fur-trading post or station. The rest of the house or houses have entirely disappeared and the site is completely overgrown with large spruce trees, quite indistinguishable from those of the surrounding forest. In many other instances the sites of the ancient fur-trading posts could be recognized as small, usually rectangular, poplar covered areas, in the midst or on the border of the adjoining forest.

Site of old fur-trading post.

About north latitude 55° 9′ Grass river flows out of the north-east end of Setting lake over Sasagiu (or Golden Eagle) rapid, which has a descent of twelve feet. The rock is a reddish-gray gneiss striking N. 15° E. and dipping N. 75° W. at an angle of 30°. Below this rapid the river opens into another small lake four miles long, the western shore of which is composed of vertical thinly foliated dark-gray hornblende gneiss, interfoliated with bands of medium-grained white granite. At the foot of the lake is Pisew or Lynx falls, with a descent of fifty feet, first over an abrupt fall and afterwards down a steep broken rapid in a narrow rocky channel.

Below Pisew falls the river flows in a very direct course north-northeastward for twenty-three miles to the south end of Paint or Nanuminan lake, though for most of the distance it is without appreciable current. Generally speaking, it follows the strike of the gneiss except at the rapids where it crosses ridges of gneiss. Its banks usually rise in gently rounded slopes to heights of about a hundred feet, and consist of rocky ridges of gneiss covered with a thin coating of soft brownish clay without pebbles or boulders. The summits and sides of these hills are generally wooded with small poplar, but through the poplar and down close to the bank of the stream are some scattered groves of large white spruce.

On the shores of Setting lake and along the banks of the river below it, the surface of the gneiss has been well-smoothed, and is generally scored by grooves and striae of the Labradorian glacier trending a few degrees south of west, but in a few protected localities striae of the Keewatin glacier were also found trending S. 41°—44° W.

Modelled by D. B. Dowling.

PHOTO OF RELIEF MAP.

To show general features of area described in reports.

GEOLOGICAL SURVEY OF CANADA

ROBERT BELL, M.D., Sc.D. (Cantab), LL.D., F.R.S.

REPORT

ON

GEOLOGICAL EXPLORATIONS

IN

ATHABASKA, SASKATCHEWAN AND KEEWATIN DISTRICTS

INCLUDING

MOOSE LAKE AND THE ROUTE FROM CUMBERLAND LAKE TO THE CHURCHILL RIVER, AND THE UPPER PARTS OF BURNTWOOD AND GRASS RIVERS

BY

D. B. Dowling, B.A. Sc.

OTTAWA

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

1902

13—FF. No. 787.

To Dr. ROBERT BELL,

Acting Director, Geological Survey of Canada.

SIR,—I have the honour to present the inclosed report on a portion of the eastern part of the District of Saskatchewan and parts of the Districts of Athabaska and Keewatin.

The descriptions of the eastern part of these districts is to be found in the accompanying report by Mr. J. B. Tyrrell, and the part for which descriptions are here given is in a general way the western and southern part of the area shown on the accompanying map.

Mr. Tyrrell's report was accompanied by tracings of his surveys, but in order to make a map which would extend as far west as does the sheet to the south of it describing the geology of north-western Manitoba, additional surveys were undertaken, but the limited time at my disposal in the field (less than three months) did not enable me to visit all the localities which seemed of interest.

To illustrate this report and also that by Mr. Tyrrell, I have compiled the accompanying map on a scale of eight miles to an inch, showing the whole area described in both reports. For much of the information shown on the eastern portion, I was obliged to consult Mr. Tyrrell's note-books, but the geology of the country east of the Nelson river is entirely from Dr. Bell's reports.

I have the honour to be, Sir,

Your obedient servant,

D. B. DOWLING.

OTTAWA, February, 1902.

NOTE.—*The bearings throughout this report are given with reference to the true meridian. The variation of the magnetic needle in the vicinity of Lake Winnipeg is 16° E. This is found to increase toward the north-west and is on Kississing river about 19° and on the Churchill river 20° E.*

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INTRODUCTION.

Early Maps and Surveys.

The early mapping of the northern part of the area which is shown on the accompanying sheet, is no doubt due to the labours of David Thompson, while in the service of the Hudson's Bay Co. His travels, as recorded in "A Brief Narrative of the Journeys of David Thompson," by J. B. Tyrrell,* were commenced in 1799, when he was in his twentieth year. He made carefully estimated traverses of all the routes passed over in his journeys, and also checked them by latitude observations. It may be interesting to follow the record of his journeys in this district. In 1792 he left York Factory and ascended the Nelson river to Sipiwesk lake to spend the winter. On May 28, 1793, he left Sipiwesk House and crossed to Chatham House on Chatham lake, which he places in latitude 55° 23′ 40″, and longitude 97° 44′ 34″ W. This is, no doubt, a point on what is now called Wintering lake. On May 31 he left this place and travelled in a westerly direction to Burntwood river, up which he went to Burntwood lake, and from the western end he crossed to the Missinippi or Churchill river, which he

Reference to David Thompson's work.

*Proceedings of the Canadian Institute, 1887-88, 3rd Series, Vol. VI., p. 135.

ascended to Duck or Sisipuk lake, from which he returned and journeyed back to York Factory. In the spring of 1794 he appeared at Buckingham House, on the Saskatchewan river, above Fort Pitt.

Surveys made by him.

From there he made a survey of the Saskatchewan river as far as Cumberland House, and thence of a route east to York Factory, by which he followed up and surveyed Goose river and lake, and Athapapuskow lake, then crossing Cranberry portage he followed the Grass river to Reed lake. Here he left one of his associates, a Mr. Ross, probably to build a house, and then proceeded by File lake and the Burntwood river to York Factory. He returned in the autumn to Reed lake to spend the winter at the new house, which he placed in lat. 55° 40′ 36″ N., long. 102° 7′ 37″ N. His meteorological register shows that he remained there till May 1797. Shortly after this he transferred his services to the North West Company and moved to a western field of action. In 1804 he again appeared in this district, to build a house at the narrows of Cranberry lake. He wintered at Granville lake, on Churchilll river, and in the spring of 1804 he retraced his steps to Cumberland House. Several minor trips were made to Cranberry lake and one to Reindeer lake in the north, before he went west to cross the mountains.

Compilation of map.

The various surveys made by Thompson were compiled by him in 1814 to form a map of the North-west Territories. The original of this is now in the Crown Lands office, Toronto. This formed for many years the basis for much of the geographic detail of our general maps, but it is now being superseded by the more accurate surveys.

Later Explorations.

Later explorations.

In 1878 Dr. R. Bell commenced explorations in the valley of the Nelson river and in the next two years the Nelson river, the lower part of the Grass river and parts of the Churchill and Little Churchill rivers. Mr. A. S. Cochrane, in 1880, surveyed the Minago river and part of the Saskatchewan from Moose lake to Cumberland House.

The principal instrumental survey through this district was that of the Saskatchewan and Nelson rivers, made in 1884 by Mr. O. J. Klotz, D.T.S.

The exploration by Mr. J. B. Tyrrell, in the summer of 1896, consisted of traverses of several channels of Nelson river and small streams tributary to it on the west side, the waters of Grass river from Cranberry lake to Paint lake, part of Burntwood river from

Three Point lake to the mouth of Manasan river, Goose river and lake and a traverse of part of the shore of Athapapuskow lake.

In the summer of 1899, the writer made traverses of the upper part of Burntwood river from Three Point lake to its head near Reed lake. Kississing river was also explored by following a route from the north end of Athapapuskow lake to its mouth on Churchill river. The latter stream was also surveyed from above Sisipuk lake, shown on the western edge of the accompanying map, eastward to the end of a long arm running from Nelson lake. In the southern part of the district traverses were made of several lakes to the west of Moose lake as well as the western part of this latter lake, all of which had not been delineated on any of the former published maps.

The series of surveys made by the later parties were in the nature of preliminary traverses, but were done with considerable detail.

General Description.

General description of country.

The general nature of the country shows a rather low relief. The difference in level between the higher part of the upland surrounding Cold lake and the lower portion of the Nelson valley in the vicinity of Sipiwesk lake, is but slightly over 500 feet.

The most noticeable range of hills is that which crosses the Saskatchewan river at The Pas. This ridge is mainly of glacial origin and is from twenty up to ninety feet high, but situated as it is in a flat country, it forms a very prominent feature. The escarpment formed by the outcrop of the Palæozoic limestones along the southern edge of the valley of the upper part of the Grass river, is another prominent feature. This is in the form of a nearly continuous cliff fifty or sixty feet high facing generally to the north. An eastern face of this escarpment may be seen on Lake Winnipeg, from which it probably continues north.

Division of area.

The area described in these reports and illustrated on the accompanying map is divided naturally into three distinct parts. The largest in area is probably the plateau, which is underlaid by the nearly horizontal limestones of the Palæozoic. Next in importance is the broad valley of the Nelson river and its tributaries. To the west of this is a higher, rough, rocky tract extending west from the outlet of Burntwood lake. In the part underlain by limestone the surface features are very similar to those obtaining in the lake region to the south, but in the depression occupied by the Saskatchewan river and the lakes through which it passes, the change brought about by the gradual filling up of the channel by detritus, is a marked feature. In the early history of the river, several lakes were situated along this channel. The ridge crossing the valley at The Pas, at one time held back a large lake, and in this was accumulated a thick deposit of sediment, but as the outlet across the ridge was worn down, the lake disappeared. The river channel across this basin is built apparently above the flood plain. The land on either side is raised but little above the bed of the river channel, and so is subject to periodic inundations. In the country which formed the shore of this lake, it is generally found that limestone beds are not far below the surface, being covered by a light deposit of boulder clay and the lacustrine silt which supports a growth of spruce and poplar.

Old lake basin.

The basin of Moose lake is apparently the remains of a larger one, the southern end of which has been silted up by the river, and through the plain so formed the latter now winds in several crooked channels. The present outlet for the water of Moose and Cedar lakes is by the channel which reaches Lake Winnipeg at the Grand Rapids. There seems, however, to be a possibility of there having been an earlier outlet to the north-east from Moose lake by the channel of Minago river.

East of the outlets of Reed and Burntwood lakes the surface of the country slopes gradually to the east to Nelson river, while beyond that again there is a slight rise to the south-east, forming in this manner a wide though shallow valley or depression running north-east and south-west. This depression is probably continued under the Palæozoic limestones to the south-west. It is quite possible that the limestone beds formerly extended through this shallow depression and joined those bordering the west and south sides of Hudson bay. From the Nelson river westward, the rock, mainly gneisses, are buried beneath a thickness of from ten to one hundred feet of soft gray stratified clay. This clay has rarely been deposited in sufficient thickness to level up the original inequalities of the underlying rocky floor.

Rocks covered by stratified clay.

West of this clay-covered country of the Nelson valley, the underlying rocks emerge at a slightly higher level than in the rest of the district, and form a plateau with rough surface partly barren and unattractive in appearance. The surface deposits are meagre, being limited to a thin sheet of till and occasionally sandy beds in the lake basins.

In the valley of Churchill river a narrow strip of clay is found on which there is a fairly luxuriant growth of small timber. The central and higher parts of the area are nearly barren, but where covered by forest growth it is found to consist of stunted Banksian pine. The general level of this rocky district is over 900 feet above tide, and the greatest elevations above this amount are not over 150 feet. The hills bordering the valley of the Churchill river may, in some cases exceed this, but their greater relative height is mainly due to the great denudation along the line represented by the valley of the above river and again along that of Burntwood lake.

General Geology.

Laurentian.

Laurentian

This term as applied to rocks in Eastern Canada has been given significance as a formational term and the rocks comprising it are thought to form an older series on which the Huronian or earliest sedimentaries rest. Throughout the central part of the continent all the rocks in the Archæan complex, which do not belong to the earliest sediments, are found to have been subjected to such metamorphism, that in the writer's opinion it is impossible to definitely assert at present that any of the various gneisses or schists met with are older than the Huronian, though many bands might be considered to be altered equivalents. In a few instances, between the rocks classed as Huronian and the surrounding granites and gneisses the contact is igneous, and shows granites and gneisses to have been in a state of partial fusion at the time of the folding and crumpling of these rocks.

In the district under discussion it is impossible to map out, under the conditions of a reconnaissance survey these newer gneisses from any that might be supposed to be older. The rocks therefore described and mapped as Laurentian are a series of gneisses composed in part of highly metamorphosed material in close relation with granites and gneisses whose age the writer supposes to be younger than either the series of gneisses noted above or the Huronian.

Extensive denudation.

The original crust of the earth, after its great crumpling and folding subsequent to the deposition of the Huronian sediments, suffered such extensive denudation that the rocks now exposed can be considered as a horizontal section of the crust at a considerable distance below the original surface. The present areas of Huronian are thus the lower parts of such deep folds as penetrated to this level through the harder crust. It may be supposed that the lines on which the greatest movement would take place would be over such areas as might be still in a semi-plastic condition, and the lower parts of these folds might penetrate areas of uncongealed matter which would digest and remove much of their lower members. The subsequent denudation would reveal at successive depths a lessening amount of the original crust and so it is problematical if any of the original upper beds are to be seen in this area.

In the eastern area, reported on by Mr. Tyrrell, the contacts are more nearly conformable and might indicate that their original relation had not been disturbed in the subsequent alteration to which both had been subject. In the western part of the district there is a marked difference between the gneisses of the area lying north of Athapapuskow lake, reaching to near the Churchill river, and those with which they come in contact in the vicinity of the valley of this stream. In going north the first rock met with after leaving the Huronian area is a granite that gradually becomes foliated and appears as if it might be newer than the Huronian. On reaching the vicinity of the Churchill river an apparently older series is noted, which in some instances is separated from the rocks to the south by wide dykes or areas of an eruptive granite of the nature of pegmatite. Beyond this zone of intrusion there are broad bands of mica schist, garnet-bearing schists and dark gneisses which are a contrast to the generally reddish granitic gneiss to the south.

Huronian.

Huronian.

To the west of Lake Superior the areas which have been referred to the Huronian and of which detailed studies have been made are those on the Lake of the Woods. As the typical section could not be exactly correlated, the group described by Dr. Lawson was called by him the Keewatin, and a lower and more highly altered part, the Couchiching, but it is generally accepted that these constitute in the west rocks representative of the Huronian. The small areas of similar rocks found to the north are thus classed as of the same general series, and evidence is not wanting that many of the beds composing their mass have a clastic origin.

In the eastern part, as will be seen from Mr. Tyrrell's report, clastic rocks, such as quartzites and conglomerates, are associated with basic eruptives and greenstones whose origin is volcanic. Parts of the areas to the west are described in the present report and the same character is found as in the rocks to the east, or in the Nelson valley.

Cambro-Silurian.

The outcrop of these rocks along the western shore of Lake Winnipeg is continued northward and then westward, passing to the south of the chain of lakes on the upper waters of the Grass river. In the southern part of the Lake Winnipeg basin the section gives a thickness of about 270 feet of limestone belonging to the Trenton, but in following the escarpment northward the beds thin out and the lower members disappear. The basal member, a sandstone which rests upon the Archæan, appears on the shore of Reed lake, but it is evidently an equivalent of higher horizon than farther south and is immediately below beds which on Lake Winnipeg are called the Upper Mottled. The section on Reed lake is described by Mr. Tyrrell. The fossils collected by him from the sandstones belong to the middle and upper part of the Trenton. A thickness of less than a hundred feet of Trenton limestone appears above these beds, and a reddish band above these is supposed to indicate a transition to the Niagara. Cambro-Silurian.

Silurian.

Undisturbed horizontal limestones of about the horizon of the Niagara were seen at several low outcrops on Namew lake to the east of Cumberland lake, as well as on Cormorant, Yawningstone and Moose lakes. On Cormorant lake the sequence observed was as follows. The lowest beds exposed are of a compact reddish dolomite, above which, five or six feet of similar beds weather very rough on the surface. A thin compact dolomite up to ten feet in thickness forms the upper member. These latter beds are shown in better exposures on Moose lake near the old Indian Reserve and on an island to the north. The exposure is in a cliff about thirty feet high showing at the base only two feet of a granular dolomitic limestone and the remainder of thick beds of a lamellar dolomite apparently of coraline formation. The rock is built up in thin plates having a crumpled surface from which many saucer-shaped pieces can be broken out. These are possibly remains of stromatoporoid corals which form the mass of the rock. No fossils were found in these beds but from a few loose fragments of a lighter and more granular rock, pushed up probably by the ice from below, the following forms were observed: Fragments of a Cyathophylloid coral like *Zaphrentis*, *Favosites*, sp., *Strophomena acanthoptera*, *Conchidium decussatum*, *Murchisonia*, two species, *Euomphalus*, sp., and *Gyroceras*, sp. These fossils are all common to the Niagara rocks Silurian. Fossils.

of the Grand Rapids of the Saskatchewan and are from rocks probably in place beneath the section given above.

The Stromatoporoid beds are also exposed along the shore of this lake southward to the outlet at the present Indian Reserve. Slightly higher beds occur near the Saskatchewan river below the "Cut-off" and north of the Moose lake branch, in which small shells like *Isochilina* or *Leperditia* are found. These fossils are very scarce and not well preserved but are sufficient to show that the rocks of Cedar lake which are rich in these forms, continue to the north-west.

Rocks probably Trenton.

On Namew lake the rocks exposed on the north side are probably Trenton but these are overlain by reddish beds and again by white hard dolomites which seem to belong to the base of the Silurian. Fossils obtained at the south end of this lake below Whitewhiley narrows, though many are of new species, show a horizon similar to the Niagara of Cedar lake. The extension of the beds north and east to near the edge of the limestone escarpment is quite probable, since on Cowan river they were followed to near the source of that stream. The eastern edge of the formation is evidently drift-covered, so that the definite outline is hard to trace and it is only in a few localities that it is observed. Westward from Cranberry lake the Trenton probably occupies a narrow band with the Silurian rocks to the south. One exposure on the middle one of the Cranberry lakes shows Trenton beds below a broad red band which is no doubt continued to Namew lake as the transitional beds, and above this again are a few beds of dolomite which are the representatives of the lower members of the Silurian.

Pleistocene.

Pleistocene.

The rocky surface of all this area is scored and polished by the progression across it of a great glacial ice-sheet and in the eastern section evidences are found of a second invasion by another sheet from the north-east. The first came from the north, a part of what is known as the Keewatin glacier. This advanced south beyond the boundaries of Manitoba, and on its retirement or when the accumulation of ice in the north ceased, there was still an active progression in the Labrador ice sheet, and its front ultimately passed the eastern border of the district already scored by the Keewatin glacier. The ice fronts of both the Keewatin and Labrador glaciers are supposed to have met in the region through which the lower courses of the Nelson and Churchill rivers now run, and as the general slope of the land is to the north, the melting of the ice formed a large lake whose western shores were along the face of the escarpment lying to the west of the present Manitoba lake basin, the north-eastern edge being formed by the mass of ice both to the east and north. This lake, of which the present lake basins are small remnants, is described in our reports as Glacial Lake Agassiz.* In the district here mapped, the accumulation of lacustrine material deposited by the waters of this temporary lake, are found in the eastern part to aggregate in some cases as much as one hundred feet in thickness of a fine clay and clayey silt. The discussion of the characters of the deposit will be found in Mr. Tyrrell's report, as well as a combined list of all the observations for the whole district relating to the directions of glacial markings. Many of the observed directions are also indicated on the accompanying map. Lacustrine deposits.

The western limit of these stratified clays is found to run southward from the outlet of Burntwood lake and enter the basin of Reed lake. To the north of this latter lake instead of a deposit of clay, a sand plain was found, on which were numerous beach ridges formed no doubt at a stage of this temporary lake. Another series of sand and gravel beach ridges were also noted at Cranberry portage. As these ridges are at a much lower elevation than those marking the maximum height of this lake, it must be supposed that the accumulation of lacustrine material was either added to the basin at a late and lower stage, or that during the high and early period this country was still ice covered, and the lake existed only in this locality at a lower level. Over the western portion the rocks are but thinly covered by a glacial till, and on the higher parts, mainly around Cold lake and in the hills near the Churchill river, there is very little covering over the rocky surface Boulders are in evidence, but mainly of gneiss and granite of nearly the same character as the underlying rocks.

Recent.

Evidence of the recent action of the rivers in forming valleys, is not well shown in the western part of the district, as the mantle of clay, or other covering over the harder rocks is there very thin and valleys consequently follow old courses, but in the eastern part many of the valleys of minor streams have formed new channels. Recent deposits in the valleys are of small amount, with the exception of the delta of the Saskatchewan river above Cedar lake. Part of this deposit may have been formed before the recession of the glacial Lake Agassiz, but it is clear that there is an enormous amount of sediment still being brought Recent changes

*Annual Report, Geol. Surv. Can., vol. IV., (N.S.) part E.

down by this stream and the largest part is deposited before the water leaves Cedar lake. From analysis of water from several of the streams in the district a comparison of the amount of sediment contained may be gathered by reference to the following table :—

One Imperial gallon contains suspended matter.

	Grains.
*Nelson River (Sea River falls)	2.565
Reindeer lake	2.02
Churchill river	7.96
Saskatchewan river (near Cumberland lake)	16.60

Peat.

Small deposits of peat are to be found in various places, but the most important, from an economic point of view, is the area north of Lake Winnipeg described by Mr. Tyrrell. Along the valley of the Burntwood river, where it is cut through the thick clay deposit, the general surface of the terrace is quite level. The drainage near the river is general, but back from the edge of the valley, on the more level parts, there is very often a wide expanse of swamp covered by a stunted growth of spruce and carpeted by heavy layers of moss. These swamps may at some future time supply peat for fuel.

Economic Resources.

Agricultural possibilities.

As the area is situated so far north of the boundary of Manitoba, it might be presumed that much of it is unfitted for settlement, but it is discovered that over a large part there is a good soil, and the evidence of several gardens at various posts show that for all the ordinary vegetables and coarser grains the climate is not too rigorous. Splendid gardens were found as far north as Nelson House, which is in the northern part of the area here mapped. Proper drainage is however needed to bring much of the surface into a condition fit for agriculture. Along the river banks this is evident, for while the strip bordering the streams produces a great variety of grasses, shrubs and trees, a short distance back this is replaced by a swamp covered by moss and stunted spruce. This is more noticeable in the western part of the Nelson valley, where the country is thickly covered by a coating of clay, and the surface is so uniformly level that its gradual slope to the east is not sufficient to drain it. The areas to which it would be possible to introduce a system of drainage, would at first be restricted to a narrow margin along the streams.

*Report of Progress, Geol. Surv. Can., 1879-80, p 79c. and 1880-82, p 6 H.

The north-west corner of the district for present purposes may be classed as without a sufficient soil for agriculture. This may roughly be outlined as being composed of all the country lying to the west of a line from the outlet of Burntwood lake to that of Reed lake, and north of the escarpment which shows the northern limit of the Trenton limestone. In this the surface is rolling and hilly, the rocky ridges having a scanty coating of boulder clay and an occasional thicker deposit in the depressions. It will probably remain the home of the hunter and the trapper. Area unsuited for agriculture.

To the south the country underlain by limestone has many of the characters of the northern part of Manitoba. In the valley of the Saskatchewan there are large areas of rich soil formed principally by the river itself which has brought down an enormous amount of silt from the upper part of its valley.

The western part of the valley of the Nelson river is covered by a thick lacustral deposit which reaches west to Burntwood lake and east to the channel of Nelson river. In this area good soil is found in almost every part and where drained would no doubt make fair farming land.

Timber.

In the southern part of the district, spruce of both the white and black species is found of fair diameter, but in going north the size materially decreases. Over the major portion of the rocky country Banksian pine is the principal tree, which though not large enough in general for timber, might in the future be of use for pulp wood. Timber.

Peat.

Reference has been already made to the deposit of peat north of Lake Winnipeg, and when a process for preparing this for fuel has been perfected this deposit may perhaps be utilized. Peat.

Minerals.

The several large areas of Huronian rocks which are here partly outlined will at some future time be thoroughly prospected, and, as has been the case in nearly all such areas, ores of the useful and precious metals are likely to be found. As it is at present a very hasty visit has shown that many quartz veins and intrusive dyke cut these rocks. and indications of the precious metals are not Minerals.

wanting. In the Pipestone area on the Nelson river, mispickel and copper-pyrites are recorded by Mr. Tyrrell, as well as a promising showing of mica on the south side of the Indian Reserve island in Cross lake.

Detailed Descriptions.

The Saskatchewan River.

Saskatchewan river.

From the foot-hills to the edge of the second prairie steppe the Saskatchewan river flows through a country underlain by soft easily disintegrated rocks and therefore it has cut a deep channel. From Nepewin to Thobin rapids the high banks gradually become lower, until below the latter point the river emerges on a low delta plain which reaches to Cedar lake. In its upper part the stream is still actively cutting in its channel, and its waters are at all times heavily charged with the denuded material. In the lower part of the delta the process is reversed and the stream becomes the active agent in filling up what seems to have been a chain of lakes. The uppermost one was probably partly filled while the higher levels of Lake Agassiz still covered this basin. On its recession to an elevation of about 900 feet in this vicinity, it is probable that there still remained a lake whose eastern margin reached to the ridge at The Pas. On the further recession of this former lake, the outlet at The Pas was slowly worn down through the boulder clay and parts of the original lake were drained. The eastern end near the outlet seems not to have been so deeply filled by river detritus. Through the plain thus formed, now winds not only the channel of the main stream, but also several other smaller ones. The course followed by the river of late years is by a channel that has been built up so high above the surrounding plain that at several points other channels have broken out and connected with streams both to the north and south. Latterly, however, one has been opened to the upper part of Cumberland lake, and now most of the water of the river passes through it, and in this way the lake acts as a new settling basin which will rapidly silt up.

Lacustrine deposit not deep.

Near The Pas ridge the depression is but partly filled and shallow lakes appear on either side of the channel. That the lacustrine deposit is not of very great depth is shown in the fact that boulder clay knolls appear as islands in Saskeram lake and also in a ridge crossing the Saskatchewan below Tearing river, on the south side of which an Indian reserve is located. In the low stage of water at the time of Mr. Klotz's survey of the river, boulders appeared at this locality and their occurrence was noted as rare for this part of the river.

The ridge, which forms the eastern boundary of the delta-filled lake above noted, is uneven on its summit and seems to be formed of morainic deposits of varying thickness heaped upon the comparatively even floor of limestone. Exposures of the underlying rocks are wanting where the river cuts through it, but farther to the north on the small island at the north end of the Indian reserve ten feet of horizontal beds are exposed. They are light coloured and, similar to those on Cormorant lake, of the Niagara horizon. On the north side of the river the ridge is higher than any part of it that is visible to the south. The Indian reserve includes the western edge and highest of an irregular hill or ridge running to the north-east. North of this and parallel to it, another ridge runs from north of Watchi lake to the south-western border of Cormorant lake. North of that again another ridge follows the western side of the valley of Cowan river. There is no doubt that south of the Saskatchewan river similar ridges combine to form a strip of high ground to join that which is north of Red Deer river. An outlying hill belonging to the same series was observed on the east side of Cormorant lake. Glacial deposits.

The lowest gap in the ridge is that at the outlet of the river. Here the stream has worn a channel of considerable depth. On the south side of the plot of ground on which the dwelling belonging to the mission stands, is an old channel, the bottom of which is now at about the level of the ordinary range of high water. The amount of erosion since the river left this channel has been considerable and I am informed that the house mentioned above has been moved three times to prevent its being undermined. Evidence of erosion.

The following extract from Mr. Otto Klotz's report of 1885 bears on the same subject: "The action of the water in the course of time is well illustrated here. Forty years ago a lad could throw a stone from the banks of the parsonage across the river where it is now fourteen chains wide. Within a few years an island upon which the Hudson's Bay Company's powder magazine was kept, has disappeared. The banks where formerly houses of the company stood (in front of the present post), have been washed away. The same fate is rapidly approaching the parsonage close by." This has since been moved.

On the western bank of this island where the banks are scarped a section of fifteen feet of till is shown. This consists of light-gray un- Section of till.

stratified clay, containing striated pebbles and boulders. The boulders are of limestone with some of Archæan gneiss and greenstone.

Land suitable for farming.

The high ground here cut through by the river extends only a short distance to the eastward of the Indian reserve and the only land available for farming has been taken up by native settlers. Back from the river-bank there is probably yet plenty of good land. The height of the ridge east from the Big Eddy is estimated by Mr. Tyrrell at seventy feet. The following description from his notes gives particulars as to its surface composition: "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 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."

Probable beach deposits.

In the interval between this ridge and the one to the north there are traces of the thirty feet terrace as well as several ridges like beach deposits. The rise is very little over thirty feet above the lake level —an abrupt slope at the beach of fifteen feet and then a gradual rise to the beach ridges on the surface. To the east the descent to Atikameg lake is very gradual and the impression is gained that the lake there is at least twenty feet above Watchi lake, but as Atikameg lake is only some twelve feet above Cormorant and Moose lakes, which are at the level of the Saskatchewan river twenty miles above Cedar lake, the difference in level of the two lakes across the ridge cannot be so large.

The hill to the west of Atikameg lake appears to be at least one hundred feet high. Along the eastern face runs what appears to be a terrace of sand and gravel with scarped banks, but as it was viewed from a distance the exact character and height could not definitely be made out. The terrace appeared at about thirty feet above the lake and probably a continuation of that at The Pas. These terraces represent a stage in the level of Lake Agassiz when the waters reached far up the Saskatchewan river and formed a partly inclosed lake. Traces of this terrace or of beaches at a similar level were observed at Cranberry portage and to the north of Reed lake. The beaches on the ridge which separates Cedar lake from Lake Winnipegosis are also at about this level.

Below The Pas the banks of the river again become low and are made up of river deposit, fringed for most of the distance by tall balsam poplar. The first high ground reached by the river is at Pine bluff, forty-one miles below. In low water, limestone is reported outcropping there, and also on the Moose lake branch, a few miles to the north-east. At Kettle point, twenty-one miles farther down, a small hill rises ten feet above high water and on its surface boulders of limestone occur. A small exposure of the limestone is seen in places, but the surface of the hill is made up mainly of boulder-clay. The banks below this become noticeably lower as the river is descended and near Cedar lake are just above the water and fringed with willow, showing less of the river deposit than in the upper reaches. Limestone exposure.

Where the banks are built up above the range of ordinary high water they are of very much the same character throughout. A fringe of trees skirts the river on both sides and consists principally of balsam poplar (*Populus balsamifera*, Linn.), elm (*Ulmus Americana*, Linn.), ash (*Fraxinus pubescens*, Lam.) and gray willow (*Salix longifolia*). The latter grows generally either along the edge of the bank or at a distance from the river where the land is swampy. In the shade of the forest, the Saskatchewan berry, (*Viburnum opulus*) or "high bush cranberry," grows very luxuriantly. The negundo is occasionally met with, as well as black spruce, though the former is generally confined to the higher land on each side of the valley on the dryer soil. In low water the banks rise to over six feet and are apparently level for a short distance back from the river, but soon sink with a gradual slope to the level of the marsh or hay flat in the rear. In high water the river rises to the top of the bank and is then above the general level of the surrounding country, so that any further rise is followed by a flooding of the hay lands and an enlargement of the lakes and marshes adjoining. The water is highly charged with a very fine sediment which gives it a muddy colour. This is to a great extent deposited before leaving Cedar lake, and the water issuing to Lake Winnipeg is therefore fairly clear.

The slightly sloping plain through which the lower part of the river flows is not so pronounced a lake basin as that above The Pas. A strip of higher land follows at no great distance to the west of the main channel. To the east and north the margin of the higher country is much more irregular. From the north side of the strait at The Pas the dry ground forms a bay to the north-east, approaching the river again a short distance below what is called the Moose Lake channel. From a few miles east of this a wide low flat runs to the north-east to Moose lake channel.

the western bay of Moose lake, and running through this is found a small overflow channel draining towards the lake. Another low plain runs directly east to the south end of the lake, and along the northern edge a line of timbered country is found, in front of which runs another small overflow channel through a chain of lakes emptying just south of the Hudson's Bay Company's post. Between the Moose lake channel and the main river there is probably another small island of high ground, as Mr. Cochrane there records an exposure of limestone. From the eastern bend of the main river a small creek runs to Moose lake. In this the flow is in either direction according to the height of the water in the river and lake respectively. A small stream is reported by Mr. Cochrane as draining from Moose lake to Cedar lake. It is quite possible that this stream flows during high water only, or that the outflow is over a rocky barrier, as even a small stream running through soft deposits would soon cut out a sufficiently deep channel to materially affect the height of Moose lake and thus deflect more of the water of the Saskatchewan river in that direction. Previous to the silting up of the channel through which the river now flows, it is quite probable that the relative elevations of the northern and southern parts of this basin were somewhat different. The northern uplift which is shown in the beaches of Lake Agassiz had not then probably been completed, so that the low country north of Moose lake might have been much lower than at present. The basins of these two lakes were then probably merged in one and for a time drained north-eastward by the valleys of Minago and Metishto rivers. The further uplift at the north to assume its present contour would close off these channels and deflect the river more to the south. Taking this view we can imagine that at first the stream flowed over a wide marsh to the west end of Moose lake, then as the delta grew and the northern uplift was more pronounced the stream went mainly in the direction of the present Moose lake channel. A further uplift caused the breaking away of the smaller branches to the south. The present western channel is a deflection from the higher part of the delta to the margin of the basin, along which less of the river deposit would be found.

Effect of uplifts.

Moose Lake.

Moose lake.

This lake is situated to the north of Cedar lake, and acts as an overflow basin to the Saskatchewan river. The direction of flow in the creek leading to it from the Saskatchewan is regulated by the height of the water in each. When the river is low the lake gradually drains out and then is refilled when the Saskatchewan rises. Through a marsh situated to the east of Moose Lake creek there appears to be some drainage also to Cedar lake. The upper part of this, near Moose lake, is blocked by a dense growth of tall reeds so that the channel is lost and the flow distributed over a wide area of marsh.

The present system of water supply is not of a permanent character owing to the shifting of the channel of the Saskatchewan. Older channels formerly flowing to the lake are numerous. The largest of these is one which flows north-eastward to the western arm of Moose lake.

Dolomitic limestone forms shore line of lake.

The basin in which Moose lake lies is very flat and the shores rise comparatively little above the water. The contour of the shore line is very irregular and is determined by the remains of portions of a thick bed of flat-lying dolomitic limestone which overlies a porous and easily eroded band f rming the floor of the lake. Those portions of the thick bed which were not removed form the main shore. The shallower parts or bays becoming silted up or previously filled by boulder clay have left many stretches with low marshy margins. One of these marshes cuts off Cormorant lake from Moose lake, leaving as a connecting link a sluggish stream flowing to Moose lake. Another low stretch runs north-eastward from the north end and, by report, extends for fifteen miles to the head-waters of Metishto river, a branch of Grass river. The land at the south end of the lake is also level, and except for a few low limestone ridges, is probably all river deposit. Another marshy tract extends from the north-east corner of the lake to the head-waters of the Minago river.

Hudson's Bay post.

The Hudson's Bay Company's post is built on a ridge of flat-lying limestone near the south end of the lake, just to the west of the outlet. The land here is elevated from six to eight feet above the lake and the beds exposed seem to be all of an apparently unfossiliferous limestone, made up principally of thin layers having numerous cup-shaped depressions and dome shaped elevations, suggestive of Stromatoporoid coral formation. A prominent point about six miles north of the post is formed by a ridge of limestone similar to that at the post. On the north side of a large island north of the narrows a cliff of limestone is seen in which thirty feet of beds are exposed. The lower beds show two feet of a granular dolomite capped by thick beds of a lamellar dolomitic limestone which seems to be of organic origin, though no structure is visible to the naked eye The rock is, as before noticed, built up in thin plates having an uneven surface, and many saucer-shaped pieces can be broken out. These are possibly remains of Stromatoporoid corals which form the mass of the rock. The exposures are very like the cliffs at the Grand Rapids of the Saskatchewan, classed by Mr. Tyrrell as Upper Niagara. The lower members of the formation are exposed near the foot of the rapids and contain as one of the principal fossils the large *Conchidium decussatum*, Whiteaves. No fossils were here found *in situ* in the lower beds, but from a few loose slabs, of a lighter and more granular rock, pushed up probably by the ice, the following forms were observed:—Fragments of a Cyathophylloid coral like *Zaphrentis*, *Favosites* sp., *Strophomena acanthoptera*, *Conchidium decussatum*, *Murchisonia* two species, *Euomphalus* sp., and *Gyroceras* sp. From the top of the cliff, the shore opposite toward the north-west appears low, with a few scattered stunted spruces near the lake, while behind is a low marsh or muskeg, over which can be seen the hills bordering the north shore of Cormorant lake. To the east the shore appears low but covered by spruce and poplar, and is probably underlain by a continuation of the limestone beds here exposed. The north shore is higher and forest-covered.

Fossils.

The eastern arm running to the north-east from the outlet was surveyed by Mr. A. S. Cochrane in 1880 and 1882. Reference to the map will show its general character and its many islands. Of the north shore, Mr. Cochrane reports that the points are mainly piled high with limestone shingle. Exposures of thin-bedded limestone also occur. Some of these beds are very fine-grained and resemble lithographic stone. The east shore is much lower though also underlain by limestone. Low land extends for a short distance to the south-east and large bays are found behind the islands and points. A high ridge, estimated at 100 feet above the lake, extends to the south-east. Of the appearance of the shores, Mr. Cochrane in his notes says:—'The timber along the eastern shore is, generally speaking, very poor, though occasional large sticks are to be seen from fourteen to twenty inches in diameter, very scattered and far apart. All this shore has been burnt over in patches at different times, which gives the timber a very mixed appearance. The beach is all low and composed almost entirely of limestone shingle, though in one or two places a short cliff of limestone four to six feet high is to be seen standing a few feet back from the water's edge.'

Timber poor.

Cormorant Lake.

Cormorant lake.

Ascending the small stream from the north end of Moose lake for about six miles through a swamp, a small crooked bay of Cormorant lake is reached. This bends around the north end of an oblong hill, rising at its highest point to over one hundred feet. It is lying with its longer axis north and south and appears to be partly of morainic origin, similar to that at The Pas. Underneath, limestone in horizontal beds is exposed. This consists of a rough-weathering lumpy dolomite, probably fragmental, overlying somewhat reddish fine-grained beds. The south-eastern shore of the main body of the lake is low, passing in front of a long strip of swampy land, but as the south end of the lake is reached, where a small stream enters from Atikameg lake, limestone is again exposed in cliffs about ten feet high. The beds are thin and of very hard compact dolomite without fossils, and have a slight dip to the east. To the west, the cliffs rise slightly, and around the bay at intervals are sections of the same rocks with an addition at the base of five feet of hard whitish dolomite, having a very rough surface and showing numerous joints or cracks filled with a more earthy looking but hard matrix. These are very like the rocks on the east side of Namew lake, six miles north of Whitey narrows. At the north-eastern extremity of the lake a stream of dark water flows from a narrow bay lying parallel to the lake to the west, and into this, Cowan river flows from the north, so that this bay, which looks like a part of Cormorant lake, is in reality one of the chain of lakes situated on the above stream. The rocks exposed on the shore to the north of this, in the several cliffs which are there seen, are composed of reddish beds capped by the firm whitish thick beds. The thin beds exposed on the south shore are evidently to be found in the higher country to the north, but do not show in the cliffs near the lake.

Owing to the great similarity of the different beds an estimate of the thickness of the section exposed on these lakes is very difficult to obtain, but the order of occurrence seems to be as follows:—The lowest beds are of a compact reddish dolomite, above which are five or six feet of thick beds weathering very rough on the surface. Above this are ten to fifteen feet of thin-bedded compact dolomite which might possibly be near the horizon of the Moose lake rocks. Section difficult to obtain.

Atikameg lake lies to the south-west of Cormorant lake. The water is very clear and deep. On the eastern shore the Indians have a fishing reserve, and in the autumn resort there to obtain their winter supply of whitefish. Twenty-four fathoms is reported as the greatest depth for the waters of the lake, and this would indicate that even in summer a good quality of fish would be found if the Indians could set their nets in deep water. Along the western shore is seen the high ridge which also touches the western side of Cormorant lake. This is partly broken through at the south-western end of the lake. Over the lower part of the gap a road has been made to a small lake to the west of the ridge and connected with Reeder lake near the Saskatchewan river.

The appearance of the country to the east is that of a slightly rolling wooded plain, but it is probably partly underlain by horizontal beds of limestone with an occasional swamp. To the south, The Pas ridge is seen to extend eastward a few miles and then die away. The shores are generally strewn with boulders, and near the north end limestone slabs are piled on the beach. At the south-west corner a long point, running parallel to the south shore, cuts off a narrow bay to the south leading to the portage across the ridge. This seems to have been a morainic ridge.

Cowan River.

Cowan river.

The ridge which runs west of Cormorant lake continues in a north-east direction and parallel to this along its eastern slope is a depression which becomes shallower towards the north. In this a small stream flows from a swampy tract a few miles south of Reed lake. On its course are several narrow lakes which together with the stream afford a canoe route to the waters of Grass river. The lake at its mouth is but very little over the level of Cormorant lake, but the next above is about eight feet higher than this level and finds its outlet to the lower lake by two streams falling over a steep slope. The fall is passed by a portage through a spruce grove on the east side of the east branch. The lake above is a narrow canal-like body of water about eight miles long, bordered by high banks which, on the west side, show cliffs of hard white and grayish dolomitic limestone similar to the beds at the south end of Cormorant lake. They consist of thick beds which break up into irregular fragments and some of the cliffs are so much broken and shattered that the bedding is not easily made out.

Yawning-stone lake.

The upward continuation of the river enters through a small gap or break in the shore-line on the east side near the north end. At the turn into the river a small projecting cliff has its middle beds so denuded as to bear a fancied resemblence, when viewed in profile, to a face with wide-open mouth—hence the name of the lake, Yawning-stone. The stream is very crooked above this and partly blocked by fallen timber. At the part near the lake some small rapids occur, but fallen timber also blocks it to such an extent that a portage of more than half a mile is made. This leads over a limestone ledge covered by very little soil and a scanty growth of spruce which has been mostly fire-killed. For five miles the river flows through a plain, sloping slightly

SILURIAN LIMESTONE ON CORMORANT LAKE, SASK.

to the south-west. The banks in the lower part are at first four or five feet high, behind which is another slight rise but this gradually disappears and in a distance of five miles both banks and the rise behind have disappeared and the stream is running in a very shallow channel. The ridge to the west becomes less distinct though the Indians report a continuous ridge to Reed lake. A small lake on the west branch of this stream being situated to the west of the general course of the valley is in a break in the higher ground of the ridge and has on its western shore several exposures of limestone. These beds are similar to those at the base of the Cormorant lake reddish beds, and are evidently near the base of the Niagara, though no fossils could be found to prove the horizon. Above this lake the country is generally flat and swampy and no exposures of the underlying rocks are to be seen, but on the last portage, which is made to the shores of Reed lake, pieces of red sandy limestone are found which evidently come from the shore of the lake and represent the basal beds of the Trenton which must be here very thin. The small hills near the lake seem to be of morainic origin but are probably made up principally of material from the denuded edges of the limestone beds beneath. Trenton rocks are found elsewhere on this lake so that their presence here is certain.

Limestone exposures.

Of the surface features observed on this stream and Cormorant lake it might be of interest to note that the soil of the country near Cormorant lake is thin over the limestone ridges but in the valleys, such as that of Cowan river, a good quality and depth was observed. Between Cowan river and Cormorant lake there is a strip of fair-sized spruce. This is seen to extend up the river as far as the banks are high, but above this the principal tree is tamarack (larch). A long strip of country along the eastern face of the high ridge west of the lake is burnt over and the timber is dead.

Minago River

This stream rises in a low swamp north of the north-east extremity of Moose lake. The Indians occasionally travel by this stream from Moose lake to Cross lake and the route thus followed is practicable for small canoes. A survey of the stream was made by Mr. A. S. Cochrane of this Department in July, 1880, and from his notes the following brief description of the upper or that section above Hill lake is compiled. The lower portion was visited by Mr. Tyrrell in 1896 and his description is given in part of this report.

Minago river above Hill lake.

Route from Moose lake to Minago river.

The route from Moose lake to the Minago river leaves the lake by a small opening in a floating muskeg which fills the northern part of a narrow bay. This stream or opening is barely wide enough to admit of a canoe being hauled through and in a distance of about a mile the shore is reached. A portage of a mile and a half across the height-of-land is reported as very bad and through a knee-deep muskeg. In two places however the portage crosses strips of flat-bedded limestone of about one hundred and three hundred paces wide and about three feet higher than the water in the swamp. The portage ends at a small stream leading directly into a pond of a mile in length. This seems to be the head of the river and the stream draining it is very small and crooked, blocked by beaver dams and overhanging willows so that portages are frequent, including one a mile below the lake of over a mile in length. From Lily lake to Hill lake the river seems to have a wider valley and more water in the channel, though few entering branches are noted. In this stretch there are several rapids and portages which appear to be made over ledges of flat-lying limestone with a slight dip to the south. The highest exposure on this stream appears to be at about four miles below Lily lake and is of an unfossiliferous limestone. This is probably a bed situated near the top of the Trenton or the base of the Niagara formation.

Burntwood River.

Burntwood river.

The upper part of the Burntwood river lies in a rocky depression on the surface of an uneven plain which is situated between the valley of the Churchill river and the wide and rather shallow depression in which the Nelson river runs. In that part which lies above the point at which the portage-route from Nelson lake joins the river, upward, the fall in the river is trifling and occurs mainly on the short stream near Loonhead lake. Below the point mentioned, the stream enters the country sloping toward the Nelson river. From Reed lake to these waters there are three routes. From the eastern end of Reed lake a small stream may be ascended to near File lake and a portage made to it, or to another stream entering at the northern side of Reed lake which flows from the west side of Methy lake and affords a fair route with a short portage. The third route is by a direct portage from Reed lake to Methy lake. This starts from a sandy bay on the north side of Reed lake and runs directly north through a sandy country covered in the highest parts by Banksian pine. The trail ascends gradually to gain a series of beach ridges which run parallel to the east shore of Methy

Banksian pine.

lake, but from its south end they spread out towards the east to become parallel to the north shore of Reed lake. At Methy lake it is found that this series of beaches, which are along the margin of a plateau of sand lying to the east, rises in steps to a height of fifty or sixty feet above the lake. By a short excursion to the east it was found that for two miles the surface was nearly level but had a slight fall to the east from the highest beach which was only a quarter of a mile from the lake.

These beaches appear to have been formed when the Labrador glacier made a dam across the valley of Grass river and a lake occupied the basins of both Reed and Wekusko lakes. An outlet seems to have existed along the valley of Methy lake. Not enough is yet known of the general disposition of the lacustral deposits and of these beaches to warrant any definite statement, but they may possibly be traces of glacial Lake Agassiz. The basin of Methy lake is along the strike of the Huronian schists. At the south end, as before noted, the valley reaches Reed lake and at the north end joins the depression filled by File lake. The outlet is near the north end where a small stream trickles over dark-greenish schists containing many needle-like crystals of hornblende apparently of secondary origin. A short portage of 150 yards long is made to File lake. Along the western shore the rocks strike north-and-south and are mainly hornblende-schists which at the north end become very much contorted and the strike is there bent through an angle of 130° so as to run south-west and north-east. Beaches formed by Labrador glacier.

These beds are exposed again on the stream above Loonhead lake and are there found interbedded with light-coloured gneisses or granites. Instead of the evenly fine-grained beds of Reed lake which are smoothly glaciated, the surface of the rocks of File lake are roughly weathered, owing no doubt to the partial decomposition or recrystallization of the hornblende constituents. On Loonhead lake the schists give place to a wide belt of granite included in the Laurentian and after an interval of muskeg, through which the stream passes, the gneisses of the Burntwood lake region make their appearance, striking north-north-west and south-south-east with a few local deflections as far down the river as the beginning of Burntwood lake. Leaving Loonhead lake the stream runs northward and at a mile from the lake falls ten feet over a ledge of gneiss, past which there is a portage of 200 yards on the south side. The rocks are fine-grained, thin-bedded dark gneisses. Below this the river makes a long bend round by the east and approaches the same gneissic ridge, over which it crosses Belt of granite.

a second time, falling, in two rapids, about six feet. From here on to Burntwood lake the navigation is hardly interrupted, the channel narrowing occasionally so that there is a noticeable current, but it seems to consist of a succession of narrow lakes bordered by rocky banks, and as Burntwood lake is approached these rise in to hills. Very little Banksian pine was seen. A few groves of small spruce and poplar occupy the low parts where there is a little clay and sand between the rocky knolls.

The surface of the rock is everywhere glaciated, showing striæ running S. 20° W. At a lake about eight miles below Loonhead lake where the river makes a jog to the east for three miles, the central island and a long point reaching out from the south-east, are both found to be composed of light fine-grained dolomitic limestone, dipping along the eastern edge, towards the north-east. As the beds are not all standing in this position but are more nearly horizontal at the south-west side, it is possible that beneath these are sandstones of a friable nature which have been denuded so that the beds have fallen down. There appeared to be no fossils in the beds with the exception of a few broken crinoid stems, so the exact age could not be decided, but in their general appearance they resemble the beds exposed on Cumberland lake which are of Niagara age. The limestone is fine-grained but pitted by numerous small cavities, possibly impressions of salt crystals. This outlier of limestone is the only one known in this district at any great distance from the general outcrop of the Silurian and Cambro-Silurian rocks. The lake in which they are found is generally called Limestone Point lake.

Age of limestone beds doubtful.

From here onward for about eight miles the river runs north-northwest, following the strike of the rocks, which become garnetiferous and generally of a dark colour at the end of that distance. It then turns N. 20° E. till it enters the main body of Burntwood lake, flowing through a succession of narrow lakes connected by deep channels. In this distance the channel cuts occasionally across the strike of the rocks. Those in the upper half of the distance are running N.W. and S.E., becoming more and more contorted, until at the middle of the course, light reddish gneiss and granite appear with included fragments of the darker rocks. The reddish rocks seem to have been in a plastic state at a later period than the dark gneisses.

The strike of these later rocks is about east-and-west and they continue north to the main body of the lake, approaching which they are seen to be broken into by large dykes of flesh-red granite.

Burntwood lake is unlike many of the other lakes of the district as it is but a narrow channel, or rather three channels meeting to form a Y. The southern branch may be said to run as far as within two miles of Limestone Point lake, as the first current is there met. The western arm reaches to near the waters of the Churchill to which there is an old portage road. This part is more regular in shape than the southern one as well as wider, probably because its course lies nearly along the great break indicated by the flesh-coloured granite dykes also noted on Cold lake and part of Churchill river. Near its western end it breaks across through some of the ridges and continues on in the same direction but on a course three miles to the south-west. In this latter part the lake is bordered by high rocky hills The eastern arm broadens out and several large islands are found. The rocks of this eastern portion and also down the river (as the outlet is from this branch) as far as the first rapid, are all striking nearly north-and-south or about N.N.W. and S.S.E. They are gray and dark garnetiferous gneisses which show in high ridges on both sides of the valley. The channel runs about north-east but is deflected back and forth along the direction of the gneiss ridges. The outlet of the lake may be said to be situated at the first narrows where there is a strong current. This point is only about four miles below the widest part of the lake and about twelve from the inlet of the south branch. From there to the portage from Nelson lake, the river is very much of the same character as that of the south branch-narrow and with a deep channel flanked by high ridges of gneiss.

Burntwood lake.

Rocks of eastern portion.

From the above mentioned portage the river turns to the east, and begins its descent to the basin of Three Point lake. This basin is situated, by an estimate of the fall in the river, about 150 feet below the level of Burntwood lake. In this part of its course the character of the surrounding country is of a totally different character owing to a deposit of clay of lacustral origin which is spread over the eastern side of the slope lying to the west of the Nelson river.

Clay deposit of lacustral origin.

Near Three Point lake the deposit is of considerable thickness as the river has cut out a deep valley which decreases in depth up to Burntwood lake. On the Burntwood lake basin there is but a thin coating of soil of any kind. Small terraces between the rocky ridges appear here and there but as the river is descended these are more pronounced and, as noted at the portage from Nelson lake, form a definite terrace at five or six feet above the river. The slope of the underlying rocks is apparently a trifle steeper than the surface of the clay as the high ridges of gneiss, which form a prominent feature of the western part of the district, are here partially buried by the clay and the summits only appear at a distance from the river. At the various rapids the underlying rocks are generally seen, but elsewhere rock exposures are infrequent. The first portage is at a fall of eight feet. The trail road is on the south side and is called Carrot portage. It is through a fairly heavy bluff of poplar, small spruce and Banksian pine to a small lake or pond at the foot of the rapid. Shortly below this, the stream enters a rocky gorge, through which there is another fall of eight feet. There the principal tree is the Banksian pine and the hills on either side seem to be fairly well covered by it. The rocks at the fall are a reddish gneiss striking north-east and dipping 20° to the north-west. Below this fall there appears to be a belt of land with good soil skirting the river for some distance. Occasionally a rocky point protrudes from beneath the clay, though as a rule the banks are fringed with willow indicating alluvial soil.

Timber all small.

The timber near the river is mostly poplar but a short distance back it is Banksian pine and spruce, but all very small. Flathill portage, the next below, is at a fall of ten feet. The granite ledge which crosses the river here is seen on each side rising in a high ridge fifty feet above the clay terrace. For a short distance below Moose portage the valley is not deep, but at Clay portage the stream falls twenty-five feet into a much deeper channel which for six miles has scarped banks. The channel then widens out and the stream emerges on what appears to be a lower terrace. Below the fall at Clay portage the rock is a reddish gneiss with bands of mica-schist and garnetiferous gneiss lying nearly horizontal but with a slight dip to the north-east. The banks there are about forty feet high and are composed of sand and gravel with a bed of clay on the surface. For a considerable distance below this the river flows through a fairly level country with here and there a boss of the harder rocks protruding through the clay plain. The mantle of clay here covers all the interval between the greater ridges and the river which in flowing down the slope to the east runs more or less across the direction of these ridges, so that when the valley is worn down to any extent, rapids are nearly always found situated in line with these rocky hills. The stream is more or less a succession of still stretches with deep quiet flow, and shallows and rapids, generally at the points as above noted. Many of these ridges form isolated knolls with their longer axes running in the direction of the strike of the rocks. One of these is noted just above the mouth of Muddywater river and on the line of its axis rapids appear in the river. At Driftwood rapid there are two falls of four and five feet respectively over red granitic gneiss, striking N. 20° E. and S. 20° W. A mile below this, at Grindstone portage, the river again falls over beds of similar red gneiss. There is very little fall for the next four miles, or until it passes along the west side of another rocky ridge. Then it turns to the east and there are four falls at intervals of less than a mile, making a descent of about forty feet. The first is a fall of seven feet, and the second of eight feet; the third, Leaf rapid, is a fall of eight feet, and the last, Gate rapid, of seventeen feet. At the first of this series the rocks are reddish granitic gneisses with a few bands of included fragments of darker gneiss striking north and south. At the second, the rock is a contorted garnet-gneiss, followed on the east by a porphyritic granite-gneiss. At the third, the rock is similar to the second, and the same rocks continue to the fourth. The river below Gate rapid enters a deeper valley and makes a bend to the north. The banks are sand and clay, and before Three-point lake is reached, they have risen to about thirty feet. In this interval several rapids are situated but the portages are all short. The last rapid to be passed before reaching the lake is called Moose-nose rapid, where the channel is constricted by an out-crop of gneiss which forms on the east side a boss of rock bearing a rude resemblance to the nose of a moose—hence its name. Below this the channel broadens out and the current is sluggish, except at a few points. Near the lake the valley turns to the north-east and joins the basin in which lies Three-point lake. Banksian pine is growing thickly on the edge of the valley, but in places large groves of spruce and tamarack appear in the lower parts and along the edge of the stream are groves of black poplar and birch.

Falls at Driftwood rapid.

Timber.

Athapapuskow Lake.

From the north shore, which is profusely dotted with islands, a long bay runs to the north. The shores and islands in the north-eastern portion of the lake consist of green Huronian schists and fine-grained massive gabbro. About five miles south-west of the head of the river, this greenstone is overlain by Trenton limestone which soon forms a low escarpment a short distance back from the beach. The southern end and part of the north-western shore were not visited. On the south-west shore considerable areas are covered with large white spruce. The route to the headwaters of Kississing river is by a stream flowing into the north end of this lake. To reach it the north-east shore was followed from the outlet. The main body of the lake stretches to the south-west and is generally free of islands.

Athapapuskow lake.

After passing a prominent point a mile from the outlet the first rocks noted on the north shore are of a dark-green squeezed eruptive; the lines of stratification or foliation, though indistinct, run north-east and south-west. The shore is fringed with small spruces and occasional birches. At five miles west of the outlet, on passing through a narrow channel behind an island two miles long, another bay is crossed which runs to the north-east with the strike of the rocks, and to the west on one of the islands, is seen a cliff of limestone capping the central part, the lower margin of the shores being of Huronian greenstone. Westward from there the north shore is said to be capped by similar limestone. Passing behind another island by a narrow strait, a much larger opening is entered, but at the entrance, two small islands are observed composed of a light reddish-coloured rock. This is found to be a granular granite, partially stained by greenish-coloured minerals, probably from the nearby contact with what seems to be an intruded Huronian mass. The rocks along the shore of the larger islands just passed are more crystalline than those first seen and appear to be massive. The colour is a dark gray-green, weathering brownish.

Huronian rocks.

The first of a group of islands half-way across the bay to the north is made up of a dark-green squeezed and altered granitic gneiss with the foliation bearing N. 38° E. The rocks of the islands and on the point north of this are of a soft fine-grained greenstone, containing many rusty specks and small masses of calcite.

On the point to the east of the entrance to the next bay are green schists striking N. 29° E., but most of the rock in the vicinity is massive in structure. The hills around this bay are partly bare and seem to be of rounded bosses of greenstone. The only timber seen is spruce, with a few birch trees.

Indian camp.

In the strait, a small level patch on which there is some soil, is the site of an Indian camp where there are a few graves carefully preserved and neatly enclosed by a wooden fence. This camp is occupied each year by a few families whose hunting ground is at the height-of-land to the north.

The rock is a pseudo-conglomerate formed most probably by pressure and shearing. The matrix is a fine-grained green schist inclosing angular and sometimes ovoid fragments of a coarser crystalline rock lighter in colour. In a few cases the latter consisted of fine-grained greenstone apparently, broken up dyke material. The foliation was N. 20° E.

The Pine-root river, which was ascended, empties into the west side of this bay two miles from the entrance. The mouth is hidden in a grassy flat and the valley through which it flows is not a prominent feature, as it is crooked and narrow. It drains three closely connected lakes at elevations estimated at 60, 65 and 75 feet respectively above Athapapuskow lake. The lower one is only about four miles from the mouth of the stream. Most of the fall occurs near the outlet from the lake where several cascades make a descent of forty feet. Lower down smaller rapids are met, but these are each not over five feet in height.

Rocks of Pine-root river.

The rocks noted on the river are mainly at the several portages. Near the mouth the stream flows along the eastern face of a ridge of greenstone running with the strike, nearly due north-and-south and at several places on the faces of some of the more abrupt parts the rock is seen to be glaciated, the striae running down the valley. The rock showing at the foot of the lowest rapid is a black or dark green quartz-porphyry. The particles of quartz are small and the matrix very fine grained. At the upper end of the rapid the rock is a dark quartzite-conglomerate with a few small pebbles of a bright red jasper. This band lies to the west of the quartz-porphyry and the river crosses it again a short distance up. Irregular veins of a milk-white quartz appear on a boss of rock on the west side of the fall but they seem to be segregations and not fissure veins. At this portage a terrace of sand and gravel is crossed which is about fifteen feet above the water.

Ridge of conglomerate.

The strike of the rocks in this part of the valley is very nearly north-and-south, and the first two rapids cross and recross a band of conglomerate which to the north and south forms a distinct ridge. The stream cutting through this from the eastward leaves a small basin in which is a narrow lake. From the north-east corner of this lake to the larger one above, the rocks are all green schists striking along the course of the stream or about N. 20° E. and for most of the way the stream runs between high ridges of the schists. At the outlet from the lake the valley terminates and the water descends about forty feet in a series of cascades. A portage of $\frac{1}{4}$ mile on the east side passes over a ridge of greenstone and green schist striking N. 12° W.

Wabishkok lakes.

The lake is not above two miles in length and scattered through it are several small islands lying in rows parallel to the strike of the schists. At the north-east corner a small round lake is separated from the main body by a ridge of dark-green rock, partly schistose, over which the water of the upward continuation of the stream flows, making a fall of two or three feet. At the east side across the pond is the mouth of a small quiet stream which connects with the middle lake.

House occupied by Indians.

There is a small well-built house on its banks, the winter home of one of the families of Indians who hunt in this vicinity. The middle lake is not as large as the lowest but longer and rather narrow. About the middle of the distance up this lake to the inlet of the stream above, the strike of the rocks, which for a short distance had been difficult to make out owing to their massive character, was clearly observed to be nearly at right angles to that on the lower lake. They are here striking east-and-west, nearly vertical, but at the inlet of the small stream from the upper lake, where there is a short portage, there is a semblance to a dip of W. 38° S. $<40°$. The rock is dark-coloured, massive in structure and very much weathered or pitted on the surface. Some of it which is dark gray is soft enough for pipestone.

The stream from the upper lake is only some 500 yards long and as it leaves the lake it falls ten feet over a ridge of dark serecite schist striking across the stream in a direction W. 28° S. or E. 28° N. dipping at an angle of 70° to 80° southwards. On the upper lake the Huronian greenstones come in contact with Laurentian granite-gneiss and the line of contact occurs along the longest diameter of the lake.

Islands of Huronian rock.

All the large islands appear to be of Huronian rock. On one near the contact this appears to be partly recrystallized giving the rock the aspect of a diorite. The surface is rough and many grains of quartz appear throughout the rock.

On the north-west side of the lake the rock is a fine-grained granite with few inclusions or patches of dark hornblende-rock in it. There is a slight foliation running N.E. and S.W. A crooked channel leaves the lake at the north end and runs with a general north-west direction for two miles, ending in a small round pond into which only a rivulet runs. This is just to the south of the height-of-land.

Kississing River.

Kississing river.

The portage over the height-of-land is three-quarters of a mile in length, and the direction followed from the south side is generally about N.N.W. At the south end the rocks are reddish-gray gneiss striking north-east. The northern half of the portage is through muskeg, but rocky ridges occur here and there showing gneisses and schists dipping steeply to the north-west. Before reaching the north end the trail descends a steep hill, the boundary of a basin in which lies a small lake. Muskeg extends from this hill out to the edge of the water and the outer edge is more or less a floating bog. It was estimated that this lake is lower than the one south of the height-of-land, probably ten feet. Another portage is made from near the eastern end, where a small stream trickles out to the north, to a pond lying ten feet lower. This is connected by a crooked channel through a grassy and muskeg flat with the east end of an arm from Kisseynew lake, the first of consequence on Kississing river.

The timber here is all very small and chiefly Banksian pine on the ridges with stunted spruce and tamarac in the muskegs.

Kisseynew lake.

Kisseynew lake, of which only a part was surveyed, seems to occupy a long basin or hollow lying along the strike of the gneisses which outcrop on its shores and islands. The islands are mainly the summits of long ridges of gneiss which at the north-east end also form long finger-like bays. The rocks at the south of the first bay are light-reddish gneiss, striking east-and-west and dipping north at an angle of 70°—80°. On the lake, however, they seem to run nearly north-north-east and south-south-west. On the island near the north shore the rock is a grayish green massive granite with a slight foliation north-east and south-west, while along the north shore of the same island these are overlain by dark-gray hornblende-gneiss and schists which strike N. 70° E., dipping north-east 45°—60°.

The river leaving this lake is wide, and with sluggish current. For two miles it passes through a muskeg through which here and there appear ridges of rock. It was quite evident on entering the stream that the small creek by which we reached the lake did not form a very important branch, but that the head-waters must be situated much farther to the west and a stream of larger size will probably be found to enter at the western end of the lake.

At the outlet from Kisseynew lake there is a small fall of three feet, above which is a gray gneiss striking east and west and nearly vertical. The river is wide and deep for nearly two miles down, but then suddenly turns to the north and runs through a small break in a ridge of gneiss, falling eight feet to follow for a short distance its previous easterly course. At this fall the gneiss is striking E. 10° S. and in it are granitic inclusions or segregations of feldspar and quartz drawn out into long stringers. A little soil here covers the rock, and below the fall the river banks are found to have a low terrace of five to eight feet of sand. On the ridges Banksian pine is the principal timber and in the valley below to near Cold or Kississing lake this tree is found in tall grooves on the sandy terrace. A few scattered spruces are also seen.

Kississing Lake.

Kississing lake.

Nearing the lake the valley broadens out to half a mile between the line of trees on either side and the stream winds in a very crooked course through grass and reeds. At the south-west end of Kississing lake the stream falls into a long bay, the shores of which are low and the water a dark yellow. No timber, except small spruce and Banksian pine, is seen on its shores. On the first island the rock is mostly light-coloured pegmatite, containing fragments of schist. Light-coloured rocks appear on the east shore, probably belonging to the same intrusion. North of the island gray-gneiss appears in nearly horizontal, wavy beds, which have a slight dip to the north-west.

In the strait leading to the larger part of the lake the gneisses containing a few veins of pegmatite, dip about 10° north-east and on the bank there is exposed about six feet of sand with a light soil on the surface containing a few boulders. Entering the larger part of Kississing lake it is found to be so thickly dotted with islands that any extended view is limited to an occasional glimpse between them. The hills on the east side are very thinly coated with timber and a few of the islands have a little spruce on them.

Lake traversed to outlet.

The lake was traversed on a direct line through the islands to the outlet. As the country to the north-west is rather low the mainland in that direction could not very well be made out. On the east a range of hills, bare and rocky, forms the east shore and the limit of the lake in that direction was seen to be about four miles, keeping nearly parallel to our course. As the several rock-exposures noted are all on the islands and not easily identified a few notes are given on these localities with their distance from the outlet.

At 10·8 miles from the outlet, the rocks are gray micaceous hornblende-gneisses dipping to the north-north-east at angles of 10° to 20°. A third of a mile north-east on a large island a wide dyke of pegmatite breaks through hornblende-gneiss and schist, which in places are liberally charged with pyrites. The contact with the intrusive mass has oxidized some of the pyrites so that the surface in the vicinity is stained with rust. The dip is not constant and the beds are somewhat wavy, but the average inclination is W. 30° N. at an angle of 40°.

Three miles from the outlet the rocks are light-coloured gneisses containing quartz and very little feldspar with specks of biotite. Small garnet crystals also appear in a few of the beds which are dipping N. 30° E. at an angle of 30°. At the outlet, the gneisses are gray in colour and dip N. 20° E. at an angle of 20°. Kississing river below this lake is much larger than the stream above. Its course is at first in a northerly direction, passing over several ridges of gneiss with sandy terraces near the stream. The course of the river is then deflected more to the east, and at half a mile falls eight feet over a ledge of gneiss. Below this for two miles the stream flows due east between ridges of gneiss parallel to the strike, falling at last over several small rapids. The central one of these has a fall of over five feet and a portage is made for seventy-five paces past it. A sudden turn to the north reveals another fall of ten feet over a rocky bed, past which it is necessary to portage for a distance of 400 yards. Clay is observed on the portage road, which rises ten feet above the water at the upper end. The upper surface has the appearance of a terrace but mostly of sand.

Kississing river below lake.

This is another small rapid with two feet fall a short distance below this, when the valley is seen to open out and the view ahead is of almost bare rocky hills, a continuation of the ridge forming the eastern boundary of Cold lake. As the river approaches this ridge it is deflected to the north-east and soon, bare and rocky hills appear, on the north side the timber having been burnt over. The course of the river from the edge of the ridge to Takkipy lake is in the form of a long curve to the north-east. In this distance one rapid of four feet was run at five miles from the lake, where the course of the river crossed the strike of banded red and white gneiss and a few thin belts of mica-schist dipping north at an angle of 10°. Below the rapid the course of the stream is with the strike of the rocks. The hills on either hand seem to reach an elevation of somewhat less than one hundred feet. The whole country appears to be covered by small Banksian pines of four or five years growth.

Country covered by first of small Banksian pine.

A ridge of red granite rises on the north side of the valley three miles from the lake and is probably the same as that which crosses again below the lake. The valley broadens out and the stream flows with a very crooked course and little current through grassy flats before reaching the lake. Between the ridges on the side of the valley small terraces of sand and gravel with a little clay, rise to fifteen feet above the water and the Banksian pines become much taller in patches and are associated with a sprinkling of spruce.

Takkipy lake lies in a basin surrounded by nearly bare hills. The outlet flows from the north end of a narrow arm where the river breaks through a ridge of reddish granite-gneiss, with a fall of eight feet. A portage of one hundred paces is made over heavy bedded gneiss dipping north-east at an angle of 30° to 40°. The valley below this fall continues in the same northerly direction but soon narrows to a canyon with steep rocky sides through which the river falls fifteen feet in a distance of two hundred yards. At the lower end of the portage is a small thicket of poplar and spruce, but the timber on the higher parts, both at the portage and on the surrounding hills, consists of small Banksian pine only.

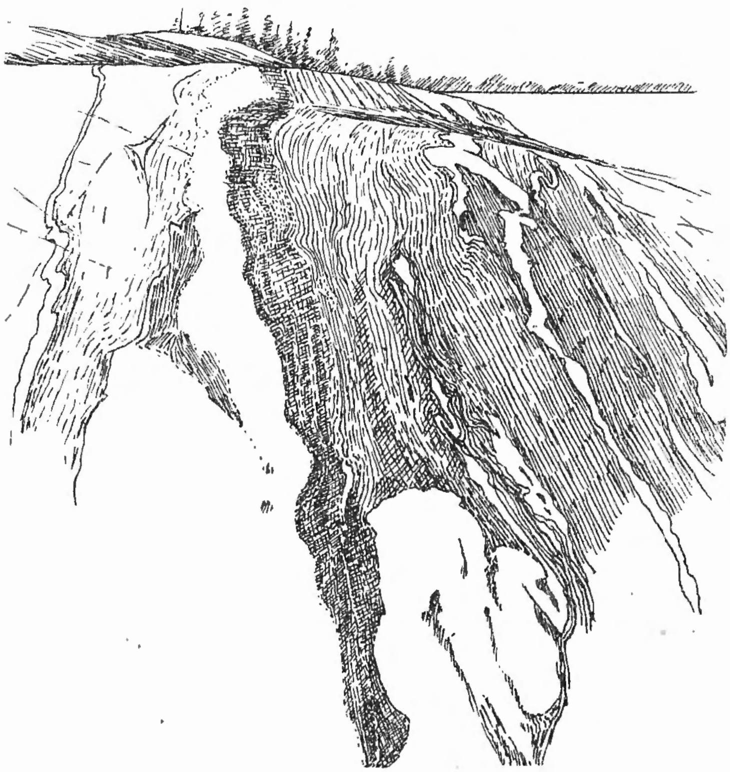
From below the fall the northern edge of the high rocky country which surrounds Takkipy lake runs to the west, but on the east it is not so definite, as rocky ridges extend to the north. From a valley on the north a small branch enters and half a mile below this the river falls about four feet in small rapids. The rocks are quite massive and appear to be nearly horizontal but dip slightly to the north. After passing a small round hill on the west side, a branch, the largest yet seen, joins the stream from the west. From this to Beaver fall the stream is fringed with rushes and the current is sluggish.

Island of garnetiferous gneiss at Beaver fall.

At Beaver fall the river divides and falls fifteen feet nearly perpendicularly on each side of an island of garnetiferous gneiss. A portage is made across the island over bare rocks to the foot of the fall, a distance of about twenty-five yards. The rocks are nearly horizontal. Before reaching the portage they appear to be dipping slightly to the south but at the foot they are dipping slightly to the north. The beds are of garnetiferous gneiss interstratified with a light red granite-gneiss. Protected surfaces show glacial striae running S. 39° W. On the banks there is some good soil on which is growing fair sized timber, mostly poplar. The area of good land in this part of the valley must be small as the rocky hills are but a short distance back from the river.

The lake into which Kississing or Cold river enters is on the same level as the Churchill river, with which it is connected by a narrows at Shaving point. It occupies a deep rocky valley dotted with many islands. Along the sides of the valley and covering the summits of the islands is found a deposit of clay in which are noticed many small concretions somewhat similar to those from the clay of the Nelson River valley. It is confined here, however, to a narrow strip along the valley of the Churchill.

The character of the rocks in a great measure contrasts with those on the Kississing river. The evenly bedded gneisses are here broken into by large dykes of a salmon-coloured granite and the dip is increased to a high angle, becoming almost perpendicular. At the south end of the lake the salmon-coloured granites are much in evidence and form large patches on the prominent points. Near the mouth of Kississing river they are seen in the cliffs to be generally interstratified with darker gneiss. A short distance to the north there are many examples of beaded gneiss in which the darker rocks are very much altered and drawn out in irregular forms. Many of the beds are very much seamed and broken by dykes of the pegmatite and the fragments show greater alteration and squeezing. The direction of the dykes is about parallel to the strike of the gneiss or W. 30° N. and E. 30° S. Character of rocks.



*Pegmatite dykes and squeezed Gneiss and Schist Churchill River.

Churchill River.

Churchill river.

The uneven nature of the rocky floor of the valley is seen in the many island-studded lakes along its course. From Shaving point westward for five miles the channel is generally wide with a moderate, even current, but where there are contractions the current becomes stronger and at two or three places for short distances reaches four miles an hour. On the lake the gneisses seem to be running east-and-west, and are generally studded with garnets. The glaciation here is all to the south-west.

At the foot of Pukkatawagan fall the rocks are contorted garnetiferous gray gneiss which seems to have been so much crumpled and contorted as to have lost all general strike. On the lower part of Kississing river the included fragments in the granite dykes were less altered than here and preserved a rude alignment. Here, there has been more movement in the magma and greater alteration. At the fall there is a beautiful cascade of twelve feet broken by an island in the centre. On the north side two other falls occur on another channel which runs to the north of a large island. The portage is on the south side, 340 paces long, mostly over bare rock. This is a dark-gray gneiss dipping north at an angle of thirty degrees, broken into in many places by large red granite dykes.

Portage over high terrace.

Continuing in the same general direction for another mile the stream falls through a rocky cañon in a long rapid, with a total fall of about twenty-five feet. The portage road on the north-east side runs over a high terrace and point of rock for 600 paces coming down to a bend in the river below the rapid. On the terrace the soil is clay with boulders and upon this and the slopes near the river are small groves of poplar. The higher parts are sandy and thinly covered by Banksian pine. Many of the hills above this level are quite bare. The rocks at the fall are horizontal thick-bedded red granite-gneiss.

Near the Churchill river the valley is almost free of timber, except a little on the slopes of the hills and near the mouth. The rocks are massive granite-gneisses with a slight dip to the north. At the mouth the rocks are massive granites with contorted inclusions of darker gneiss. Wherever there is any foliation it is east-and-west with a high dip.

Trading post.

Above the fall the river expands again into another lake which continues on to the west for six miles and then turns to the north-west for about the same distance. On the north side, near the bend, the

Hudson's Bay Co. have a winter trading post. There are several houses and a Roman Catholic mission building. These are all built on the surface of a terrace of clay ten feet above the lake, and although there did not seem to be any gardens attached, there were several potato patches on the islands in the vicinity. The rocks above the fall are light-gray massive gneiss, and on the islands two miles to the west they are mostly of the light salmon-coloured pegmatite. At the post the rocks are a light-gray gneiss, nearly horizontal, but with a slight variable dip to the north. On the part of the lake running to the north-west the strike of the gneisses follows the direction of the lake. About the centre of this part of the lake the strike is nearly north-and-south, with a dip of only 30° to the east. At the western end of the lake the strike has again changed to east-and-west. Roman Catholic mission.

The depression filled by the lake. thus seems to follow very closely the line of the strike of the foliation of the gneisses as well as that of the great break or breaks now filled by the light-reddish granite.

On Bonald lake the rocks are mostly of the light granite with inclusions or streaks and patches of dark gneiss, running in many directions. The hills are clothed mostly with Banksian pine, but occasional groves of black spruce with a few tall trees of white spruce are seen. At Bloodstone fall gray gneisses running east-and-west and dipping to the north are cut in the vicinity of the portage trail on the south side of the river, by wide dykes of a coarse red granite. The name of the fall is possibly given on account of the red granite. A few garnets are to be found in the gneisses but these are not so prominent or large as at Pukkatawagan fall. Banksian pine.

Sisipuk lake occupies the upward continuation of the valley in which the river flows from Bloodstone fall to the inlet to Pukkatawagan lake. On the south, skirting the shores of the lake, rises a prominent line of hills. To the north between the lake and the river the country is not so elevated. The rocks at the east end run east-and-west with a slight dip to the north. They are mostly of gray gneiss with lighter-coloured streaks of granite. Towards the middle of the lake the rocks are garnetiferous gneisses. On the islands leading northward to the mouth of the river the rocks strike north-west and south-east, dipping to the north-east, and show many examples of the striped rocks such as are seen in the lower part of the river. A short distance north of the lake the river divides passing around a large island. On the smaller branch the fall is at two and a half miles from the turn. This is a chute about forty feet wide. Past this the port- Sisipuk lake age trail is over a clay terrace rising ten feet above the water and lying between two hummocks of rock. Above this fall the channel broadens out, and running to the west, joins the main body at the south end of Loon lake.

The gneisses here trend nearly north-and-south, with a high dip to the east and many granite veins cut through them. On one of the small islands in the channel the exposure has the appearance of a patchwork of dark fragments inclosed in a light granite.

Above Loon lake the river again passes on each side of a large, high island for eleven miles. The channel on the east side is narrow and in a few of the narrower places a slight current is observed, otherwise all this part is of the nature of a straggling lake. The strike of the rocks gradually swings around from a north-and-south direction on Loon lake to east-and-west in the narrow channel above mentioned, and on Mountain lake, from which the portage to Sisipuk lake starts, the strike is south-west and north-east.

Portage to Sisipuk lake from Mountain lake.

The portage to Sisipuk lake measure three-quarters of a mile through gap in the hills, leaving Mountain lake at a terrace of sand fifteen feet high, on the surface of which there is some good soil. Most of the distance is through small spruce to a marshy inlet from the west end of the lake. Above this the river issues from a narrow gorge in the range of hills which runs along the south side of Sisipuk lake. The usual course taken in ascending this part of the stream is to follow a channel on the east parallel to the main river, and portage over a ridge to Doctor lake above. Descending from Doctor lake, the rapids may be run by keeping close to the shore on the west side. At the foot of the rapids the gneisses are generally light in colour and contain many dark fragments of contorted schists. On Doctor lake the strike is north-and-south with a dip to the west. The Sturgeon Stone is a steep cliff over 100 feet high at the entrance to Doctor lake. Several small islands of sand and clay are seen in the centre of the channel and on the sides of the valley traces of a terrace still remain.

Above this the stream was not examined, but its course is from the west and is said to be very rough with many rapids and falls as far as the mouth of Deer river.

The hilly country to the south of Sisipuk lake and north-west of Loon lake is not well timbered but the lower land between the two and on the islands is fairly well covered by groves of small spruce.

On our trip to Nelson House we descended the Churchill to Nelson lake and went east up a long inlet or branch of Nelson lake to near the Burntwood river, to which we portaged. From Shaving point the river for a distance is flowing in a narrow crooked channel in which the current is about two miles an hour. This soon lessens as the channel broadens out to lake-like dimensions in which are scattered many large islands. The rocks are generally light-gray and whitish gneisses with fragments of dark schist and gneiss held as contorted inclusions. One long string of schist was observed to have been entirely folded back on itself. All these are again cut by flesh-coloured granite in large dykes. The general strike of the rocks seems to be about north-west and south-east. The hills here again become prominent and there are still on some of the islands and in sheltered bays traces of a terrace deposit of sand and clay. A short portage was made across a narrow neck at the centre of a long irregular island stretched across the course of the river. This road was cut through a small poplar grove growing on one of these terraces of clay.

Route taken to Nelson House.

Nelson House, formerly located on this lake, was an important post when the trade for the northern interior passed up the Churchill river. The site was pointed out on a small island at the south end of the lake opposite the channel leading to the portage to Burntwood river. At the present time the Hudson's Bay Company have established an outpost for winter trade on an island just within the narrow strait and therefore not very far from the old post. The rocks on the arm running to the east are light-coloured granites and gray and dark-coloured gneisses striking south-east and north-west. Occasional glimpses are had of the bare hills running along to the south. Several irregular bays branch off from the south side and by making two portages across narrow necks a straight course is formed which is much shorter and is generally followed by canoe parties. Two miles east from the present post the rock is a mass of granite dykes inclosing irregular areas and fragments of dark gneiss striking in several directions. At the first portage the rocks are dark garnetiferous gneisses striking south-east and north-west. The second portage is over a clay ridge filling up intervals between rocky ridges of light-coloured granite and gneiss. Both portages are of moderate length—the first 600 yards and the second 200 yards.

Nelson House.

The portage to Burntwood river starts from a small stream which flows from the east and enters the southern end of the long lake noted above through a gap in the ridge which bounds its southern shore. It begins in a willow swamp but soon gains a rocky ridge at half a mile

Portage to Burntwood river.

and again dips through a swamp. Half a mile farther a higher ridge is gained and from there on to the river there is a long clay slope or terrace covered by Banksian pine. At the river bank the vegetation is richer and in the tall grass is found the wild pea vine. Poplar trees replace the pine. It seems probable that the better drainage of the river bank makes the soil warmer and so encourages earlier growth

GEOLOGICAL SURVEY OF CANADA

ROBERT BELL, M.D., Sc.D. (CANTAB), LL.D., F.R.S.

REPORT

ON THE GEOLOGY OF THE

BASIN OF NOTTAWAY RIVER

WITH A MAP OF THE REGION

1900

BY

ROBERT BELL, M.D., Sc.D. (CANTAB.), LL. D., F.R.S.

OTTAWA

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REPORT

ON THE

GEOLOGY OF THE BASIN OF NOTTAWAY* RIVER

WITH A MAP OF THE REGION

1900

The present report relates to the geology of the extensive region lying to the south-eastward of James bay or between the upper Ottawa and the Rupert river, which was explored and partly surveyed by myself and assistants in 1895 and 1896. My summary reports for those years, already published, contain general descriptions of this region, including its topography, physical features, character of its rivers, soil, timber, climate, geology, &c. Since the publication of these reports, a map, on a scale of ten statute miles to an inch, has been prepared, showing the results of our surveys and explorations, and on this I have laid down the distribution of the various kinds of rocks observed, with as much accuracy as our examinations permitted, together with notes on their characters, the dips, strikes, directions of glacial striæ, &c.† It is considered desirable to supplement the outlines of the geology contained in the above mentioned summary reports by a general description and it is the object of this report to supply this. Before doing so, however, I shall briefly recapitulate the means by which our surveys and explorations were accomplished.

Region S.E. of James bay.

Map.

Those portions of the topography shown upon the map which have not been compiled from our own surveys and explorations are taken from the maps of the Crown Lands Department of the province of Quebec, and represent field-work done by Provincial Land Surveyors Henry O'Sullivan, John Bignell, Lindsay Russell, and others. The resulting map, herewith presented, shows both the geography and the geology in sufficient detail to obviate the necessity of lengthy descriptions.

Acknowledgments.

Grand Lake Victoria, on the Upper Ottawa river, was made the starting point of our work both seasons. In 1895 I was accompanied by six voyageurs and by Mr. Alexander Barclay as a non-professional assistant.

*This word is pronounced Noddaway by the natives of the region, but the government geographic board has decided to call it Nottaway.

†This information will not be repeated in the text of the present report.

In the southern part of the region explored, the height-of-land dividing the waters of the St. Lawrence from those flowing to Hudson bay runs in an easterly direction, passing within two miles of the northern extremity of Grand Lake Victoria. From this divide we descended a stream, small at first, but increasing rapidly, with a general course due north, astronomically, for a distance of about 150 miles in a straight line. At the end of this distance it terminates in a lake called Mattagami, which lies east and west, or at right angles to the course of the river, and has a length of twenty-five miles, with a large bay or arm extending to the northward.

Descend river.

Cochrane's survey of 1887.

In 1887 this stream was followed for upwards of sixty miles downward from its source and a track-survey of it made by my assistant of that year, the late Mr. A. S. Cochrane. At that period and up to the time of my tracing the stream to the sea, it was supposed to be identical with or to form part of a river which flows into Hannah bay at the head of James bay, and it had no recognized name of its own.

O'Sullivan's survey of 1894.

In 1894 Mr. H. O'Sullivan, inspector of surveys of the province of Quebec, made a track-survey of the course of this river for about thirty miles beyond the point which had been reached by Mr. Cochrane in 1887. My own work of 1895 included a new track-survey and a geological examination of the portion which had been gone over by Mr. Cochrane, and beyond this the work was continued as a careful micrometer and compass survey of all the rest of the river.

Survey of 1895.

Survey of 1896.

In 1896 I employed five voyageurs, and had Mr. R. W. Brock and Mr. J. M. Bell as assistants. At the start, we followed the same route as I had taken in the previous year and used the main river as a surveyed base. Mr. Brock ascended and mapped three of its branches and followed one of them, which comes from the east side and is called the Migiskan, and one of its tributaries, up to a local watershed which he crossed and thence descended another stream to Lake Waswanipi. Meantime I devoted myself to making track-surveys and geological examinations of nine other branches of the main river.

Waswanipi to Mistassini.

After these operations, Mr. Brock proceeded eastward from Lake Waswanipi to Lake Mistassini by way of a large stream which we recognized at the time under the name of Waswanipi river, while I made a track-survey and a geological reconnaissance of a chain of lakes and rivers northward to the Rupert river at Namiska lake. The general course of this chain runs due north from the south end of

Waswanipi lake to the northern extremity of Namiska lake and the distance, in a straight line is 140 miles. Waswanipi lake, sixteen miles long, discharges north-westward by a stream, eleven miles in length, which is swift, but with uninterrupted navigation, into Gull lake. The latter extends north with a length of thirty miles and is divided by narrows into three parts, the southern being the largest, the middle next and the northern the smallest. The middle division receives the Mai-kask-sagi from the east and the northern division the Tchen-sagi from the same direction.

Waswanip and Gull lakes.

Near the north end of Gull lake, I crossed the watershed between the Broadback and the Nottaway rivers and soon entered upon Lady Beatrix lake. A short 'narrows' or strait connects this with Opatawaga lake. Six miles below the latter we entered Long lake, twenty-four miles in length. Two large streams, the Ni-puck-a-ta-sé and Victoria rivers, enter this lake from the east. From the northern part of Long lake, the Broadback river flows out at right angles and after a westerly course of sixteen miles, broken by many rapids, it falls into the east side of Lake Evans. This is the largest sheet of water in the region, its length being thirty-two miles and its breadth in the middle about twenty miles. Its largest affluent is Mill river, which comes from the east. From Lake Evans, four miles of river, with two portages, brought us to Sandy lake, thirteen miles in length. The Broadback river flows out of the north end of this lake with a westward course and a rapid descent to Rupert bay. From a point on this river, three miles below Sandy lake, we made a portage three miles and three quarters long to Wettigo lake, two and a half miles in length, and only half a mile from the south shore of Rupert river, to which the last mentioned lake discharges.

Other lakes and rivers.

Broadback river.

By an inspection of the map it will be seen that the above chain of lakes and rivers intercepts all the streams from the east, six of which are of considerable size, and that it receives none of any consequence from the west. This circumstance illustrates the fact that the whole country slopes westward. The Nottaway river in its course from Lake Mattagami, the Broadback river in that from Sandy lake and the Rupert from Namiska lake, all descend more rapidly than do the rivers above these lakes, showing that the great plateau above them is more nearly horizontal than the tract between the lakes and the sea.

Country slopes west.

While making either instrumental or track surveys, my positions were frequently verified during both seasons by observations for latitude, and the compass bearings were checked by numerous observations

Instrumental checks.

for the magnetic variation. All the data agreed very well, so that the resulting map may be regarded as tolerably accurate. We are indebted to the Honourable Commissioner of Crown Lands of Quebec and to Mr. Henry O'Sullivan for copies of maps showing the surveys of the latter in this region in 1897-98, and we have used them in addition to our own in compiling the accompanying map.

Three large lakes.

A short distance to the east and south-east of Mattagami lake are three other good sized sheets of water, discharging into the former, namely Gull lake, already mentioned, which is thirty miles in length, Lake Olga, sixteen miles long and Lake Waswanipi also measuring sixteen miles. Mattagami lake thus lies in the lowest part of the whole region, except that stretching to the northward, and it collects the waters of all the country to the southward and eastward as far as the water-shed of the St. Lawrence.

Nottaway river.

The great stream which flows from the north side of Lake Mattagami and discharges all these waters into Rupert bay is called the Nottaway river, and my Indian guide informed me that the river from Lake Waswanipi, which is larger than the one we descended from the height-of-land near Grand Lake Victoria, had the same name, and Mr. O'Sullivan, who, since his work of 1894, above referred to, has made further explorations in this part of the country, writes me that he considers it to be the natural upward continuation of that river. Lake Waswanipi receives a stream from the south, which I named the O'Sullivan river, in honour of that gentleman, who was the first to map its course, and it also receives a larger one from the east, which, for convenience at the time of our visit to that region as above stated, we recognized under the name of Waswanipi river, although I am not aware that it had been generally known by this designation. The western branch, which we surveyed from the height of land near Grand Lake Victoria to Mattagami lake had no name, and since my survey of it in 1895 it has become known as the Bell river.

Bell river.

The entire length of the Nottaway river, from Lake Mattagami to its mouth in Rupert bay, as well as this bay itself, as far as Rupert House, were surveyed by micrometer and compass by myself in 1895.

Instrumental survey.

The whole region under description has a generally level character with the surface covered by drift and soil, interrupted in some sections by isolated hills and short ridges of rock. The most noteworthy of these occur on the southern sides of the three largest waters of the territory, namely Mattagami, Gull and Evans lakes. Mount Laurier, the highest point of the east-and-west range running along the south side of the first mentioned lake, was found by the barometer to have an elevation of 670 feet above its surface. Dalhousie mountain, to the south of Gull lake, appears to have an altitude of nearly 1,000 feet, while Mount Reid and Mount Middleton, two isolated knobs on the south side of Lake Evans, may be equally high. Mount Hugh and two or three other hills on the east side of this lake appear to have similar elevations. A group of hills called the Rabbit mountains at the north end of Long lake and Mount Scott and Dome mountain, in the same neighbourhood, are probably from 400 to 600 feet high. Hills of less height occur near the shores of Lakes Millie and Shabogama and also among and around the group of lakes about the head of Bell river. Isolated conical and dome-shaped hills of no great height were seen here and there at a greater or less distance from this river and also at intervals along the Nottaway river, but, with the above exceptions, the region, as far as we could judge from our explorations, is of a generally level character.

Names of mountains.

GEOLOGY.

The following account of the geology of the whole country explored in 1895 and 1896, covers Mr. Brock's traverse from Lake Shabogama to Lake Mistassini in 1896, although his results were fully described in the Summary Report of that year.

The fundamental rocks of the region consist of gneisses, crystalline schists, granites and greenstones, together with exceptional occurrences of some other rocks, such as dolomite, quartzite, arkose, conglomerate and agglomerate. The gneisses are of the ordinary types of the older or primitive Laurentian system, and constitute a class easily distinguished from all the other rocks of the district. The latter are here grouped together as Huronian, although some of the eruptives among them may be of somewhat later age. The crystalline schists are apparently the oldest rocks of this group, and the granites and greenstones, which are associated with each other, may have been erupted among them, although constituting a large proportion of the whole.

Various rocks.

HURONIAN AREAS.

The Huronian rocks, as thus defined, occur principally as a large area near the centre of the region and this constitutes the leading feature in its geology. The only other Huronian rocks known to occur in this part of the country consist of two areas of much smaller extent, lying north of the centre of the region, and the Lake Wakonichi band, south of Lake Mistassini in the eastern part.

Huronian boundaries.

If we draw a straight line from the point where our route crossed the height-of-land, two miles north of the extremity of Grand Lake Victoria, in a true north bearing for a distance of 150 miles, or to the northern arm of Mattagami lake, it will pass over Huronian rocks entirely, with the exception of the points of two spurs of Laurentian gneiss which extend into this great Huronian area from the westward. If we draw another line from the same starting point, north-eastward to the southern extremity of Lake Mistassini, but with a moderate outward curve towards the north-west, it will have a length of 240 miles, and will mark approximately the south-eastern boundary of the large Huronian area. A straight line drawn east-by-north, astronomically, from the west end of Lake Mattagami to the southern extremity of Lake Mistassini measures 180 miles and lies not far from the northern boundary of this area. This large tract of Huronian rocks forms part of what I have elsewhere designated as the Great Belt of the system, which extends continuously from the eastern side of Lake Superior to Lake Mistassini, a distance, following its axis, of more than 700 miles. The portion within the region explored and mapped has an area of about 7,000 square miles.

The Great Belt.

Two other areas of Huronian.

To the northward of this main belt of Huronian rocks, as already indicated, there are two smaller areas of the same formation. One of them occurs along the section of the Broadback river which runs west from the junction of Victoria river to Lake Evans, and I have called it the Lake Evans area. The length of this part of the river, along which these rocks were actually examined is seventeen miles in a straight line. Judging from the probable structure or arrangement of the strata within this area, as deduced from the strikes and dips and what is known of its apparent limitations by the surrounding gneiss, these Huronian rocks are supposed to extend from the south bay of Lake Evans for about forty miles in an east-north-easterly direction, with a breadth of about thirty miles at right angles to this bearing. The rocks of this area as seen along the Broadback river consist of schists of various shades of green and dark gray, sometimes much disturbed and passing into massive greenstones, also of gray feldsites and dove-coloured arkose, with one occurrence of bluish-gray dolomite. Granular iron pyrites, sometimes stained by "copper greens" was found in several places, at one or two of which it may be in sufficient quantities to be of economic value.

Adjoining this Huronian area at its north-west angle is one of light gray hornblende-granite which is exposed on the shores at the narrows between Crow bay and the main body of Lake Evans. It appears to be nearly circular in outline, and to have a breadth of about six miles. Within it are several isolated rounded and conical hills or mountains, the southern and most conspicuous of which I have called Mount Hugh after Dr. Hugh Robert Mill. Granite area.

Huronian rocks occur, as a band running nearly east-and-west, on the course of the Nottaway river at the outlet of Lake Kelvin. The last Laurentian gneiss observed to the southward of the first appearance of this band was about the middle of the lake, and gneiss was not seen again for two miles to the northward of the outlet, so that this belt may have a breadth of between three and six miles and it may be of considerable length. On the island at the outlet of the lake, the rock consists of dark gray micaceous schist with quartz inclusions and it holds a good deal of disseminated iron-pyrites. The strike is N. 80° W. <90°. Lake Kelvin Huronian.

Since the Huronian rocks constitute the great metalliferous system of Canada, east of the Mississippi-Mackenzie depression, the discovery of the above mentioned three areas belonging to the system in this part of the Dominion and the work done in the way of subdividing the rocks of the Great Belt are of considerable importance as one of the geological results of the two seasons devoted to the survey and exploration of the region. Importance of discovery.

THE GREAT BELT.

As above stated, the rocks of the great Huronian belt in the region explored may be grouped in three classes, namely (1) crystalline schists, together with some other rocks forming a comparatively small proportion of the same series, (2) massive greenstones and (3) granites. The schists embrace a considerable variety, but the greater part of them are dark green and hornblendic or dioritic, and they often pass into more or less massive greenstones, so that it becomes difficult to map the two varieties separately. In laying down the distribution of the rocks upon the accompanying sheet, when the massive greenstones are found in minor quantity among the schists they are included with the latter in the colouring, and only the larger occurrences of distinctly massive greenstones are shown separately. These latter are intimately associated with the granites, especially in the region around Lake Mattagami and Gull lake, comparatively small bodies of the former penetrating the larger ones of granite and vice versa. Huronian of three classes.

Southern part of Huronian area.

The most southerly contact of the Huronian rocks with the gneiss is in the vicinity of the height-of-land, where it passes close to the northern extremity of Grand Lake Victoria. These rocks are found on the shores of all the five lakes of the group at the sources of the Bell river, folded among the sinuosities of the boundaries of the gneiss which latter occurs on all sides of this area except to the north-west. Around Lake Simon, the uppermost one of the group, the rocks consist entirely of dark-green dioritic schists, having a westerly strike. They are of the same character on the lower part of Obaska lake, but here the strike is northwesterly. Schists of the same kind with nearly the same strike occur at both extremities of Christopherson lake. Red granite is found on the north side of Mutchi-manito lake, but elsewhere around this sheet of water the rocks consist of green schists, with one occurrence of gray glistening mica-schist on the east side, all striking westward. Bluish-gray mica-schist, striking nearly west, was found all along Sleepy river as far as the uppermost lake, where micaceous Laurentian gneiss comes in, striking northeastward or at a large angle to that of the Huronian schists close by. A considerable area of massive greenstone occurs at Obaska lake as represented on the accompanying map.

Crystalline schists.

From the outlet of Lake Shabogama to the middle of Ka-ni-kwa-ni-ka island, a distance of 36 miles in a straight line, crystalline schists of various kinds, but mostly green or dioritic, constitute the prevailing rocks, both on the main Bell river and along the various branches which we explored. The strike in this interval varies in different localities to all points of the compass, but the general trend of the whole belt in crossing the river-valley is southwestward. An area of greenstone occurs on Lake Shabogama and another on the river just below the junction of the Kiask branch.

Granite areas.

The granite area which extends northward from Mutchi-manito lake crosses Bell river just above Shabogama lake and it is found again on the upper part of Coffee river. Another area of granite extends from the mouth of the latter river to the Kiask river, and a third is met with at Granite narrows. From Clay river to the bend in the main stream below Rain lake, both gneiss and granite occur and these rocks are believed to form the point of a Laurentian spur from the westward. The river crosses similar rocks, supposed to be a second Laurentian spur from the west, between the middle of Ka-ni-kwa-ni-ka island and the outlet of Taibi lake. Below this point, green schists were the only rocks seen all the way to the Island portage. All along the river between this portage and Lake Mattagami and around the greater part of the lake itself, as far as the widening of the North arm, the rocks consist principally of a mixture of massive and schistose diorites. These are followed to the northward by Laurentian gneiss, which appears in the north-west bay of Lake Mattagami, and by red granite at the east end and again on the North arm just beyond the diorites. Crystalline schists occur along the south side of Lake Mattagami and at the northern extremities of Lake Olga and Gull lake. The greater part of the shores of the latter lake and all the southern part of Lake Olga are surrounded by red granite. This rock was the only one found on Lake Waswanipi, excepting at one place, where schists occur apparently as a continuation of those crossing the upper part of Ka-ni-kwa-ni-ka island.

Contact of gneiss.

Various Huronian rocks.

THE LAURENTIAN ROCKS.

On the Twenty-one mile bay of Grand Lake Victoria the gneisses are much disturbed so that no general strike can be determined. At the head of Sleepy river the gneiss strikes N. 36° E. and at its contact with the schists to the south-east of Mutchi-manito lake it runs N. 16° E. On the west side of Shabogama lake opposite the mouth of Migiskan river, it is from N. to N. 15° W., but around the lower or wide part of the lake it is north-north-eastward. About the foot of Ka-ni-kwa-ni-ka Island and around Taibi lake, the general strike is south of west. Along the Nottaway river, all the way from Mattagami lake to its mouth and also along the route we followed from Gull lake to Rupert river, the prevailing strike is between west and west-north-west. The gneisses along these two traverses consist of both the mica and hornblende varieties and they are mostly gray in colour.

Gneisses.

The dips, strikes and all other bearings given in this report have reference to the true meridian.

SHEFFORD MOUNTAIN AND BROME LAKE.

GEOLOGICAL SURVEY OF CANADA
ROBERT BELL, M.D., Sc.D., LL.D., F.R.S.

REPORT

ON THE

GEOLOGY AND PETROGRAPHY

OF

SHEFFORD MOUNTAIN

QUEBEC

BY

JOHN A. DRESSER, M.A.

OTTAWA
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No 776

To Robert Bell, M.D., LL.D., Sc. D., F.R.S.,
Acting Director of the Geological Survey of Canada.

Sir,—I beg to submit a report on the Geology and Petrography of Shefford Mountain, Quebec, the field-work for which has been done chiefly under the auspices of the Geological Survey at intervals during the seasons of 1897-8-9. The accompanying map is based on the topographic survey of the late N. J. Giroux for the Montreal sheet of the Eastern Townships maps, published in Volume VII of the Annual Report of the Geological Survey of Canada, 1894, in connection with the report of Dr. R. W. Ells on the areal geology of the district.

My warmest thanks are due to Dr. F. D. Adams, Logan Professor of Geology at McGill University, for valuable aid and advice in many parts of the work; also to Mr. M. F. Connor, B.A. Sc., Radnor Forges, Quebec for three rock analyses.

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

JOHN A. DRESSER.

St. Francis College,
Richmond, Que., May 1, 1901.

REPORT

ON THE

GEOLOGY AND PETROGRAPHY OF SHEFFORD MOUNTAIN, QUEBEC

BY

JOHN A. DRESSER, M.A.

The broad valley of the St. Lawrence river, which crosses the southern part of the Province of Quebec in a north-easterly direction, separates the Laurentian highlands on the north from that part of the Appalachian system to the south, known as the Green mountains in Vermont, and as the Notre Dame, or Shickshock, range in the Province of Quebec. The valley is a nearly level plain, and in the western part of the province is about eighty miles in width. It is underlain by strata, which are often nearly horizontal in position and are of Palæozoic age, ranging from Cambrian to Devonian. In its topography, this region is sharply distinct from the undulating Laurentian which emerges from underneath it at the north-west, but is less definitely separable from the hilly country on the south-east, into which it gradually passes. Certain strata along the main axes of the Notre Dame mountains are now classed as *pre-Cambrian, but the Palæozoic members become highly contorted in many places before these are brought into view. Topography.

Across this valley a single line of hills extends in a general easterly course at about the latitude of Montreal. These hills appear at intervals of ten to twenty miles, often rising to a height of a thousand feet or more, above the surrounding plain, and form conspicuous features of that part of the valley in which they occur. †Their igneous origin and intrusive character have been long known. They were thus described by Logan in the "Geology of Canada," 1863 (p. 655): Monteregian Hills.

*Annual Report Geol. Sur. Can., Vol. III (N.S.) 1894 ; Part J.

†In a recent communication upon the subject of Mount Johnson (Trans. Roy. Soc. Can. 1902), Dr. F. D. Adams has proposed the title of "Monteregian Hills" to designate this series. A name for the series is an almost necessary convenience and hat proposed seems most aptly chosen.—J. A. D.

Logan's description.

'The palæozoic strata of the district of Montreal afford a great variety of intrusive rocks, which may be classed under the heads of trachyte, phonolite, diorite and dolerite. These various rocks appear along a line of disturbance which is nearly transverse to the undulations of the Notre Dame mountains. Commencing at the hills of Brome and Shefford, which are nearly on the line dividing the eastern and western districts of palæozoic rocks, this disturbance may be traced for a distance of one hundred and eighty miles nearly westward, to the Lac des Chats upon the Ottawa. In this vicinity the undulation, which is more gentle to the eastward, gives place to a break in the strata.

'The most important of the intrusive masses appears along this line in the form of hills breaking through the Lower Silurian strata; and are as follows, beginning with the contiguous mountains of Brome and Shefford, and going westward: Yamaska, Rougemont, Belœil, Montarville, Mount Royal and Rigaud; the last being about ninety miles distant from the first *.

'A few miles to the south of Belœil is Mount Johnson or Monnoir, another intrusive mass; which, although out of the range of those just mentioned, apparently belongs to the same series. The mineral composition of these rocks varies greatly, not only for the different hills, but for different parts of the same one. Thus, Shefford and Brome mountains consist of granitoid trachyte; while the succeeding one of Yamaska, and Rigaud at the other extremity of the line, are partly of trachyte and partly of diorite. Monnoir and Belœil are made up of diorite; while Rougemont, Boucherville,† and Mount Royal consist in great part of dolerite; presenting, however, many varieties in composition and sometimes passing into pyroxenite. The dolerites of Rougemont and Mount Royal are cut by dykes of trachyte; similar dykes also traverse the dolerite of Yamaska, and may perhaps be connected with the trachytic portion of the mountain. It is probable, judging from some specimens from Rougemont, that the dolerite is there intersected by veins of diorite; some of which resemble that of Belœil and others that of Mount Johnson. Dykes both of trachyte and dolerite are also found traversing the sedimentary strata in many localities in the vicinity of these great eruptive masses.'

Shefford and Brome mountains.

* The recent investigations of Mr. LeRoy, (Bull. Geol. Soc. Am., 1900), show that Rigaud may belong to the Laurentians, which would thus shorten the line of intrusives, Mount Royal, the next undoubted member of the series being about fifty miles from Shefford.—J. A. D.

† or Montarville.

The mountains of Brome and Shefford, with which this series appears to end towards the east, are separated from each other by some four miles of stratified rock, and Yamaska, the next mountain of the series, is eleven miles distant from Shefford. Concerning the relative positions of these mountains Dr. Ells* says: 'Brome and Shefford occur along the line of contact between the Cambro-Silurian and Cambrian rocks, while Yamaska mountain is situated on the line of fault between the Sillery division of the Cambrian and the Lower Trenton formation. It is probable that the Shefford and Brome extrusion is also along a fault line, the presence of which is not so clearly indicated as that on which Yamaska mountain lies, although the amount of dioritic matter is much greater at Brome.' Position described by Dr. Ells.

The extreme length of Shefford, which is the smallest of these three mountains, is three and a half miles, its greatest breadth two and a half, and its area somewhat less than nine square miles. Extent.

The mean altitude of the surrounding plain is approximately five hundred feet above sea level,** but the mountain rises in two ridges from one thousand to twelve hundred feet higher. The intervening 'notch' between these ridges is, on the south and west sides, about seven hundred feet above the base of the mountain, or nearly twelve hundred feet above sea-level. Altitude.

The sedimentary strata which surround the igneous part of the mountain, consist of quartzites, conglomerates and light and dark gray slates. The last mentioned rocks are described by Dr. Ells as belonging to the Lower Trenton formation, while the others are referred by him to the Cambrian system. All these rocks strike in a N. N.E. direction and dip at varying angles; always, however, above 45° towards the W.N.W. They have a nearly vertical cleavage, which agrees in the direction of its strike with the stratification. Surrounding rocks.

Near the contact with the igneous portion of the mountain, the sedimentary rocks "pitch" or dip longitudinally away from it at high angles. They wrap around the base of the mountain, mantling it with a hardened contact zone, to a height of three hundred to a thousand feet above the plain, *loc. cit., varying with the amount of glaciation.

The mountain thus attests the enormous amount of erosion which the whole region has suffered, its present elevation above the surround- Relief due to erosion.

* Annual Report Geol. Surv., Can. Vol. vii, (N.S.), p. 73 J.

** West Shefford station on the Canadian Pacific Railway, is 440 feet above mean sea-level. Can. Pac. Ry. profile, P. Alex. Peterson Chief Engineer. The other elevations given are the means of several aneroid measurements from this station.

ing plain being evidently due to the greater resistance to denuding agencies that is offered by the igneous than by the little altered sedimentary rocks. For, in addition to the facts just cited, there is a large mass of black slate, similar to that which was said to be of Trenton age, on the highest ridge of the mountain above Knotts' corner. It is scarcely more altered than that near the contact at the base, and is penetrated by dykes from the underlying igneous rocks, which, in the area beneath it, are of two different ages of intrusion.

This slate covers an area of not less than a quarter of a square mile and its thickness near the head of Plamondon's wood slide was estimated at one hundred feet. From these facts, together with the entire absence of any tuff-like material, and the holocrystalline character of the igneous rocks, it is inferred that Shefford mountain is an uncovered A laccolite. laccolite rather than the denuded 'neck' of a once active volcano. This view is also corroborated by the occurrence of smaller patches of sedimentary rock in several other places on the igneous portion of the mountain.

THE CONTACT.

Ektomorphic contact phenomena. An approach to the contact of the sedimentary with the igneous rocks is generally well indicated in the former by the development of a rusty-brown colour. In the quartzite the alteration is comparatively inconspicuous, the zone of discoloration being never more than a few yards in width, while in the black slates the rusty colour and other evidences of local metamorphism are quite distinct at a distance of one hundred yards from the contact. Where they are especially altered the slates often resemble fine trap rocks so closely that their actual character cannot be ascertained without seeing a freshly fractured surface.

Along the actual contact they are commonly reduced to a 'gossan-like' mass resulting from the oxidation of the large amount of iron sulphides which have been developed in the slates by igneous meta-Pyrrhotite. morphism. These are usually in the form of pyrrhotite and are extremely oxidized.

These sulphides, where unaltered, are sometimes evenly disseminated throughout the rock, but at others are segregated in small masses, which on alteration produce rusty or brown spots on the weathered surface four or five inches in diameter, (plate iii.).

A specimen of the black slate was taken about two hundred yards from the contact with igneous rocks near Dounan's quarry. It is a dark steel-gray rock with a good slaty cleavage and shows a rusty colour along the joint planes. The specimen when taken was thought to be entirely unaffected by the intrusion of the mountain mass.

Altered slates.

On the sawn surface fine light gray lines are quite apparent, which were not previously noticed, and under the microscope these are found to be crystalline feldspar. The greater part of the dark-coloured layers consists of magnetite, with possibly a little graphite, and feldspar grains. Shreds of mica, generally colourless, are also present. Besides the light coloured, feldspathic bands, the rock contains numerous rounded spots also of a lighter colour. These are so small as not to be noticeable to the naked eye. They differ from the rest of the rock in showing no banded structure, the dark minerals which are in smaller grains being evenly distributed in them. The spots are therefore regarded as an incipient form of alteration which has evidently taken place since the foliation of the rock was well advanced, if not quite completed, and hence as probable contact phenomena. The light-coloured bands appear to be only miniature veins of feldspar, such as might occur in any part of the regionally altered rocks, and are not thought to be due to contact metamorphism.

Four specimens from the slate cap on the top of the mountain, which was referred to amongst the evidences of laccolitic structure, show that rock to consist of feldspar and brown mica with smaller amounts of magnetite and pyrite. In thin sections from specimens near the contact, the feldspar and mica are recrystallized and form a mosaic-like structure, the individual grains being bounded by polygonal outlines.

The oxidation of the pyrites in this mass, as in the contact previously described, gives much of the rock a reddish-brown colour.

Mica-schist.

A specimen from the light-coloured mica-schist near the base of the mountain, was taken about twenty yards from the contact near Beauregard's corner, is similarly discoloured in streaks by the alteration of pyrites which here occurs in cubical grains about $\frac{1}{16}$ inch in diameter. The feldspar is in part little altered from its original clastic character, while in other parts it is recrystallized, presenting much the same appearance as in the previous specimen. The mica here is in shreds, and some ferruginous matter that is present is in string-like forms following the cleavage of the rock.

Quartzite.

Quartzite comes in contact with the mountain for a short distance on the east side, and also on the west. It is best seen on the north side of the road leading from McCutcheon's corner to the mountain, where it contains a considerable amount of feldspar, and has rather the composition of quartzose sandstone. It is but slightly altered at a distance of fifteen yards from the contact.

Conglomerate.

The principal sedimentary rock, besides those already mentioned, is a conglomerate, which may be seen at West Shefford, on the Central Vermont Railway. It consists of feldspar, biotite, quartz, augite, hornblende and magnetite in order of importance. The larger grains are comparatively few, and are either feldspar, which may be either plagioclase or orthoclase, or more commonly, quartz. No composite grains of larger size were distinguished. Much quartz appeared also in veins or irregular masses of secondary origin. But even these are often broken and faulted, sometimes showing very distinct strain shadows, the results of pressure subsequent to their deposition.

The dark minerals, of which biotite is the chief, in places, make up nearly half the rock. The structure is highly schistose, the larger nodules giving the appearance of a rather fine augen gneiss.

Few dykes

The sedimentary rocks are invaded by dykes from the main mass of the mountain in several instances, but on the whole somewhat rarely, while dykes, more recent than the mountain, cut both it and the sedimentary strata much more frequently. Fragments of the surrounding sediments are occasionally included in the margin of the igneous mass and the stratified rocks are much contorted in many places at the contact, yet on the whole the intrusion of the body of the mountain does not seem to have been accompanied by any very violent catastrophic action.

IGNEOUS ROCKS.

Kinds of igneous rock.

Three main classes of igneous rocks are easily distinguished in the field. The first is a rock of dioritic aspect, which weathers to a dark brown and shows a predominance of dark minerals. Detailed examition shows it to belong to the *Essexite* group. The second is almost wholly composed of rather coarsely crystalline feldspar. This is classed as *Nordmarkite.*

The third resembles it, but generally shows a somewhat porphyritic structure, and near the contact with the other rocks becomes still finer in texture and often assumes a greenish shade. It is *Pulaskite.*

Structural relations.

Their structural relations are clearly defined, each being the product of a separate irruption. The first is penetrated in many places by dykes of each of the other rocks, and the second by a large number of dykes of the third. The contacts of the different masses with one another can be seen and in all cases corroborate the evidence of the dykes. The second mass has generally been intruded along the former line of contact between the earlier igneous and the sedimentary rocks, although it also divides the former into two parts, while the third has been injected between the other two igneous rocks. These relations can be most easily seen by a reference to the accompanying map.

Essexite.

ESSEXITE.—This is a rather coarsely crystalline rock of granitic texture, dark-gray in colour and weathering to a dull brown. On a fresh fracture, feldspar is seen to be the most abundant of any one class of constituents, and by the aid of a pocket lens part of it can be seen to be striated by polysynthetic twinning and hence is triclinic.

Hornblende.

The most conspicuous of the dark minerals present is hornblende, which is of a black or dark-brown colour and varies considerably in amount. In some of the contact phases it makes up fully half of the rock, but in general it is quite subordinate in amount to the feldspar. In typical parts of the essexite it is also exceeded in amount by a light coloured variety of augite which it is difficult to discern in the rock by the naked eye. Brown mica is often closely associated with the hornblende, probably by intergrowth due to contemporaneous crystallization.

Feldspar.

A mechanical separation of a specimen of this rock (No. 179) plate iv, was made by Mr. O. E. LeRoy at the petrographical laboratory of McGill University by means of Thoulet's solution, and the following specific gravity determinations of feldspars were obtained. When the specific gravity of the liquid was reduced from 2·689 to 2·651, much feldspar fell; between 2·651 and 2·62, much feldspar both in clear and also in turbid grains; between 2·583 and 2·524, a smaller amount of feldspar, all turbid. There were no lighter constituents.

Specimens of the powder taken at 2·524, 2·62, and 2·651 were mounted in Canada balsam and ground for microscopic examination.

Orthoclase. The first shows no striation and in ordinary light is quite turbid. It is presumably all orthoclase. Of that which fell at 2·62, the clear grains are finely striated by polysynthetic twinning, to the plane of which the extinction is nearly parallel. They are oligoclase or andesine. The turbid grains of this weight are mostly composite, being made up of orthoclase and a heavier constituent, but a few are found to show albite twinning and an extinction angle of at least 30°.

Oligoclase-andesine.

Labradorite. These are doubtless altered labradorite. The grains having a specific gravity between 2·651 and 2·689 showed the same differences in diaphaneity as those taken at 2·62, but the clear grains are here labradorite since the extinction angle on the twinning lamellae rises to 36°.

These three feldspars may also be distinguished in the thin section, where the oligoclase-andesine, which is in the greatest amount, is seen to differ from orthoclase by twinning structure and from labradorite by its small angle of extinction, finer twinning lamellae and more allotriomorphous outline. The labradorite constitutes the largest and best formed of the feldspar crystals.

Microscopic features. In thin sections from typical parts of the rock (specimens 179, 177, 174, 147, 146, 142, 141 *et al*) the minerals were found as follows in order of relative amount.

Essential constituents: Plagioclase, orthoclase, augite, biotite, hornblende.

Accessory constituents: Magnetite, sphene, apatite, quartz (rare); with leucoxene as a secondary constituent.

The structure is hypidiomorphic, and the order of crystallization, the normal one for plutonic rocks, that of decreasing basicity. The ferro-magnesian constituents enclose the usual basic accessories, apatite, sphene and magnetite, and are themselves generally of an earlier crystallization than the feldspars. Of the latter, the more basic plagioclase shows the strongest tendency to assume idiomorphic forms, while both it and the more acidic varieties of plagioclase are cemented together by orthoclase.

Augite. The *Augite* is colourless, or of a light greenish-gray colour, and is without perceptible pleochroism. In polarized light, extinction takes place when the plane of either nicol bisects the angle of cleavage, which is nearly a right angle, in sections approximately parallel to OP, while the angle of extinction on the vertical axis rises to 45° as the zone of the clinopinacoid is approached.

Hornblende is trichroic, ranging in colour from deep chestnut to yellowish brown in ordinary light, its scheme of absorption being $\mathfrak{c} < \mathfrak{b} > \mathfrak{a}$. The greatest angle of extinction, $c \wedge \mathfrak{c}$, that was observed was 27°.

Biotite frequently encloses augite and seems to have generally crystallized later than that mineral. In some specimens (No. 147) an excellent micropoikilitic structure is thus produced, a number of augite individuals being set promiscuously in the larger crystals of biotite*.

Accessory constituents.

Sphene is an abundant accessory and occurs in characteristic wedge-shaped individuals, and also in larger columnar sections. It sometimes polarizes very brilliantly.

Iron is constantly present in small grains commonly enclosed in some of the ferro-magnesian silicates. It has the general characters of magnetite and the presence of leucoxene indicates its probable titaniferous character, as sphene was not observed to be altered to that mineral.

Apatite occurs in the usual forms and position, but in places becomes a very prominent accessory.

Chemical composition.

The structure and mineral composition of this rock ally it with the essexite group and the chemical analysis quite establishes this view. The variety and character of the feldspars, the features of the bisilicates and the prominence of apatite and sphene as well as the occasional occurrence of nepheline and sodalite in very subordinate amounts on the one hand, and quartz in even still smaller proportions on the other, indicate a magma intermediate in composition between diorite and theralite. The specimen for analysis (No. 179) plate iv, was taken from the more acid portion of the mass (Morriseau's quarry).

In its chemical composition this rock seems most nearly equivalent to the essexite from Rongstock, Bohemia, being in this case somewhat higher in silica than the original essexite of Salem, Massachusetts. Its resemblance to the augite-diorite of Rosita Hills, Colorado**, especially to its orthoclase facies is also noticeable.

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* 'On the use of the terms Poikilitic and Micropoikilitic in Petrography.'—G. H. Williams—The Journal of Geology, Vol. 1, No. 2.

** W. Cross, U. S., Geological Survey, 17th Annual Report, Part II, p. 291.

The analysis has been made by Mr. M. F. Connor, B.A.Sc., of Radnor Forges, Quebec.

—	I	II	III	IV	V
$Si O_2$	53·15	50·50	50·47	53·80	47·94
$Ti O_2$	1·52	1·91	·51	·43	·20
$Al_2 O_3$	17·64	17·64	18·73	20·13	17·44
$Fe_2 O_3$	3·10	5·41	4·19	3·57	6·84
Fe O	4·65	4·02	4·92	2·63	6·57
Mn O	·46	—	·11	·29	—
Ca O	5·66	7·91	8·82	5·60	7·47
Ba O	·13	—	—	—	—
Mg O	2·94	3·33	3·48	2·26	2·02
$K_2 O$	3·10	3·02	3·56	4·49	2·79
$Na_2 O$	5·00	5·52	4·62	5·20	5·63
$P_2 O_5$	·65	·92	·10	·56	1·04
$C O_2$	·39	—	trace.	—	—
$S O_3$	·28	—	—	—	—
Cl	·07	—	trace.	—	—
$H_2 O$	1·10	·45	·58	·90	2·04
	99·84	100·63	100·09	99·86	99·92

I. Essexite. Shefford (No. 179). Analysis by M. F. Connor.
II. " Rognstock, Bohemia. Quoted in 'Elemente der Gesteinslehre,' by Prof. Rosenbusch.
III- Augite-diorite (olivine facies), Mount Fairview, Rosita Hills, Colorado. This rock is also included in the Essexite group by Prof. Rosenbusch, loc. cit.
IV. Augite-diorite (orthoclase facies). Ibid.
V. Essexite. Salem Neck, Massachusetts.

CONTACT FACIES.

Endomorphic contact.

Along the original contact zone, the dark minerals are in increased amounts, and the texture of the rock becomes variable.

Couplands lake.

In a section exposed for a time during the construction of an aqueduct from Couplands lake to the town of Granby the contact facies were well shown. For forty yards from the contact the rock was fine-grained, and about one-half of it was made up of black hornblende. By a sharp transition, the rock then became exceedingly coarse for the next thirty yards, and the proportion of hornblende was somewhat increased. The hornblende crystals here are seldom less than half an inch in the smallest dimension. It next returned quite abruptly to the fine-grained type for two hundred and ten yards, when it passed more gradually into the normal type.

These phases are sometimes finer, at others coarser, than the texture of the main mass, but are marked by no other change of structure, unless possibly that the earlier crystallization of the hornblende than the feldspar is less apparent. (plate iii). The mineral composition, however, changes by a distinct increase in the amount of hornblende and decrease in augite, while the minerals sodalite* and nepheline* appear as accessary constituents. These are found chiefly in the coarser band that has been mentioned, but are not entirely confined to it.

Essexite of Massachusetts compared.

The rock then becomes practically identical in microscopic character with the essexite of the type occurrence at Salem, Massachusetts, which has been described by J. H. Sears, (Bulletin Essex Institute, 1891). Many of the finer specimens bear a strikingly close resemblance, both to the naked eye and in the thin section, to a type specimen for which I am indebted to Mr. Sears. These features are best shown in sections 102, 117, 144, 156, 202, 203, *et al.* One or two of these (202, 117) approach very closely to theralite.

Olivine, which is a variable constituent of the Massachusetts essexite, and also marks the more basic facies in the Rosita Hills, has not yet been found at Shefford, except at a single narrow dyke about one and a half inches in width, whose relations to the other igneous rocks could not be well ascertained. It is thought to belong to the later theralite dykes, but may be an offshoot from the essexite.

The breadth of the altered zone varies considerably, yet it was found wherever the contact could be well observed. Near Couplands lake, as noticed above, it was two hundred and eighty yards wide, and on the 'mountain road' at Lavigne's hill it is not less.

On the other hand at the southwest side of the mountain near Knott's corner, and also on the extreme opposite side, at Morriseau's quarry, no evidences of contact metamorphism could be seen at a distance of ten yards from the sedimentary rocks.

PEGMATITIC FORMS.

Pegmatite.

Another phase of this rock, whose occurrence could not be very well defined although it is quite extensive, as it appears continuously for half a mile in one direction, is distinguished by a very coarse texture and a singular reversal in the order of crystallization of the feldspar and hornblende.

*Both these terms are used throughout this sketch in the generic sense. The former mineral is sometimes a colourless variety in rounded or polygonal outlines with characteristic dust-like inclusions, and at others it occurs in strings between the feldspars and is blue in colour. In both cases it is isotropic. The latter is usually much decomposed and might be more precisely called elæolite.

Large individuals of hornblende, frequently measuring from two to three inches in each dimension, here enclose great numbers of small well formed feldspars, producing a very distinct poikilitic structure.

When light is reflected from the cleavage faces the hornblendes appear to be unbroken individual crystals, but on closer examination half their area is sometimes found to be occupied by the included feldspars. Hornblende is the chief of the dark minerals which can be seen on the fresh surface by the unaided eye, the large interspaces between the hornblende areas showing only white or light-gray feldspar. (plate v, fig. 3).

Under the microscope the crystals of feldspar in the dark portions of the rock are found to be set in large fields of hornblende without reference to the orientation of their host or of one another. They are often extremely well formed showing that they had reached their present degree of crystal growth before their inclosure by the later formed crystals of hornblende.

Character of crystallization.

This order of crystallization is in direct exception to that prevailing amongst eruptive rocks, viz. that of decreasing basicity, as defined in the 'laws' of Prof. Rosenbusch, according to which the ferro-magnesian minerals are formed in a cooling magma earlier than those of the feldspathic series. The principal exception to this law, is the case of the diabases in which augite crystallizes contemporanously with if not earlier than, feldspar. This, however, is commonly regarded as conforming to Rosenbusch's second law that the combinations of smaller amount in a magma crystallize out the earlier. Of the other ferromagnesian silicates, augite appears in its usual position in relation of the feldspar, that is, distinctly earlier in crystallization, and enclosed by the biotite which is frequently intergrown with hornblende. The feldspar thus inclosed appears to be chiefly plagioclase and of the most basic character that is found in any of these rocks. The twinning lamellæ are broad and the extinction angles measured upon them rises to 40°, indicating basic labradorite or bytownite.

Bytownite. Apatite.

Apatite crystals are large and numerous, the mineral almost assuming the proportions of an essential constituent.

The mode of occurrence of this phase of the rock gives no discernible clue to the origin of the structure. It appears to be in segregated masses, certainly not in veins or with vein-like structure, and occurs both in the zone of contact and well removed from it, hence it cannot be regarded as a contact phenomenon. The nature of the rock precludes the idea of the structure being of secondary origin, hence it must be attributed to the conditions of the primary solidification of the rock, perhaps analogous to those under which pegmatite is formed. Pegmatite, which was formerly regarded as a more or less distinct rock species, is now generally considered as a possible varietal phase of almost any deep-seated rock, distinguished from the normal rock of its type by a more acid composition, usually by the presence of rare minerals, and certain structural differences, the whole being ascribed largely to the accumulation of water attendant upon the last stages of the progressive crystallization of a cooling magma confined under considerable pressure.* It is especially marked by peculiar mineral intergrowths produced by the nearly contemporaneous crystallization of minerals which usually form in succession, as quartz and feldspar granitic pegmatite, which produce the structure known as graphic granite, or in microstructure, as granophyre, or microgranite. In such cases the relation of quartz to feldspar in respect to their changed order of crystallization is quite analogous to that between feldspar and hornblende in the quartz-free basic rock of Shefford. Origin of pegmatite.

Basic or Amphibolitic Segregations.

Irregular patches of fine dark rock material occur frequently in the essexite. Hornblende can be distinguished in them with the unaided eye, and under the microscope is found to be the only constituent of importance besides plagioclase feldspar. There is a smaller amount of magnetite also present. The hornblende is generally green, and the feldspar always plagioclase. They have thus the composition of amphibolite, but have not the schistose structure which is a common though not an invariable characteristic of that rock. These masses appear in irregular string-like forms, ranging in size from a few inches in either dimension, to bodies commonly fifteen or twenty feet in length and perhaps a foot wide. One such mass was found which was exposed for over one hundred yards in length and about fifteen in breadth. It is intersected in many places by offshoots from the enclosing essexite in different directions giving it the appearance of an Amphibolite.

*W.C. Brögger.—'Die Mineralien der Syenitpegmatitgange der südnorwegischen Augit-und Nephelin-syenit," I Theil, pp. 215-225, translated by N. N. Evans, Canadian Record of Science, Vol. VI, Nos. 1 & 2, pp. 33–46 & 61–71.

A. Harker.—'Petrology for Students,' Cambridge, 1897, p. 25.

G. H. Williams.—"On the Origin of the Maryland Pegmatites," XV. Rept. U. S. Geol. Survey, pp. 675-694.

A. E. Barlow.—Annual Report Geol. Surv. Can., Vol. X, (N.S.) part I, pp. 61–67.

W. O. Crosby and M. L. Fuller.—Technology Quarterly, Vol. IX, Dec. 1896, pp. 236-356.

inclined sediment invaded by the igneous rock. A block of this is shown in an accompanying figure, plate II. The mineral composition of these masses, however, seems to be so widely different from that of any of the sedimentary rocks of the locality as to make it a more probable theory of their origin that they are due to primary segregation. Yet it is one that requires still further evidence to be fully verified.

WEATHERING.

Disintegration.

The essexite is generally fresh in specimens obtained at any considerable depths, as in open quarries, yet the disintegration is strongly marked at a depth of eight feet in the excavations for the Granby waterworks, near Couplands lake, at a point where glaciation appears to have been quite as heavy as usual. Wherever decomposition is seen, calcite seems to be an important resultant product. This, together with the release of the potassium attendant on the breaking down of the orthoclase molecule (for orthoclase besides being the last to crystallize is the first to yield to disintegrating agencies) gives a considerable degree of fertility to the rock waste. Little of the virgin forest (conifers) remains, but a thrifty second growth (deciduous) is borne by a soil of angular grains of feldspar all but destitute of the slightest vestige of leaf mould. Roots can be seen penetrating the joint cracks of the rocks, and by their growth in size forcing the divisions of the rock apart. This healthy vegetation is, however, attributable in no small degree to the regular rainfall of the district, which amounts to about forty inches per annum. Pomological experts claim that the apples which are raised in great abundance on these eruptive hills are distinguishable by their flavour from those on the surrounding plain of stratified rock.

Effect on vegetation.

Spheroidal weathering.

The tendency of the essexite to weather into spherical forms by casting of concentric shells is well shown in the mountain road, near Lavignes brook. Here rectangular blocks have been largely reduced to rounded forms, leaving less surface in proportion to their volume.

Nordmarkite described by Logan.

2. NORDMARKITE.—The second variety of intrusive rocks in order of age is described by Logan (Geology of Canada, 1863, p. 656), as 'being made up in great part of a crystalline feldspar, with small portions of brownish black mica, or of black hornblende, which are sometimes associated. The proportion of these two minerals is never above a few hundredths, and is often less than one hundredth. The other mineral species are small brilliant crystals of yellowish sphene, and

others of magnetic iron, amounting together probably to one thousandth of the mass.'

It varies from a light-gray, almost white, to a fawn colour, and in some parts shows very noticeable amounts of the darker minerals, being often stained by oxide of iron to a light buff colour. Though not discernible by the naked eye, there is a nearly colourless augite present, which commonly equals the hornblende in amount, and is a rather more persistent constituent.

Microperthite

In thin sections of specimens that are considered typical, the essential constituents are feldspar and augite, the latter scarcely rising above accessory proportions (plate V, fig. 4). The feldspar in such specimens is wholly in the form of the interesting orthoclase-albite intergrowth, microperthite. The following analysis shows its composition, and comparison analyses are added of the original perthite from Burgess, Ontario, kryptoperthite from Laurvik, Norway, and an orthoclase from the keratophyre of Marblehead, Massachusetts. No. I, II, IIa and V are taken from the Geology of Canada, 1863, pp. 474-6 and 657; III is cited in 'Igneous Rocks of Arkansas,' Vol. II, Geological Survey, Arkansas, 1890, p. 60, from "Syenite-pegmatitgange,' W. C. Brögger, p. 524; IV is given in Bulletin of the Museum of Comparative Zoology, Cambridge, Mass., Vol. XVI, p. 170, 'Keratophyre, from Marblehead Neck,' J. H. Sears.

The microphotograph numbered IV is from a specimen taken probably from the same exposures as that analysed under No. I, while in the locality assigned to Nos. II and II*a* the only form of feldspar that could be found is also microperthite.

All the analyses are of feldspar only. In column VI the approximate theoretical composition is given of a soda-potash feldspar made up of albite and orthoclase molecules in the proportion of 3:2.

Chemical analyses.

ANALYSES.

I. Feldspar—Shefford. Analysed by Hunt. Described by Logan.
II. Feldspar—Brome. " " " "
II*a*. Feldspar—Brome. " " " "
III. Kryptoperthite—Laurvik. " Gmelin " Brögger.
IV. Anorthoclase—Marblehead Neck. Analysed by Chatard. Described by Sears.
V. Perthite—Burgess. " Hunt. " Logan.
VI. Approximate theoretical composition of feldspar having the formula $Ab_3\ Or_2$.

—	I	II	IIa	III	IV	V	VI
SiO_2	65·15	65·70	65·30	65·90	65·66	66·44	67·06
Al_2O_3	20·55	20·80	20·70	19·46	20·05	18·35	19·00
Fe_2O_3	....	....	....	·44	Trace.	1·00	
Mn O	....	....	....	....	·13		
Ca O	·73	·84	·84	·28	·67	·67	
Mg O	....	....	*	....	·18	·24	
K_2O	6·39	6·43	*	6·55	6·98	6·37	6·93
Na_2O	6·67	6·52	*	6·14	6·56	5·56	7·00
H_2O	·50	·50	*	·12	{†·91 ‡1·28}	·40	
	99·99	100.79	....	98·90	100·64	99·03	99·99

* Incomplete. † At 110°. ‡ Above 110°.

These analyses show clearly the chemical identity of the feldspars here compared. It is noticeable, however, that in minerals from Shefford and Brome, sodium is slightly in excess of potassium, while the proportions are reversed in all the others cited. An analysis of microperthite from pulaskite at Moultenborough, New Hampshire,* however, shows potassium to be slightly subordinate to sodium in amount.

Augite. The augite of this rock occurs in a few stout columnar crystals, and in ordinary light is either colourless, or has a pale greenish tint without perceptible pleochroism. It is frequently associated with smaller grains of magnetite, and both may enclose needles of apatite.

Hornblende. The hornblende is green in colour, never brown as in the essexite. Sections parallel to $\mathfrak{c}$ = deep-green; $\mathfrak{b}$ = yellowish-green; $\mathfrak{a}$ = straw colour. The scheme of absorption is accordingly $\mathfrak{c} < \mathfrak{b} < \mathfrak{a}$, and the maximum extinction angle that was observed, $c \wedge \mathfrak{c} = 26°$, practically the same as in the brown hornblende. It is sometimes more abundant than augite, and at others nearly or altogether wanting. The same may be said of the occurrence of biotite. This mineral is of a deep brown colour in ordinary light and polarizes in brilliant tints, probably indicative of a larger proportion of iron than usual in its composition.

Biotite.

Sphene. Quartz. Sphene frequently appears, and occasionally a few grains of quartz are seen, (Nos. 166, 118, 188). One of these shows an uniaxial cross and positive sign, thus clearly identifying it.

In structure the rock is coarsely granitic, but the absence of quartz in sufficient amount to form a cementing material for the other con-

* Quoted by Prof. Rosenbusch in 'Elemente de Gesteinslehre.'

stituents tends to render the rock friable. On exposure to the atmosphere it is easily disintegrated and in places is reduced to a loose mass of rectangular grains of feldspar for several feet in depth.

Compared with some of the syenite types of southern Norway, which have been made classic by the work of Prof. W. C. Brögger, the resemblance is found to be a very close one. It probably approaches most nearly to gray nordmarkite from Christiania, from which the chief descernible microscopic difference is in the coarser intergrowth of the feldspar of the Shefford rocks. This resemblance in microscopic characters is also corroborated by the chemical composition as shown by the accompanying analysis by Mr. Connor. Norwegian rocks.

Its similarity to the akerite type of Norway will also be noticed, as well as to that of a syenite from Mount Ascutney, Vermont.

——	I	II	III	IV	V
SiO_2	65·43	64·04	66·13	65·43	65·15
TiO_2	·16	·62	·74	·50	
Al_2O_3	16·96	17·92	17·40	16·11	20·55
Fe_2O_3	1·55	·96 }	2·19 }	1·15	
FiO	1·53	2·08 }		2·85	
MnO	·40	·23	·13	·23	
CaO	1·36	1·00	·81	1·49	·73
BaO	none	....	....	....	
MgO	·22	·59	·04	·40	
K_2O	5·36	6·08	5·60	5·97	6·39
Na_2O	5·95	6·67	5·28	5·00	6·67
P_2O_5	·02	....	....	·13	
SO_3	·06	....	....	{ FeS_2 ·07, F ·08	
Cl	·04	....	....	·05	
H_2O	·82	1·18	1·22	·58	·50
	99·86	....	....	100·18	
Less O	0·09	....	....	·04	
	99·86	101·37	99·54	100·14	99·99

I. Nordmarkite—Shefford—(No. 166). Analysis by Connor.
II. " (gray) Tonsenas, near Christiania. Cited by Rosenbusch, 'Elemente der Gesteinslehre.'
III. Akerite—Between Thingshong and Fjellebuns, Norway. Cited as above.
IV. Syenite—Mount Ascutney, Vermont. Jaggar and Daly. Analysis by Hillebrand. U.S.G.S. Bull. 148.
V. Feldspar—Shefford—Already quoted.

Contact Facies.

The contact zone of the nordmarkite is commonly distinguished by an increase in the dark minerals. Hornblende and biotite rise to the importance of essential constituents, while the microscope shows larger and more numerous sphenes. Nepheline is also occasionally present around the periphery of the mass, though only in very subordinate amount. The feldspar becomes more finely laminated until the perthitic structure is all but lost, becoming discernible only in parts and under high power. This gives the mineral, which has otherwise the general aspect of orthoclase, a peculiar mottled appearance, answering apparently to the characters of kryptoperthite. A few grains of finely twinned plagioclase also appear.

Endomorphic contact.

Dounan's quarry.

In a mechanical separation made by Mr. LeRoy of a specimen (No. 145) from Dounan's quarry, about thirty yards from the contact, the feldspathic constituents fell at the densities 2·62, 2·583, and 2·566. The specific gravity of the specimen selected for analysis I of the feldspars, cited from the Geology of Canada, 1863, (p. 657) was 2·561. The darker colour which these rocks acquire in proximity to the contact often gives them a marked value for decorative purposes.

It is also noticeable that while the changes in the mineral constituents which characterize the endomorphic contact zone are such as to denote a more basic composition, yet certain dykes (No. 188, 135) radiating from the mass appear to be more acid than the normal rock. In them there is no increase of ferromagnesian constituents but rather an increase of quartz, a variation which has not been found in any other part approaching the contact.

Basic Segregations.

Basic masses.

The nordmarkite also contains dark masses in which the iron-magnesia minerals are prominent. The feldspar in these becomes finely granular and sometimes shows perthitic structure under high magnifying powers. The leading dark constituent is biotite, deep brown in colour with high double refraction. It is rather distinctly idiomorphic in form. Dark green hornblende with the usual pleochroism is abundant in these masses, but usually in small crystals. No augite appears.

The dark minerals together occupy rather less than half the rock, so that it is only by comparison with the light-gray, or fawn-coloured nordmarkite that these patches appear as dark-coloured rock.

In mode of occurrence they are similar to those found in the essexite already described, and are probably analogous to them in origin.

3. PULASKITE.—The third class of these eruptive rocks differs from nordmarkite principally in having hornblende as the characteristic bisilicate instead of augite, and in its structure, which though holocrystalline, is of a porphyritic trachytic character. It is rather variable in appearance, but is usually of a gray colour and fine texture, being too fine to admit of mechanical separation of the mineral constituents. It is often coated with a dark, almost black, oxide of iron which tends to obscure these features. Small crystals of black hornblende can be occasionally detected in the finer feldspathic groundmass, and coarse nodular masses, from six inches in diameter downwards, are commonly seen. Some of these are darker than the enclosing rock, while others are considerably lighter. In the marginal portions of this rock and in the numerous dykes which it sends off into the adjacent rocks it is more distinctly porphyritic. The groundmass in such cases assumes a dull greenish shade, due evidently to the increased proportions of the ferro-magnesian minerals, and small feldspar phenocrysts are plainly seen in it. Pulaskite. Crystallization variable.

A few specimens nearer the central portions of the mass show fine greenish specks which under the microscope are found to be ægerine-augite, while in others an occasional blue spot of sodalite is apparent to the unaided eye.

By the aid of the microscope, this rock is found to consist of feldspar, hornblende, augite, biotite, magnetite, sphene, sodalite and apatite. The first four, only, are in essential amounts, and the feldspar is by far the most important of all except in the endomorphic contact zone. Mineral constituents.

The structure varies from coarsely trachytic in the central portion of the mass to porphyritic along the margin.

The phenocrysts include both orthoclase and plagioclase as well as hornblende and occasionally augite.

Of the feldspar phenocrysts, orthoclase is far the most abundant in the interior, while plagioclase largely predominates in the peripheral portions of the area and in the dykes. The increase of plagioclase at the expense of orthoclase in the phenocrysts seems to be analogous to that described by Cross* in the Game Ridge trachyte, the last member in the sequence of important eruptive rocks in the Rosita Hills. Game Ridge trachyte.

The feldspathic portion of the groundmass consists of short rather stout prisms packed together, often in parallel arrangement (fig. 5)

* 'Geology of Silver Cliff and Rosita Hills, Colorado.' Whitman Cross. 17t Annual Report U. S. G. S., 1895-6, p. 306.

Orthoclase. with a little all otriomorphicfeldspar. A few striated grains appear, which, as they extinguish parallel to or at very low angles with the twinning lines, are probably oligoclase, but fully ninety-five per cent show no striation, have a generally parallel extinction and are doubtless orthoclase.

Cross parting. A cross parting is often noticed in the smaller phenocrysts which at first was thought to be a fracture due to pressure exerted upon the rock subsequently to its crystallization. But, although other evidences of dynamic metamorphism are seen, no displacement of the parts of these crystals could be discerned. For instance, in figure 6, the five parts into which the largest orthoclase crystal appears to be divided, extinguish simultaneously.

The hornblende is chiefly green in colour, though a few of the larger individuals are brown, resembling the hornblende of the essexite, while the green is like that of the nordmarkite. Both are trichroic having the same scheme of absorption, viz: $\mathfrak{c}>\mathfrak{b}>\mathfrak{a}$, and extinction angles, $\mathfrak{c}>\mathfrak{c}$, as high as 26°—27° have been observed in each. Augite, when present is colourless, and in one instance was seen to **Bisilicates.** have a fibrous rim of hornblende. Both these bisilicates are almost wholly replaced in one part of the rock by aegerine-augite (No. 187, fig. 6, plate VI), and in the same portion both a colourless and a blue sodalite mineral are quite prominent accessories. The former is distinguished by its rounded or polygonal outlines, its isotropic character, and frequent dust-like inclusions. The latter occurs in strings and small interstitial patches, and is bright blue in ordinary and wholly dark in polarized light. Biotite occurs in comparatively few, but large, well formed individuals. Both basal and prismatic sections are seen, but present no features which call for especial notice.

Accessory minerals. Sphene is a rather abundant accessory mineral in some portions. Needles of apatite are also frequently found. A little undetermined matter occurring interstitially amongst the feldspar was thought to be altered nepheline, but may be kaolinized orthoclase.

Fourche Mountain. The structure and mineral composition of the rock ally it with the Pulaskite type of hornblende syenite, the original occurrence of which was described by the late Dr. J. F. Williams, from Fourche Mountain, Arkansas. Its chemical relation to that rock is well shown in the following analyses, as well its resemblance to the allied mica-free sub-class, umptekite.

—	I	II	III	IV
SiO_2	59·96	60.03	59·01	58·70
TiO_2	·66		·81	trace.
Al_2O_3	19·12	20·76	18·18	19·26
Fe_2O_3	1·85	4·01	1·63	3·37
FeO	1·73	·75	3·65	·58
MnO	·49	trace.	·03	·10
CaO	2·24	2·62	2·40	1·41
BaO	·12	—	—	—
MgO	·65	·80	1·05	·76
K_2O	4·91	5·48	5·34	4·53
Na_2O	6·98	5·96	7·03	8·55
P_2O_5	·14	·07	—	·10
CO_2	none.	—	—	—
SO_3	·08	—	—	—
Cl	·14	—	·12	—
H_2O	1·10	·59	·50	2·64
	99.91	101·07	99·98	100·00

I. Pulaskite. Shefford. Analysis by M. F. Connor.
II. " Fourche Mt., Arkansas. Anal. by Brackett and Smith.
III. Umptekite, Red Hill, Moultenborough, N. H. Cited by Rosenbusch, loc. cit.
IV. Tinguaite var. Sölvsbergite, Crazy Mountains, Montana. Described by Wolff and Tarr. Bull. Mus. Comp. Zoölogy, 1893, under the name "acmite trachyte" and later renamed by Dr. Wolff as above in accordance with Brögger's classification.

In the aegerine-augite-bearing portion of this mass, the texture appears rather finer and the structure is that characteristic of trachyte (fig 6, plate VI). It then closely approaches the Sölvsberg type in appearance, and, as is shown by analysis IV, does not differ radically from it in chemical composition. Mineralogically, however, it differs from the Crazy mountain type in the character of the bisilicate constituents, which are chiefly aegerine-augite at Shefford, instead of acmite and augite intergrown with aegerine. Crazy mountain.

Nodules.

The lighter coloured of the two classes of nodules that have been mentioned consist almost entirely of orthoclase feldspar, or possibly kryptoperthite, and are somewhat similar to parts of the nordmarkite. The other is composed essentially of brown hornblende with a small amount of feldspar. The hornblende is occasionally intergrown with biotite to a small extent. Nodules of this class decompose more readily than the inclosing rock, thus forming small cavities or pits in the surface, sometimes two inches in depth. No order could be dis- Complementary nodules.

cerned in the distribution of either class. They are frequently, but not always, rounded or ellipsoidal in form, and in the latter case have the longer axes parallel to the plane of the foliation of the rock. They show no evidences of radial or concentric structure as in nodules of concretionary or spherulitic origin. Their mineralogical composition shows them to be, generally speaking, complementary parts of the pulaskite magma.

In one class of nodules the only essential mineral is feldspar similar in character to the phenocrysts of the main rock, while in the other the feldspathic constituents are of minor importance to hornblende and biotite, the former of which preponderates.

Primary origin.

They appear to be best accounted for by the segregation of their component minerals during the cooling of the general magma, perhaps analogous on a small scale to the common differentiation of an alkaline magma when it produces both bostonite and comptonite dykes from the same mass.

Comparison of Igneous Rocks.

Igneous rocks compared.

In order to give a comparative view of these rocks, their mineral constituents and chemical composition are repeated in tabular form :—

Mineralogical Composition.

—	Essexite.	Nordmarkite.	Pulaskite.
Essential constituents.	Plagioclase. Orthoclase. Hornblende (brown). Augite. Biotite.	Microperthite. Augite. Hornblende (green). Biotite (variable).	Orthoclase. Plagioclase. Hornblende (green and brown). Augite (sometimes ægerine-augite). Biotite (variable).
Accessory constituents.	Apatite. Magnetite. Sphene. Leucoxene. Sodalite. Nepheline. Quartz (rare ! !).	Magnetite. Sphene. Plagioclase. Apatite. Nepheline (rare). Sodalite (rare). Quartz.	Magnetite. Sphene. Apatite. Sodalite. Nepheline.
Structure.	Hypidiomorphic.	Hypidiomorphic.	Porphyritic trachytic.

CHEMICAL COMPOSITION.

—	Essexite.	Nordmarkite.	Pulaskite.
SiO_2	53·15	65·43	59·96
TiO_2	1·52	·16	·66
Al_2O_3	17·64	16·96	19·12
Fe_2O_3	3·10	1·55	1·85
FeO	4·65	1·53	1·73
MnO	·46	·40	·49
CaO	5·66	1·36	2·24
BaO	·13	none.	·12
MgO	2·94	·22	·65
K_2O	3·10	5·36	4·91
Na_2O	5·00	5·95	6·98
P_2O_5	·65	·02	·14
CO_2	·39	none.	none.
SO_3	·28	·06	·08
Cl	·07	·04	·14
H_2O	1·10	·82	1·10
	99·84	99·86	100·17

While the field relations of these rocks are such as to leave no doubt that they are products of three distinct intrusions, their mineralogical and chemical characters as clearly show them to be genetically related.

The most basic rock was intruded first, and that highest in silica second, while the third in order of age is intermediate in composition. All are comparatively rich in alkalies, and the greatest variation in the proportion of the bases is in lime and magnesia. The extreme range of silica is 12·28 %, alumina, 2·16 %, lime 4·30 %, magnesia 2·72 %, potash 2·26 %, and soda 1·98 %. Chemical composition.

The mean between the composition of essexite and nordmarkite, in equal proportions, approximates quite closely to the composition of pulaskite, thus :

—	Mean of Essexite and Nordmarkite.	Pulaskite.
SiO_2	59·29	59·96
TiO_2	·84	·66
Al_2O_3	17·36	19·12
Fe_2O_3 } FeO	5·41	3·58
MnO	·43	·49
CaO	3·51	2·24
MgO	1·58	·65
K_2O	4·23	4·91
Na_2O	5·47	6·98

Distribution. The areal distribution of these rocks, which is most conveniently shown by a reference to the map, cannot, however, be taken as a basis for any quantitative calculation. Nordmarkite occupies about as large an area as both the others, but it appears in places to overlie the essexite, and thus the original surface extent of that rock as well as the abyssal volume of all must remain concealed.

LATER DYKES.

Dykes. Besides dykes of the various classes of rocks which constitute the main mass of the mountain, there are considerable numbers of later age which are themselves of at least two different ages of intrusion. They were generally distinguished in the field as the dark-coloured and light coloured dykes, a distinction that was easily made, as dykes of intermediate, or doubtful, shades were seldom if ever seen.

Two classes. The directions of a sufficient number were measured to ascertain that no clue to their relations could thus be obtained, but the dark dykes were found to be intersected by the light-coloured ones in several instances, while no case of the reverse relation was found. Hence the classification according to colour seemed to be a natural one, a conclusion which has been borne out by a more detailed study of their mineralogical and structural characters.

Lamprophyres. On microscopic examination it is found that the dark coloured dykes are lamprophyres, some of which by their coarser texture, presumably due to slower cooling, become an hypabyssal form of theralite, while the light coloured series consists of trachytes, which occasionally pass into bostonite. In fact the entire light coloured series probably differs in no essential respect from the bostonites of Lake Champlain described by Prof Kemp*. But as the term was employed by Prof. Kemp to emphasize their occurrence remote from any known volcanic centre, it has been thought better to use the term trachyte as the generic one in this case where dykes occur at the seat of two intrusions of a syenitic magma. The term bostonite is accordingly restricted to those specimens in which the ferro-magnesian silicates are present in less than essential amounts. In such cases too, the trachytic structure appears to be less marked.

Trachytes.

* 'The Trap Dykes of Lake Champlain,' J. F. Kemp and V. F. Marters, U. S. Geological Survey, Bulletin No. 107, pp. 18 and 22.

Lamprophyres.

Dark dykes Fins-grained.

The number of fine-grained dark dykes is large and specimens have been taken from a comparatively small number of those whose macroscopic appearance is quite uniform.

Plagioclase feldspar appears in all with one or more of the ferro-magnesian minerals. Hornblende usually predominates, but both augite and biotite are in some cases prominent essential constituents. Consequently the chief type that is clearly distinguishable is camptonite, although it is probable that a microscopic examination of all the dykes wold reveal the presence of allied mica-bearing and augitic types.

Theralite.

Coarse-grained.

The dykes referred to this class (Nos. 104, 107*a*, 175 *et al*) consist of feldspar, (plagioclase), nepheline, hornblende, biotite and augite, wish accessory sphene, magnetite and apatite. The plagioclase has low extinction angles measured on the albite twinning lamellæ. I am indebted to Dr. A. E. Barlow, petrographer of the Geological Survey, for the following gravity separations of the feldspars, as well as for certain other assistance with the dykes of this class.

Feldspars.

The first feldspar that appears in the separation is in composite grains with a heavier constituent, which fell in large quantity when the density of the Thoulet solution was 2·714. On this being reduced to 2·699 a large number of composite grains fell and also a much smaller number of clear feldspar, presumably labradorite. After a further reduction of the solution to 2·651, the proportion of clear grains that appear is greater. Hence audesine is the chief feldspar present, as at 2·62 very little material fell, and that chiefly in composite or turbid grains.

Hornblende.

The *Hornblende* is frequently light brown with a darker, or greenish rim, but both portions in such cases extinguish simultaneously. It is trichroic, the scheme of absorption being $\mathfrak{c} > \mathfrak{b} > \mathfrak{a}$. The maximum value observed for $c \wedge \mathfrak{c}$ was 13°.

Nepheline.

The *Nepheline* has crystallized rather later than the feldspar and is thus the last mineral constituent to form; consequently its outlines are almost wholly allotriomorphic. Much of it is decomposed, the alteration product of which Dr. Barlow has determined to be 'an aggregate consisting of a radiating zeolite which possesses the optical properties of natrolite, in association with which there is also a considerable quantity of colourless brilliantly polarizing muscovite. The nepheline also weathers to a dull colourless mineral dimly polarizing substance which is probably kaolin.'

In amount nepheline is nearly equal to feldspar. The other minerals present no features worthy of note. The structure of the rock is hypidiomorphic with a noticeable tendency towards ideomorphism on the part of the larger and probably more basic feldspars.

Comptonite.

Camptonite.

Idiomorphic hornblende.

This rock is characterized in the thin section by an abundance of hornblende, always in distinct idiomorphic crystals varying in the length of prismatic sections from 2. mm. to .2 mm. In fresh crystals the colour is deep brown, with the usual pleochroism, but the greater part of the hornblende is somewhat altered, and grayish brown in colour, showing little if any pleochroism. It is studded with minute rounded or irregular grains of magnetite.

Feldspar.

Feldspar, generally of a rather indistinct character, being somewhat turbid, is present in amount about equal to the hornblende. Lath-shaped individuals are, however, of quite frequent occurrence, and have an extinction angle of as much as 20° with the principal axis. Polysynthetic twinning is distinctly seen in a few cases. A little biotite and apatite are the remaining primary constituents. Secondary calcite occurs interstitally in considerable amount.

Undisturbed occurrence.

An isolated occurrence of this rock was found, the position of which is indicated on the accompanying map as '151.' It is there exposed in the bed of a small stream for about one hundred feet or more, at a distance of some five hundred yards from the igneous part of the mountain. It is inclosed by mica schist, and seems likely to be a sheet rather than a dyke. It appears to differ from the other rocks of the mountain in showing no deformation, but the area exposed is too small to furnish very reliable evidence of the difference in age which its unaltered character seems to suggest.

TRACHYTES.

Light-coloured dykes.

The dyke rocks that have the general characters of trachyte are uniformly fine in texture and of a light-gray, or buff, colour. When of the latter shade they pass into the bostonite type.

In thin section, feldspar is always largely in excess of the other constituents, and in some instances constitutes ninety to ninety-five per cent. of the entire rock (113, 148, 205). These are the bostonites. In an average specimen (No. 103) feldspar occupies about three-fourths of the field and occurs in small columnar crystals of uniform size and parallel arrangement, and a few larger individuals which are scarcely distinct enough to be called phenocrysts. They conform to the parallel arrangement of the lath-shaped microlites, which gives to the rock a decided flow structure. Bostonite.

Slender prismatic sections of hornblende and a little biotite can be recognized in ordinary light, as well as a few grains of magnetite, and a considerable amount of granular ferro-magnesian material. The hornblende is brown, and in a few instances shows pleochroism.

Some of the largest feldspars show very clearly a cross parting similar to that already noticed in the phenocrysts of pulaskite.

In those specimens in which the dark minerals are unimportant, or altogether wanting, the trachytic is less plainly shown. A dyke at the head of Plamondon's wood 'slide,' (No. 113) while it still shows a tendency towards parallelism of the feldspar, microlites, agrees in all essential respects with the typical bostonite of Marblheead Neck, Massachusetts. Another (No. 205) from the vicinity of the outlet of Couplands lake, also agrees very closely with this in the hand specimen, but under the microscope it shows a somewhat coarser texture.

A quartz-free porphyry from Range III Lot 24, of the Township of Shefford, a distance of about four miles from Shefford mountain, which was fully discribed by Dr. F. D. Adams (Report of Progress, Geological Survey of Canada, 1880-1-2, pp. 10-11 A) undoubtedly belongs to the intrusive masses of Shefford and Brome mountains. It probably agrees more closely wlth the dykes which are sent out from the nordmarkite mass, than with any of later age. Like certain nordmarkite dykes (No. 188, 135, 131) it is free from bisilicates and contains a little quartz. It differs from them chiefly in its porphyritic structure, which, however, is a feature largely dependent on the conditions of cooling. Quartz-free porphyry.

Dr. Adams thus interestingly describes it:

"This rock occurs associated with chloritic schists, and is so far as can be ascertained, conformable to these in strike and dip. In a section it is seen to be composed of a microcrystalline groundmass, Described by Dr. Adams.

holding numerous large crystals of feldspar seattered through it. These feldspar crystals have, under the microscope, a turbid appearance; they sometimes occur in simple forms, sometimes in twins according to the Carlsbad law; and one or two of them in the section showed an extinction parallel to a crystallographic axis, thereby proving that the feldspar is really orthoclase. A few plagioclase crystals, like those of orthoclase much decomposed, but showing polysynthetic twins with very narrow lamellae, are also present in the section. No quartz crystals are present in any of the three sections of this rock which have been prepared, and it has accordingly been classed as a quartz-free porphyry, although some quartz recognizable by its unaxial and positive character is present in the groundmass, so that, strictly speaking, it would probably occupy a position intermediate between the quartz and quartz-free porphyries, such rocks being by no means rare*. The rock is, however, a good deal decomposed, calcite being present in the groundmass, so that the quartz may be a secondary product.

Disseminated through the groundmass, and in smaller amount in the imbedded crystals, there are numerous opaque black grains generally irregular in shape, but sometimes occurring in little cubes. These are probably an iron ore.

Associated with these grains, at a few places in the groundmass, there is a strongly pleochroic mineral, the colours changing from light yellowish-brown to a dark-brown, and with the greatest absorption parallel to a very good cleavage. Between crossed nicols, extinction takes place when the plane of polarization of either prism coincides with this cleavage, so that the mineral is probably a magnesia mica. In a section, the groundmass appears of a light-brownish tint, the colour being due to a yellowish-brown mineral which is finely disseminated through it and which also accurs, though in much smaller quantity in the imbedded crystals, either in little patches or running with their cleavage lines."

Condition of Cooling of Dykes.

Dykes cooled slowly.

The prevailingly coarse texture of the dykes of Shefford mountain and the absence of glassy material in them point to their having cooled slowly, presumably due to their solidification at greater depth or to a heated condition of the side walls at the time of the injection

* Compare Rosenbusch, Mikroskopisch Physiographie der Massigen Gesteine, p. 129, ed. 1877.

of the dyke material. In the case of several dykes of nordmarkite (131, 135 et al.), which cut essexite, narrow off-shoots, scarcely a quarter of an inch in width, strike off for a distance of twenty to twenty five feet, but are scarcely less coarse in structure than the dykes themselves, which are from three to five feet wide. In neither the dykes nor their off-shoots is there any approach to a porphyritic structure.

The same character of crystalization appears in the later dykes as a rule, the chief exception being in the case of dykes probably belonging to the pulaskite mass. These, like the contact facies of that rock, have either a porphyritic or, more commonly, a porphyritic trachytic structure.

Dynamic Metamorphism.

All the igneous rocks composing the mass of Shefford mountain, with one possible exception, display more or less distinct foliation in a direction parallel to the folding of the sedimentary rocks of the district. Foliation is frequently best developed in bands a few yards in width, while the much wider intervening areas are much less altered. In the foliated bands an almost perfect or slaty cleavage is developed, and in much of the less altered portions of the rock there is a slight 'rift' or tendency to cleave, always in the same direction. Regional metamorphism.

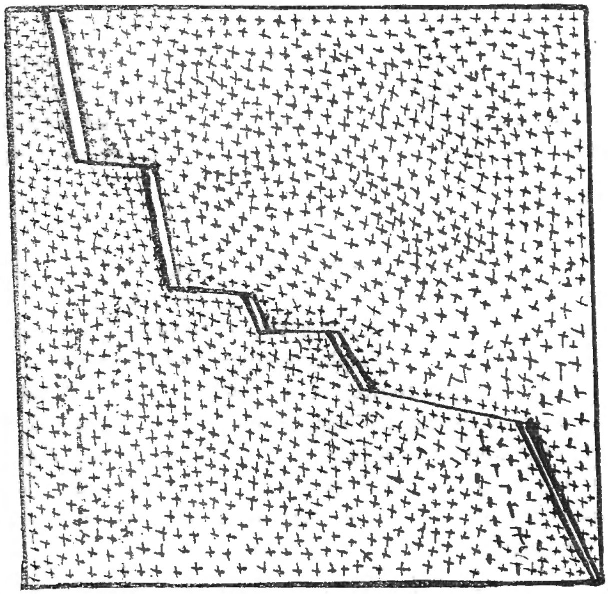
In thin sections from the least altered parts of the rock-feldspar crystals are occasionally found which are distorted and which show distinct strain shadows, thus attesting to the subjection of the rock to metamorphic agencies, at least in the final stages of the Appalachian folding.

The dykes also show evidence of subjection to pressure since their solidification. A slaty cleavage is more or less perfectly developed in both classes of dykes. That this is due to pressure is shown by the microscopic sections in which distorted crystals and grains having a wavy extinction occasionally appear. The cleavage is best shown in dykes which run obliquely to the axis of foliation. In such cases an apparent differential movement of the side walls has produced a peculiar twisted fracture crossing the dyke obliquely that is easily noticed, plate II. Cleavage.

Faulting too is well seen in numerous narrow vein-like dykes which appear in the essexite in Lavignes brook along the mountain road. Faulting.

In mineral composition and microstructure they agree completely with the bostonite dykes that have been described.

The faulting of one, about an inch and a half wide is here figured approximately to scale, the width of the vein being somewhat exaggerated.



3 feet.

Intrusions.

Owing to the intrusion of the various large masses at different periods each rock is liable to have suffered more or less deformation from the forces which caused or accompanied each subsequent intru-ion. But since the latest of these possesses a cleavage scarcely less distinct than the earliest, it too must have been in its present position before the causes of the regional foliation ceased.

There is thus ample proof that the rocks of Shefford mountain have shared in the foliation of the entire region, viz., that of the Notre Dame, or Green Mountain, range of the Appalachian system. The only possible exception is the camptonite already mentioned.

Age of Intrusive Rocks.

Important data is thus afforded for determining the age of intrusion of these rocks.

The latest sediments amongst which they have been intruded is that group of the lower Trenton formation known as the Farnham Black Slates (D 3a, map to accompany Part J, Annual Report, Geological Survey of Canada, 1894), while the earliest members of the Palæozoic system in eastern North America that have not been disturbed by the Appalachian uplift are the Permo-carboniferous of Prince Edward Island and the adjoining mainland. Accordingly, were it established that the final folding throughout all parts of the northern Appalachians took place simultaneously, the intrusion of the Shefford mass would necessarily have occurred between early Trenton and later Carboniferous time. But the simultaneous folding of so great a belt as the Appalachian system here comprises cannot be safely assumed without a better correlation of its complex structural details than is at present possible, and in consequence the latest date at which the intrusions of Shefford mountain could have taken place must meanwhile remain somewhat less precisely defined.

Age of Shefford mountain.

BASIC SEGREGATION, ESSEXITE.

DYKE SHOWING CLEAVAGE.

RUSTY SPOT IN SLATES NEAR CONTACT.

ESSEXITE, CONTACT FACIES.

Fig. 1.
ESSEXITE, POLARIZED LIGHT × 45.

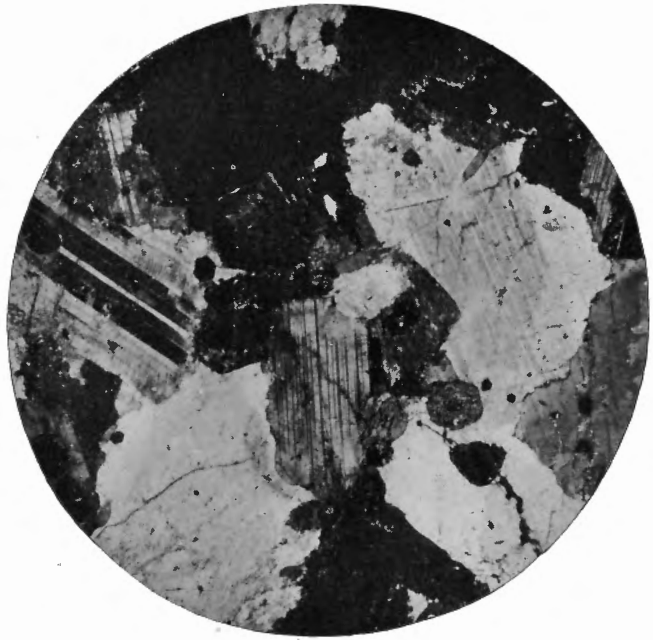


Fig. 2.
ESSEXITE, CONTACT FACIES, POLARIZED LIGHT × 30.

Fig. 3.
ESSEXITE, PEGMATITIC FACIES, POLARIZED LIGHT × 30.

Fig. 4.
NORDMARKITE, POLARIZED LIGHT × 100.

Fig. 5.
PULASKITE, POLARIZED LIGHT × 30.

Fig. 6.
PULASKITE, SÖLVSBERGTE TYPE, POLARIZED LIGHT × 45.

GEOLOGICAL SURVEY OF CANADA
ROBERT BELL, M.D., Sc.D. (Cantab.), LL.D., F.R.S.

REPORT

UPON THE

CARBONIFEROUS SYSTEM OF NEW BRUNSWICK

WITH

SPECIAL REFERENCE TO WORKABLE COAL.

BY

L. W. BAILEY, LL.D.

1902

OTTAWA
PRINTED BY S. E. DAWSON, PRINTER TO THE KING'S MOST
EXCELLENT MAJESTY
1902

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No. 799

To ROBERT BELL, M.D., Sc. D., L.L.D., F.R.S.
Acting Director of the Geological Survey.

SIR,—I have the honour to transmit for your consideration the following report upon the Carboniferous system of New Brunswick, made as the result of instructions received from the late director, Dr. G. M. Dawson, and subsequently renewed by yourself.

The report has special reference to the subject of the probable productive capacity of the New Brunswick coal-measures, and embraces a discussion, based upon personal observation, of the various considerations from which conclusions as to that capacity may be drawn. It is accompanied, in the form of an appendix, by records of the more important borings, and by a bibliography bearing upon the subject.

The report is concurrent with one by Mr. H. S. Poole, upon the comparative aspects of the coal formation of New Brunswick and Nova Scotia, in the preparation of which a large part of the former province was visited by that gentleman in company with myself during the past summer, when the topics here presented were fully discussed by us.

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

L. W. BAILEY.

FREDERICTON, March 20, 1902.

THE CARBONIFEROUS SYSTEM OF NEW BRUNSWICK.

Ever since the time of the first discovery of coal in the province, that discovery being co-incident with the first exploration of the Grand Lake region in 1782, interest in the existence of the mineral, and speculations as to its probable amount have found expression. The observations of Dr. Abraham Gesner, between the years 1839 and 1841, served greatly to intensify this interest, both by the discovery that Carboniferous rocks occupy in the province an area equal to at least one-third of its entire surface, and by the statement, now believed to be unwarranted, that the thickness of the formation and the number and size of its coal deposits were in keeping with that large superficies. Borings made at Grand Lake and elsewhere seemed to support, at least in popular estimation, the belief thus expressed, and even though some years later, as a result of the work of the Geological Survey, it was (in 1872-73) shown that the Grand Lake basin, the only one actually yielding coal in appreciable quantities, was really very thin, and that the seam of 26 inches, long known and worked near the surface, was the only one there present, people unacquainted with geological data and methods were loth to accept the conclusion arrived at, and still contended for the probable existence of other and larger seams. Then, too, the Grand Lake basin, being but a very small part of the entire area occupied by Carboniferous rocks, the question naturally arose whether there might not be other basins as well as this, and whether some of these, at least, might not prove to be more productive. To ascertain whether or not this is the case would seem at first to be an easy matter, but when it is understood that over vast tracts, indeed over almost the entire field, the coal-bearing rocks are very nearly horizontal, the upper strata thus covering all beneath them, except so far as they are revealed by erosion along river valleys, it will be readily seen that the determination of correct conclusions, otherwise than by boring, is very difficult. Such borings, it is true, have been made at a number of points, but with one or two exceptions they have been in the extreme western part of the coal field, where other facts all lead to the inference that the coal-measures

Historical summary.

Difficulty of arriving at satisfactory conclusion.

are thin. On the other hand, in the eastern part of the province, where the coal basin is widest, where the beds are nearest to its centre, and where they become directly continuous with the highly productive Carboniferous rocks of Nova Scotia, the country is, except at one or two points, a *terra incognita* as regards what lies below the surface. It would seem, therefore, very desirable that this ground should be thoroughly tested, but before incurring the expense necessarily involved in instituting any extensive series of borings, all available facts bearing upon the choice of location, probable depth, etc., need to be carefully collected and estimated. It is to aid in this direction that the present report has been prepared.

Object of present report.

It will be obvious that the question involves many different considerations, thus, the topography of the country, as being directly determined by the attitude of the underlying strata, has an obvious bearing upon the question of that attitude, as this has upon the position and spread of any coal seams which may be present. The erosion which the country has undergone, whether by the operation of glaciers or rivers, or both, has led to the removal of vast quantities of rock, and it is a subject for consideration as to how much has been thus removed, and whether such removal involved any productive coal-measures or not. In the river valleys and along the coast are the natural sections which afford the only information, short of boring, which the region offers, and these need to be carefully studied and compared. The evidences of displacement, whether by differential movements involving large areas, or confined to particular lines determining faults, require consideration. The fossils, obtained at many different localities, need to be compared, with a view to determine the horizons they represent. And, finally, a comparison of the coal-bearing rocks of New Brunswick with those of Nova Scotia, where the system is so much better displayed and has been so long and carefully studied, is of the utmost importance, for such comparison should tend to show whether the surface rocks of New Brunswick are the representatives of the lower portion only of the coal formation (in which case it would be useless to seek for serviceable seams) or of the middle or upper. The data afforded by past borings need also to be collated and compared.

Comparison of fossils necessary.

In the following pages an attempt will be made to discuss the question of possible coal supply from each of these several stand-points, with the exception of that of a comparison of the Carboniferous systems of New Brunswick and Nova Scotia, which will be the subject of another and concurrent report by Mr. H. S. Poole.

TOPOGRAPHY.

Ever since the publication, some forty years ago, of Prof. J. P. Lesley's classical work, entitled "Coal and its Topography", the intimate relationship between the surface features of a coal producing country and its underground structure has been recognized, and the study of the one, regarded as capable of throwing important light upon the other. This is more markedly true of a highly disturbed and partly mountainous region like that of Pennsylvania, to which the above named work mainly applies, but even in the case of a comparatively flat and unchanged district, such as is represented by the central coal-fields of New Brunswick, some valuable deductions may be drawn from the recognition of this relation. Relation of topography to structure.

The coal-field in question has the general form of a triangle, of which two sides, converging westwardly, are bounded by pre-Carboniferous rocks, highly disturbed and altered, while the third, forming the base of the triangle, and having a length of about one hundred and forty miles, has no natural barrier other than the Gulf of St. Lawrence. As compared with the hill ranges which confine it, the tract is, with few exceptions, low, and, except for river valleys, it presents no marked inequalities of surface, while, as compared with the sea, its elevation would probably rarely exceed six hundred feet and the general average would not be over four hundred. It is thus a great peneplain with a gentle eastward inclination, of which the irregularities are the results of erosion rather than of differential movements. At the same time, a study of the drainage system shows that, as subordinate to the general form of a broad and shallow basin, several minor undulations may be distinguished, separated by low divides, of which some are of ancient and others probably of comparatively recent origin. Form and limits of coal field. Minor undulations.

The contrast of level exhibited by the central coal-field as compared with that of its bounding sides is very noticeable wherever opportunity of surveying one from the other is afforded. Thus, from Spring Hill or other high land north of Fredericton, looking to the south and south-west, the eye appears to wander over a great plain, through which the St. John river winds a tortuous course, until in the distance the picture finds a natural setting in the range of Lower Carboniferous and older hills which bound the coal-field in that direction. So, as viewd from the ridge north of Moncton, known as Indian ridge, so uniform is the surface and relatively so low, that again all minor inequalities become lost, and one looks in vain for anything by which the local monotony of the landscape may be broken. Finally, along the line of the Inter-

Level type of scenery.

colonial Railway, from near Moncton to the vicinity of Bathurst, the flat unbroken character of the country, with consequent imperfect drainage, determines, except at a few points, scenery wholly devoid of interest, and the tract is also for the most part unfitted for cultivation. Even where, as in the case of the Nashwaak and Miramichi rivers, a more attractive type of scenery prevails, and good farming lands occur, these are almost wholly confined to the river valleys, the hills bounding which, as seen from the opposing side, appear nearly level-topped.

Minor depressions.

Of the several minor depressions indicated by drainage, the following may be noted as of importance in relation to the subject of this report, viz :—1. The Oromocto tract, including the whole of the Carboniferous area west of the St. John river in Sunbury and York. 2. The Grand Lake basin in Central Queens. 3 The Nashwaak area in York. 4. The S.W. Miramichi area, and (5) the Gulf area, including the valleys of the Richibucto, Buctouche, etc., to which, perhaps, are to be added the region of the Baie des Chaleurs and that of Shediac and Dorchester. It is not yet certainly known whether in all cases the divides separating these areas are results of surface changes, due to glacial or later agencies, or whether, as indicated in some instances by Dr. R. W. Ells, they correspond to the results of deep seated movements, but, in the case of the Grand Lake basin at least, the geologic boundary is nearly coincident with the physiographic one, and this may be true of others also. The highest divide would appear to be that lying between Cross creek, a tributary of the Nashwaak, and the S.W. Miramichi at its junction with the Taxes, the elevation here, according to the levels of the Canada Eastern Railway, being 566 feet.

Conclusions suggested.

The general conclusion suggested by the above review of the topography of the main New Brunswick coal-field would seem to be that the conditions connected with its origin were uniform, or nearly so, over the greater portion of its extent, such diversity as now exists being the result of causes operating long subsequent to the time of disposition of the strata occupying it. Hence, what is true of one portion of it is presumably true of all. Seams of coal, if existent, would be expected to spread widely, with little variation in thickness. If the strata at one point are those of the inferior or barren measures, it would seem probable that other portions are not far from the same horizon. It does not, however, follow that because the formation is

NOTE—Between Newcastle and Bathurst the mean elevation of the plateau is 414 feet, the summit on the Intercolonial Railway being 521 feet.

Between Moncton and Barnaby river the plateau has a lower mean elevation on the line of the railway of 266 feet.

proved by boring to be thick (or thin) at one point, it is necessarily so in others, as the horizontal strata may and probably do rest on an uneven floor of older rocks, and will be thick or thin, as the inequalities of the latter come near to or retire from the surface. The thickness may also, to some extent, be an accident of deposition or erosion.

EROSION.

Former greater extent of Carboniferous area.

In any consideration of the Carboniferous system of New Brunswick it is always important to recognize the fact that the representation of that system now revealed is but a fragment, relatively small, of what it once was.

In the first place, it is obvious that the great central basin, widening to the eastward, did not, in Carboniferous times, terminate with the present gulf coast. Everywhere that coast is low; everywhere the adjacent waters are shallow; and at no point in the Gulf of St. Lawrence east of New Brunswick are they deep. Prince Edward Island is separated from the mainland only by narrow straits, and the rocks of that island are largely, if not wholly of newer strata. About Baie Verte the Carboniferous rocks of New Brunswick become continuous with those of Nova Scotia, while rocks of Lower Carboniferous age crop at Smiths and the Magdalen islands and skirt the western coast of Newfoundland, part of the western shore of Cape Breton and the southern shores of the Gaspé peninsula.

Thus, all around the portion of the Gulf of St. Lawrence inclosed by the districts referred to, rocks belonging to or not widely separated from the Carboniferous system occur, and suggest the conclusion that they were at one time continuous over the intervening area. In other words, the portion of the widespread Acadian Carboniferous formation now above the sea-level is but a small fraction of its former extent, while much the thickest and deepest, and presumably the most productive portion, is now either submerged or worn away.

Carbon ferous outliers.

Nor is it only in this direction that there is evidence of loss. Around the other borders of the great central basin, where the older rocks come out from beneath those of the Carboniferous system, there is abundant evidence that these latter once spread more widely. Thus, along the western edge of the coal-field in York and Sunbury, in Cork settlement and about Oromocto lake, the edge of the Carboniferous peneplain is in the form of a long and steep escarpment, overlooking the valley of the Magaguadavic river, occupied by pre-Carboniferous rocks, while isolated patches of the first named system are found much farther to the westward, indicating a former considerable extension in that direction. To the north of Fredericton also, in the valley of the Keswick, above Cardigan station on Gardens creek and in Myshrall settlement, the same conditions may be observed. Moreover, some of the isolated Carboniferous areas in this direction are so situated as to indicate that rocks of this age at one time covered a large portion of northern as well as central and southern New Brunswick. Thus, in the parish of Prince William, in York county, occurs a small area of coal bearing rocks, resting unconformably upon what are believed to be Silurian slates, and upon granite, the interval between them and the great central coal-field being not less than thirty miles. So, between the two main branches of the Beccaguimic river, in Carleton county, and at a distance of about fifty miles from the central basin, is a similar isolated area, of considerable size, while the distribution of boulders indicate that several such areas exist between the last named river and the Lower Carboniferous tract of the Tobique. It is altogether probable that these were once connected with each other and with the central field, for their elevated position, much higher than any portion of the latter, as well as their structure and relation to the subjacent rocks, are against the supposition of their representing basins of original and separate deposition. The elevation of some of these higher Carboniferous rocks is nearly one thousand feet above the sea, and though the contrast between this and the ordinary level of the coal-measures in Queens and Sunbury may possibly in part be accounted for by differential movements, it can hardly be doubted that the facts given indicate an enormous amount of erosion, and the removal of Carboniferous rocks from vast areas once covered by them. This vast erosion is to be assigned to several periods. It is certain that after the time of deposition of the Lower Carboniferous strata, they were largely denuded, for at several widely separated points, as at Prince William in York county, and Coal creek and Newcastle in Queens county, the coal-measures rest on the earlier Palæozoic rocks, without the interposition of Lower Carboniferous deposits, as though the latter had first been swept away. Some of the coarse grits again in the upper part of the coal measures have been observed (by Mr. Poole) to contain rounded fragments of *coal*, indicating the breaking up of seams of the latter subsequent to their formation. It is probable, however, that a large part of the waste is to be ascribed to the glacial period, all parts of the coal-field showing abundant evidence of excessive glaciation, while the amount and distribution of the drift has been largely influential in determining the distribution and thickness of the mantle-covering, as well as the course and character of the existing drainage channels.

Elevation of some of the carboniferous rocks.

Period of erosion.

The subject of erosion is of interest in another way. The channels last referred to, together with the coastal sections, afford, with the exception of borings, almost the only information obtainable as to the nature and arrangement of the rocks of the district.

Erosion valleys.

The details of these sections in the gray rocks will be discussed in the sequel, but it may be pointed out here that in no case is any considerable thickness of strata revealed, and it is probable that all in the centre and eastward represent nearly the same horizon. Among them, as affording a nearly complete natural section, albeit a shallow one, across the larger part of the central basin, may be mentioned those afforded by the Nashwaak and Miramichi valleys, traversed by the Canada Eastern Railway, along the sides of which, and often for considerable distances, the cut edges of the strata are exposed in nearly vertical bluffs, sometimes 100 feet in height or more. In eastern Queens county similar bluff exposures characterize the Newcastle and Salmon river streams, while in western Queens and Sunbury they are repeated in the tributaries of the Oromocto, in the Otnabog and elsewhere. In most instances the eroded beds are those of the coal-measures (gray sandstones and conglomerates, with thin seams of coal), but on the Newcastle river the underlying Lower Carboniferous and volcanic rocks are revealed, while on Coal creek and some of the tributaries of the Canaan river, still older Palæozoic rocks have been brought to view. At no one point is a thickness of more than 150 feet of Carboniferous rocks exposed, though, even with a slight inclination, a lengthened series of exposures may represent much more than this.

Natural sections.

The coast sections illustrate the same features, though in a different way. By far the most instructive is that afforded by the shore of the Baie des Chaleurs east of Bathurst. Here for a distance of fifteen miles or more, especially between the villages of Clifton and Grand Anse, the shore presents an almost continuous series of nearly vertical bluffs, from twenty or thirty to nearly one hundred feet in height, while in places, as at Grand Anse, small adjacent islands exhibit the same precipitous character. Here too the inclination varies so little from horizontality that only by following some easily recognizable bed for a considerable distance can the fact of inclination be made evident. At various points along the gulf shore, as at Carraquette, Church point

Coast sections.

NOTE. 1.—The term coal measures as used in this report signifies no more than the series associated with the small seams of coal in the province.

2. Clifton station is 119 feet and Grand Anse 79 feet above sea level.

3. The whole thickness represented in the coast section between Clifton and Shippegan has been estimated at about 400 feet.

and the inner part of Miramichi bay, shore bluffs occur, but are less high and less continuous. Most of this latter shore is very low and without exposures.

ATTITUDES AND UNCONFORMITIES.

It will be readily understood that in any study of the coal formation, whether from a merely scientific or from an economic standpoint, the positions occupied by the strata, considered both by themselves and in relation to different divisions of the system, are of the first importance.

Horizontality of measures in central area.

In the great central Carboniferous area, as already pointed out in the discussion of its topography, the strata exposed to view are, with rare exceptions, nearly horizontal. In the very numerous sections exposed along the line of the Canada Eastern railway, following the valleys of the Nashwaak river, Cross creek and the Miramichi river, this is very conspicuous, as it is also about the shores of Miramichi bay and northward. It would however seem, as is more clearly indicated in the coastal sections east of Bathurst, that over most portions of the central field there is a gentle inclination eastward or towards the St. Lawrence gulf. It is also quite certain that there are minor undulations, though partly owing to the prevalence of false bedding and partly to the want of continuous outcrops, these foldings cannot always be clearly made out.

Grand Lake basin.

One fairly distinct basin is that of which Grand lake, Queens county, is the centre; this being indicated not only by the reverse dips clearly seen on its northern and southern sides, but by the fact that on each of these sides the rim or margin is shown, at least in part, by the coming to the surface of inferior beds. It is very probable that the valley of Coal Branch, in Kent, represents another basin, possibly continuous with the last, and having as its northern margin the swell of land lying between the valley referred to and that of the Miramichi. Doubtless, still other basins exist, but they are so shallow, and at the same time so concealed by soil and forest, that their recognition is difficult or impossible.

Exceptions to horizontality.

While very low dips are, as stated, characteristic of the central basin, some notable exceptions occur. Of these, one of the most remarkable is to be seen upon the right bank of the St. John river about four miles above Fredericton, where, over a small area, rocks, not distinguishable in character from the nearly flat coal-measure sandstones, not far off, have an inclination approaching verticality.

This is probably the result of local faulting, such as would be likely to occur near the border of the Carboniferous tract.

The approximate horizontality of strata in the central area referred to above, applies both to the Lower Carboniferous and the overlying coal-measures. These are, therefore, in apparent conformity. Nevertheless, a sort of unconformity is indicated, first, by the frequent occurrence of irregular masses of trap between the two, indicating downward movements and dislocations prior to the deposition of the gray beds; and secondly, by the fact that the latter beds rest upon different members of the Lower Carboniferous at different places, or even upon still older rocks, the last named beds being wholly wanting. Examples of this relation occur north of Fredericton. Unconformity

It is also important to notice that even where the beds are still horizontal, the rocks of the coal-measures are frequently intersected by vertical faults. These are quite common in the hills about Fredericton as they are also along the Nashwaak valley and elsewhere. Most of them seem to be of insignificant amount, but it is not improbable that there are some of considerable magnitude. For instance it is difficult otherwise to account for the peculiar outline or border of the Carboniferous system as seen north-west of Fredericton, where, upon the east side of the St. John river and its tributary, the Keswick, the pre-Carboniferous rocks are abruptly cut off by Carboniferous sediments, which, with great suddenness, are made to occupy upon one side of this line an area some ten miles wider than upon the other. In the Kings county basin, both the Lower Carboniferous and Carboniferous rocks are usually inclined at low angles, but here exceptions are to be found. Thus, while along the Narrows of the St. John river below the Boar's Head, in the Minister's Face opposite Rothesay and elsewhere, the beds (Lower Carboniferous) are in low undulations, to the east of Rothesay they dip quite steeply, their basset edges forming a series of sharply projecting reefs. About Dunsinane, where the surface rocks are those of the coal-measures, the dips are moderate (from 5° to 14°), but with indications of considerable faulting, and still further east, in the direction of Petitcodiac, like conditions prevail. Faults.

In Westmoreland county a remarkable illustration of local disturbance and unconformity is to be seen in the vicinity of Lutz mountain and Indian ridge, north of Moncton. Disturbances about Indian ridge.

The rocks of the first named ridge, as seen in the 'Gorge,' are coarse and hard brownish-red conglomerates, of Lower Carboniferous age, upon the north side of which are heavy beds of gray shale, underlying the overturned conglomerate. Still further north is a ridge of felsite breccia, together with hard chloritic granitoid rock, bearing some resemblance to an altered grit, and probably an exposure by denudation of a ridge of pre-Cambrian rocks extending eastward from ridges of similar age in Kings county. Separated from the last named ridge by a somewhat pronounced valley, is Indian ridge or mountain, which, to a large extent is made up of a very dark gray shale, which in general aspect strongly recalls the so-called Albert shales of Albert county. Like these, the somewhat compact rock shows by weathering finely laminated, somewhat wavy layers, resembling sections of wood; but it is not bituminous like the shales last mentioned, nor so tough. In places the beds contain branching vegetable stems resembling *Psilophyton*. Beneath them are hard gray flaggy sandstones, dipping, like the shales, to the southward at an angle of 45° to 55°, a similar strike and dip being preserved throughout the ridge for a distance of four or five miles. From its elevated surface an extensive view is to be had over the much lower and flat country to the north, underlaid by the gray sandstones of the coal-measures, outcrops of which may be seen a little north of the western end of the ridge, as well as to the eastward, where these rocks, encompassing both the Indian ridge and Lutz mountain, connect on the gulf side with the similar beds about Moncton.

Albert shales.

From the great bulk of these shales and their general aspect, it would seem probable that, even though not bituminous, they represent the Albert shales; in which case, if the latter are Devonian, they must also be referred to the same horizon. If this view be correct, we have here another instance of the coal-measures resting unconformably on the older rocks without the interposition of the Lower Carboniferous. With the exception of the areas last described, the rocks of the northern and eastern portions of Westmoreland and the northern part of Albert county continue to exhibit for the most part low dips, with the gray beds of the coal-measures (or in some instances the red beds of the Permo-carboniferous) mantling and concealing all older strata. But to the south, in the vicinity of the old pre-Cambrian ridges of Albert county, along a corresponding tract in Westmoreland, and finally along the Bay of Fundy trough in both these counties, evidences of physical disturbances in uplifts and dislocations become marked and general, especially as regards the Lower Carboniferous strata, while erosion has given to the details of distribution great irregularity. Through the same erosion also, the Albert shales are brought conspicuously into view, and the correct interpretation of the structure of the region is complicated by the uncertainty as to the true age of the latter. This is not the place in which to discuss this question, but it may be observed

Albert county.

in passing that if the view recently put forth, namely that these shales are Devonian, be the correct one, it will necessarily follow that the same view must be applied to the heavy beds of conglomerate which at various points, as Elgin, Mapleton and Belliveau, are found beneath them, and yet which, except as to position, are indistinguishable from the Lower Carboniferous conglomerates found elsewhere. All the strata of Strata highly inclined. the region, whether below or above the Albert shales, are, like the latter, highly inclined and broken by numerous faults, but, as elsewhere, the movements thus indicated would seem to have taken place prior to the deposition of the gray beds (Millstone Grit), of which the inclination is much lower and more regular. The tract about the old Albert mines, which close by, adjoins the pre-Cambrian hills, is one especially remarkable for its disturbed condition, not the shales only, but the associated rocks, excepting those of the millstone grit, showing great diversity of inclination, while the latter caps them all unconformably, and with a dip which rarely exceeds 10°. Upon the eastern side of the Petitcodiac river, in Belliveau and Taylorville, the red rocks associated with the Albert slates show the same diversity of attitude, ranging from 15° or 20° up to 80°, while the millstone grit beds, as in the peninsula between the Petitcodiac and Memramcook river, show but a very gentle and regular inclination.

In reaching the Bay of Fundy trough and the region about Dorchester, the rocks of the Millstone Grit formation are also found to have been affected by the movements under review. This is especially true along the Albert county coast, where many fine examples of tilted broken and unconformable strata may be seen. A few of these may be more particularly referred to.

About the plaster quarries at Hillsborough the Lower Carboniferous Hillsborough. limestones and gypsums, resting on conglomerates, are apparently in a series of low undulations, with dips not exceeding 30°; but upon two sides at least these are bounded by faults, bringing down overlying gray beds to the same level. At Hopewell cape are the wonderful illustrations of marine erosion, known as 'The Rocks,' wherein massive brownish red conglomerates of the Lower Carboniferous, dipping shoreward at angles of 30° or 40° and forming bluffs ranging from ten or twenty to one hundred feet in elevation, have been and are being cut by the sea into all sorts of fantastic forms. At Marys point are Marys point. bluffs of gray and purple sandstone dipping S. 20° W. < 45°, in which extensive quarrying operations were at one time carried on, and similar beds, abounding in plant remains, occur at New Horton, but here they dip S. 40° E. < 30°. Between the two, bright red Lower Carboniferous sandstones and conglomerates are quite conspicuous, and are apparently conformable under the gray measures. So to the westward, between New Horton and Two Islands, the red and the gray beds form parallel belts, of which the harder strata, becoming gradually more highly tilted, expose their basset edges in prominent ridges, separated by narrow trenches or valleys, all parallel to the shore. Approaching Cape Enragé, the dips rise to 70° or 75°, while at the cape itself, the strata, which are here gray beds, with fossil plants, thick fireclay beds and thin seams of coal, maintain this high dip.

Cape Enragé.

Along the shore of Salisbury cove, at Waterside, the coast section is interesting as exhibiting the unconformable overlapping of Carboniferous conglomerate by Triassic strata in the form of very soft bright-red sandstones dipping S. 40° E. < 20°, but with some irregularity and indications of a low anticlinie.

Coast section at Alma.

Another interesting coast section is that of the shore just east of Alma, including the conspicuous promontory of the Owl's Head. For about half a mile from the Alma beach, the nearly vertical bluffs are composed of gray sandstones containing many large trunks of trees, more or less carbonized, with also some heavy beds of shale, the whole dipping S. 20° E. < 22°. In nearing the head proper, however, where the bluffs are much higher and quite precipitous, this dip declines until the beds become nearly horizontal, only to rise in the opposite direction, and with such rapidity as, in a short distance, to make the gray beds not only vertical but reversed. Finally, this overturn is cut off by a fault, and along the fault the grey are met by red beds, mostly conglomerate, which slightly overhang the former, while their surfaces on and near the line of contact show abundant slickensides, stained by manganese oxide.

Quaco and Gardners creek.

The former wide distribution of Carboniferous sediments in the Bay of Fundy trough, and the extent to which these latter have been affected by disturbances of later origin, are further illustrated by the occurrence of such sediments in isolated patches along the northern side of the bay and their generally tilted and faulted condition. The most considerable of these areas are those of Quaco and Gardners creek. As the details of their structure have been fully described in earlier publications and have only an indirect bearing upon the special subject of this report, they will not be further considered here.

SUB-DIVISIONS OF THE CARBONIFEROUS SYSTEM.

Before proceeding further in the consideration of the Carboniferous system of New Brunswick, it will be necessary to refer to the sub-divisions of the system as recognized elsewhere, and especially in the Province of Nova Scotia.

In the reports and maps of the Geological Survey, it has been usual to regard this system in New Brunswick as embracing three principal members, somewhat strongly contrasted in lithological characters and conditions of origin, viz: the Lower Carboniferous, the Carboniferous proper or Coal-Measures, and the newer or Permo-carboniferous, the first consisting of reddish sediments, with evidences of a generally marine origin, the second mostly of gray or purplish, rarely red beds of marsh or fresh water origin, and the third again showing a predominance of red tints, though without the marine limestones, gypsums and salines which distinguish the Lower Carboniferous formation. In the "Acadian Geology" of Sir William Dawson (1868), the Carboniferous proper was further sub-divided into the "Millstone Grit series" and the "Middle Coal formation;" while with the marine limestones of the Lower Carboniferous division were associated, under the name of the Lower Coal-Measures (in addition to some beds resembling the Middle Coal-Measures) the bituminous deposits known as the Albert shales.

Geological survey divisions.

Arrangement by Sir Wm. Dawson, 1868.

It has already been stated as regards the peculiar shales last mentioned that there is at present a growing tendency to regard them as of Devonian rather than Carboniferous age, being the equivalents of the fish-bearing and fern-bearing rocks of the Baie des Chaleurs, though very unlike them in their physical aspects. It has also been stated that there are serious objections to this view; but as the question is mainly one of the interpretation of fossils, and has little or no bearing upon the main subject of this report, that of the true coal-bearing rocks, it need not be further considered here. The doubtful beds in question being thus eliminated, the rocks which lie above them are very easily and clearly divisible into two great groups, viz., the Lower Carboniferous formation and the Carboniferous proper, or Coal-Measures, while another, viz., the Upper or Permo-carboniferous is less certainly distinguishable. The characters of these several sub-divisions may be briefly summarized as follows:—

Age of Albert shales.

Lower Carboniferous.—The lowest beds of this formation, as here limited, are usually coarse conglomerates, their composition and hence

Basal conglomerates.

their general appearance varying with the nature of the rocks upon which they rest. They are, however, in almost every instance of a reddish colour, varying from a clear rich red to a dark brownish-red. They are usually also much harder than similar beds higher in the series, and in places are much stained with oxide of manganese. The cement is always to some extent, and often very markedly, calcareous. At some points, as at Quaco Head, St. John county, similar conglomerates are underlaid by beds of limestone, but the principal limestone strata are situated at the summit rather than at the base of the formation. The conglomerates are usually followed by or interstratified with sandstones, also usually of a reddish colour and markedly calcareous. Higher still the beds become finer, embracing shaly and marly deposits, upon which in many instances rest beds of gray flaggy, sometimes bituminous, limestone and heavy beds of gypsum. Between these higher beds and the basal rocks of the coal formation (Millstone Grit) it is common to find extensive sheets of igneous rocks, sometimes in the form of compact diabase, sometimes as a vesicular or amygdaloidal ash rock, and sometimes as claystone or rhyolite; but such plutonic masses are not confined to the summit of the formation, being sometimes, as at Quaco, near its base. Where igneous rocks are associated, as at Quaco, and Hampstead, Queens county, with limestones, the latter have been more or less completely converted into marble.

Thickness of Lower carboniferous.

The thickness of the Lower Carboniferous system varies greatly, but, according to measurements made by Dr. R. W. Ells in Albert and Westmorland, it reaches in those counties about 5,000 feet. Its thickness in the central basin is probably much less.

Coal-Measures.—The contrast between the above described rocks and those of the coal formation is, in the central counties, usually very marked, the bright red colour so characteristic of the one being replaced by an equally characteristic gray colour in the other, while at the same time the strata cease to be calcareous. The basal beds of the coal formation are especially noticeable as being very light coloured, and almost entirely made up of well-rounded pebbles of white quartz. Conglomerates which are somewhat less coarse occur also higher in the series, but with them are beds of coarse sandstone and thinner beds of shale, with, in places, thin seams of coal. Upon the shore of the Baie des Chaleurs about fifty feet of fine shales, gray, green or red in colour, with limestone nodules, extend for several miles in the coastal cliffs about New Bandon, resting upon gray sandstones, but over the larger part of the central coal-field the absence of fine sediments is a noticeable and unpromising feature.

General absence of shales.

Though gray is the prevailing colour in the rocks of the coal formation, it is necessary to add that it is not unfrequently replaced by a dark purple tint. Occasionally also the beds are reddish, but where this is the case it is always a question whether the rocks so coloured are not of the next division, viz., the newer coal formation or Permo-carboniferous. Purple strata.

The only data available with regard to the thickness of the coal-formation in the Central Basin is that to be derived from borings, particulars of which will be given later. The greatest depth attained at Grand lake was 400 feet. At Dunsianne, in Kings county, a depth of 1,200 feet was reached, apparently all in the Carboniferous. In Westmorland county north of Moncton, a depth of 700 feet has been reached in apparently Carboniferous strata. In Albert, where the strata are more highly tilted, the Carboniferous rocks alternate, by displacement, with Lower Carboniferous beds, but never attain any considerable thickness. Thickness of coal formation.

Upper Carboniferous (Permo-carboniferous ?).—In the geological survey maps of South-eastern New Brunswick, a considerable area bordering Baie Verte and portions of Northumberland strait, and extending thence across the Chicgnecto peninsula to Cumberland basin and Shepody bay, is referred to under the above designations, while in the accompanying report (1884) its author, Dr. R. W. Ells, describes the group as consisting generally of soft reddish or purple brown sandstone, grits and shales, resting unconformably upon either the Millstone Grit or the Lower Carboniferous. Upon the western side of the Merangouin peninsula, where one of the unconformable contacts is well exposed, they are estimated, by the author named, to have a thickness of 1,250 feet. As seen in the vicinity of Sackville, they are said to resemble very nearly the sandstones and associated beds of Capes Bald and Tormentine, and of Prince Edward Island. Unconformity

As the strata in question have not been to any extent personally studied by the writer, and as they enter largely into the comparison of the Carboniferous rocks of New Brunswick and Nova Scotia, a subject to be independently discussed by Mr. H. S. Poole, it will not be necessary further to describe them here.

COAL MINES, COAL CROPS AND BORINGS.

Of the various operations for the removal of coal, the oldest, as well as the most important and instructive, are those of the Grand lake Grand Lake basin.

basin in Queens county. A detailed description of this region and the work done therein may be found in the Report of Progress of the Geological survey for 1872-73. The main facts are as follows:

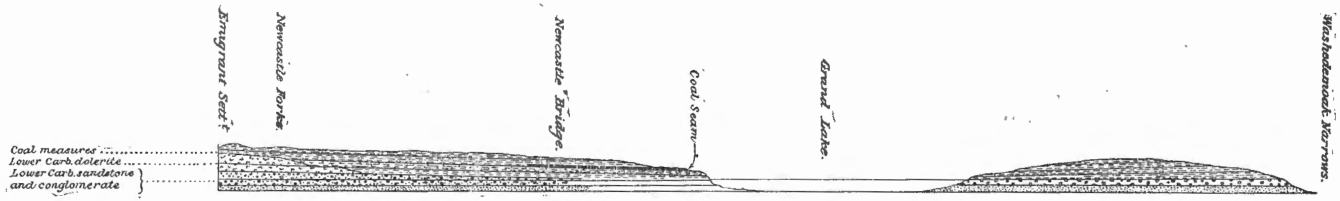
Estimated yield of coal.

With an estimated area (including the Newcastle coal-field, that of Salmon river and Coal of creek), of about 112 square miles, the thickness of the coal formation in the Grand lake basin has been supposed not to exceed 600 feet, and to include but one workable seam of coal, with a usual maximum thickness of only 26 inches, representing nevertheless, with due allowances, an aggregate of nearly 155,000,000 tons. The strata being nearly horizontal, the slight variation in the actual thickness of the coal exposed, together with a careful study of the associated strata (see report referred to above) leaves little doubt that the many openings made reveal in all cases the same bed, while all attempts by boring to ascertain the existence of more deeply seated beds have led only to negative results. At the same time these borings, taken in connection with such natural exposures as are afforded by the river trenches of the district, furnish some information of great importance in its bearing upon the probable thickness and capacity of the coal-bearing rocks elsewhere. Of these stream sections the most important is that of Newcastle river. At the 'forks' of the stream, which enters Grand lake on the northern side, and at a distance of about five miles from Newcastle bridge, the centre of the principal coal-workings of the district, the rocks exposed to view consist of conglomerates which, by their bright red colour, calcareous character and the fact of their association with doleritic and other igneous accumulations, show that they are the representatives of the Lower Carboniferous system or marine portion of the coal formation. In accordance with the same view these red rocks and their volcanic associates are, as elsewhere in the province, directly overlapped by coarse gray quartzose beds, which mark the base of the coal-measures proper or Millstone Grit; all these strata dip southward or towards the lake at a low angle. Thus a northern rim or margin to the Newcastle basin becomes determined. On the southern side of Grand lake, a similar margin is indicated where corresponding coal-measures, on the south side of Waskademoak lake, are found resting on the metamorphic hills and dipping northward. Finally, to the eastward of Grand lake, on Coal creek, is a considerable area in which slates, of Devonian age or older, come to the surface. Thus at three points, situated respectively north, east and south of the principal coal-workings at Newcastle bridge, strata older than those of the coal formation are exposed and form the natural rim of the basin. Observing further the dip of the beds on either side, which, though small, leads, as

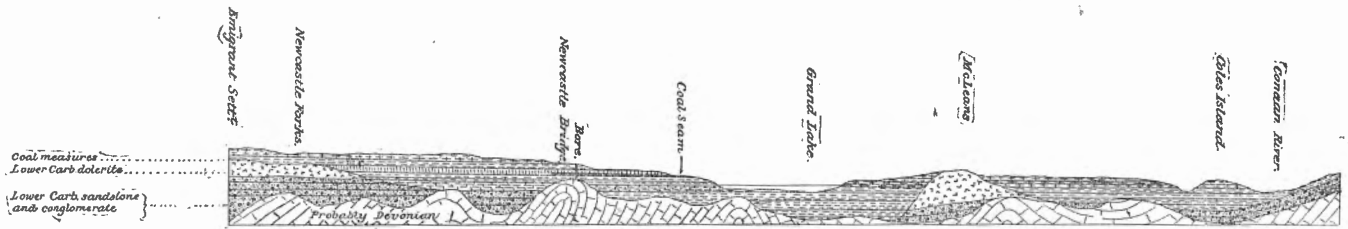
Structure of Newcastle coal basin.

Southern margin.

Direction and angle of dip.



SUPPOSING CONFORMITY OF COAL MEASURES TO LOWER CARBONIFEROUS ROCKS



SUPPOSING UNCOMCORMABLE DEPOSITION OF COAL MEASURES ON FOLDED AND ERODED SUBJACENT STRATA

DIAGRAMATIC SECTIONS OF THE GRAND LAKE COAL BASIN, QUEENS COUNTY, N.B.

on Newcastle creek, to the gradual replacement of the red by the gray beds, it is only necessary to consider, in connection with this dip, the distance through which it is exhibited, in order to have the data from which to calculate the depth of the whole basin, or that which would be required at any one point to reach the underlying and older rocks. This condition of things, if existing, would be such as is indicated in the first of the accompanying diagrammatic sections:

It will be seen, however, that this conclusion is based upon the supposition of conformity between the Lower Carboniferous rocks and those of the coal-measures, but when put to a practical test this is found not to be in accordance with observed facts. For in drilling through the last named measures at and about Newcastle creek (See Appendix) the latter were indeed found to have been passed through within the depth expected from calculation, actually at little over 200 feet, but the cores brought to the surface, instead of being those of red Lower Carboniferous sediments, as expected, were found to consist of slates similar to those outcropping at the surface along the course of Coal creek. Thus, while the facts abundantly indicate that the basin is in all probability a shallow one, they also indicate that its floor is far from being uniform, either as regards the nature of the rocks composing it or the level at which these stand. Both at Newcastle bridge and at Coal creek the coal-measures rest horizontally on pre-Carboniferous, probably Devonian, rocks, and the whole Lower Carboniferous formation, elsewhere of such great thickness, is wholly wanting. Moreover, if these points represent, as is probable, the crests of ridges subsequently buried by Carboniferous sediments, it may be the case that between the ridges were originally more or less deep valleys, and that while the coal strata burying a ridge might be very thin above the latter, or, as at Coal creek, be entirely removed by later denudation, a short distance on either side of such a ridge a deep valley might exist, and the depth of the coal measures filling such valley be of corresponding proportions. This second view of the question, based upon the known unconformity of the coal measures to the Lower Carboniferous formation and the extensive erosion of the latter, is presented in another section, which, as in the case of that previously given, is theoretical only so far as relates to the parts concealed from view.

Evidence of unconformity.

If we now pass from the Grand lake or Newcastle coal basin to other parts of the broad central coal field, we find that, so far as outcrops and openings near the surface are concerned, they throw but little additional light upon the question of the total thickness of the coal-formation or its productive capacity.

In the area west of the St. John river, (a minute description of which may be found in the Report of Progress for 1872-73) the most important exposures are those of Clones settlement, near the sources of the Nerepis river, in Queens county. Several seams of coal, in one instance of about three feet, occur here, but the situation, in the bed of a brook, is such as to make the relations of the beds obscure and the removal of coal difficult. It is however worth noting that the general succession seen in this vicinity closely parallels that of the Newcastle basin, Lower Carboniferous strata, such as occur about the head waters of the Nerepis river, and consisting of dark red conglomerates and limestones, being capped by dark olive-gray doleritic and amygdaloidal beds, above which the base of the coal formation is represented by gray conglomerates and grits, of which the former contains pebbles of limestone carrying *Terebratata sacculus* and other characteristic Lower Carboniferous fossils, while the Clones shales, like those of Newcastle, hold remains of ferns, viz : *Cardiocarpa*, *Cordaites* and *Naiadites*, of ordinary coal,measure types. Indications of unconformity between the different members of the system also occur, while, again as at Grand lake, pre-Carboniferous rocks may be seen to protrude through those of Carboniferous age, indicating the uneven bottom upon which these repose.

Area west of St. John river.

Fossils.

Of the somewhat numerous outcrops of coal which have at different times been observed in other portions of the area lying west of the St. John river, as on the North-west Oromocto, near Tracy station, (5 inches) on the Otnabog and Mersereau brooks (1 foot), it will not be necessary to speak particularly here, as they reveal no new facts of importance, and the seams themselves are of insignificant thickness. The strata everywhere lie at very low angles, are usually of coarse composition, and, as regards the coal-formation proper, apparently of no great thickness. This latter conclusion may be drawn from the study of the western escarpment of the coal-measures in the vicinity of Cork settlement and Tweedside, as well as from the results of boring operations at Three-Tree creek, near Fredericton junction. In the bluffs of the former the nearly horizontal beds consist mainly of the coarse white-quartz conglomerates so characteristic of the Millstone Grit: at the latter, where a depth of 600 feet was reached, red beds began to appear within 300 feet of the surface.

Coal outcrops.

The above observations refer to the counties of Queens, Sunbury and York. We have now to consider what may be learned from coal crops and borings in the more easterly counties of Kent, Northumberland and Gloucester.

Eastern counties.

Of coal crops many instances are known, but with one possible exception they are too small to be of any importance. The exception referred to is that of Coal Branch in Kent county. The occurrence of coal at this point was known as early as 1849, when it was examined by Dr. James Robb, who expressed his belief that it might "prove to be the same as the one at the head of Grand lake, from which the sandstones pass continuously, but in an undulating manner." The seam observed was about 15 inches thick and the inclination of the beds N. W. $<$ 10°. More recently (1900) boring operations have been undertaken in the same vicinity by the "Canadian Coal and Manganese Company" under the direction of Mr. Pollies, who states that they have drilled through two seams, viz., one of 18 inches occurring 60 feet below the surface and a second of 3 feet at a further depth of 44 feet. Allowance must, however, be made for the fact that the borings were effected with a churn drill and therefore liable to serious misinterpretation. It was the purpose of this company to sink a shaft to the lower of these seams, but results have not been made public. It may be added that the river exposures show but one seam.

Recent borings.

Borings at Cocagne river.

A second locality in the county of Kent at which boring operations for coal have been carried on is that of a small brook about two miles from the bridge over Cocagne river. Upon the side of this brook is a pit about 9 feet deep showing 7 inches of coal, overlaid by gray shales, and the site of the bore hole is but a few rods distant from this. The depth reached was 900 feet, but the particulars of the borings I have been unable to obtain.

Dunsinane, Kings county.

As tending to confirm the belief that, as a consequence of horizontal deposition upon a floor made irregular both by plication and erosion, the rocks of the coal formation, though thin in many places, may be much thicker in others, a glance may now be taken at the facts revealed in the Dunsinane coal area in Kings county. Of comparatively small extent, this area, like that of Queens county, was also for a long time supposed to be of insignificant thickness, forming only a shallow basin over the Lower Carboniferous rocks which outcrop upon its several borders. The strata being known, however, to include seams of coal (one, 22 inches out-cropping at the surface, and another, 12 inches, ten feet and a half lower), the wish to thoroughly prove the ground again led to the undertaking of borings, but with the result that, instead of finding the basin shallow, as had been supposed, the drill actually reached a depth of 1,291 feet, the beds passed through being the coal-measures at the top followed by gray beds nearly to the bottom, when a few red beds were passed, these latter only being ap. parently Lower Carboniferous.

The boring referred to, made at a point half a mile from Shives pit (first opened in 1864, on the seams referred to above), and 6,400 feet east of White's pit, indicated one foot of coal at a depth of 239 feet, with thin and irregular streaks of coaly matter at various depths to that of 800 feet or more. The locality was visited by the writer at the time when cores were being taken up from depths between 900 and 1,000 feet. These were mostly sandstones, varying more or less in texture, sometimes becoming coarse grits or fine conglomerates, but always some shade of gray, and not differing in any way from the beds usually characterizing the coal formation elsewhere. If different the lower strata penetrated were, upon the whole, finer than the upper, and included several beds, three or four feet thick, of fine dark shale. An official log of the borings, carefully compared with the cores sent to the Department of Crown Lands at Fredericton, is given in the sequel. It is impossible to draw from these any other con clusion than that the rocks passed through, with the exception of the very lowest, are those of the coal formation, though probably pertaining mainly to its lowest member, the Millstone Grit. Results of borings.

Outcrops of bituminous coal in Albert and Westmoreland counties are few and unimportant, while the occurrence over large areas of Lower Carboniferous or older rocks, revealed by denudation, would indicate that even where they are concealed by the gray measures the thickness of the latter is but small. Among such outcrops refer ence may be made to one visited by the writer in company with Mr H. S. Poole, upon Mill brook, in Fairview settlement, two miles and a half from the town of Dorchester, and which has been laid bare by the manager, of the Intercolonial Copper Company. The seam is very inferior, about eight inches thick, and rests upon fire clay and gray shales, which in turn are capped by gray sandstones, dipping S. 20° E. < 24°. In the shales are found scales, teeth and bones of ganoid fishes, presently to be more particularly referred to, together with plant remains, but the latter are badly preserved. Small seams of coal have also been observed in the vicinity of Shediac and at various points along the Albert county coast, but many of those reported are only the carbonized remains of tree trunks. Off the coast of New Horton, in the same county, a seam of coal, six feet in width, has been stated by residents to be exposed at times beneath the tidal muds half a mile or so from shore, and the fact that the locality is within sight of the Joggins in Nova Scotia, would, if substantiated, Westmoreland. New Horton, Albert county.

give to the observation peculiar interest, but the bed itself is difficult to locate, and, if at all, only in early spring or after severe storms.

Boring operations have been carried on quite extensively in Albert and Westmoreland counties, but the object in view has been the discovery of albertite and petroleum rather than of bituminous coal, and the strata penetrated have been for the most part the Albert shales and associated Lower Carboniferous rocks. At a few points, however, the borings have been in the coal-measures, and the object sought ordinary coal. Among such borings are some made in the vicinity of Lutz mountain, nine miles north of Moncton. The so-called "mountain" has already been described in this report as consisting upon its southern side, as revealed in the transverse ravine known as "the Gorge," of coarse red conglomerate of Lower Carboniferous age, and inclined northward at a high angle. Of the borings referred to, two upon the farm of Peter Wilson were to the eastward, while another, upon the Harris property, was to the westward of "the Gorge," the interval being about two miles. In the bore-holes at Wilson's, which were but little removed from the base of the Lower Carboniferous ridge, the records, as might be expected, are remarkable chiefly for the abundance of reddish sediments, indicating that the strata penetrated are either Lower Carboniferous or of a transitional character. Thus, in one bore-hole (No. 2) reddish marls were met at a depth of only 39 feet, and between depths of 200 feet and 600 feet, rocks of this character were the prevailing ones. At another hole, attaining a depth of 625 feet, the first 125 feet were through grayish beds, sometimes becoming purplish, while below this, red beds became increasingly numerous until below 450 feet all the strata were of this colour. In the boring at Harris', on the other hand, which is more distant from the Lower Carboniferous ridge, the prevailing colours are gray and purple, with hardly a trace of red, even the lowest beds, at a depth of over 700 feet, being thus tinted. In all the borings referred to, the rocks are either sandstones or shales, with but little conglomerate, and that only in thin layers.

Borings at Lutz mountain.

At Wilsons.

At Harris'.

FOSSILS.

Importance of fossils.

In previous sections of this report an attempt has been made, by the study successively of the topography, erosion, lithological characteristics and differential movements of the Carboniferous rocks, as well as by reference to the results of mining and boring operations, to reach some practical conclusions as to the thickness of the Carboniferous system in New Brunswick and the occurrence or otherwise of workable coals.

Upon this question the nature of the associated fossils, usually the most important means of fixing geological horizons, would naturally be expected to throw important light. But as in the case of the evidence already considered, the conclusions to be derived from the organic remains of the New Brunswick Carboniferous areas are far from satisfactory. Not that these remains are rare or poorly preserved, as large and good collections have been made at Grand lake, Three Tree creek, New Bandon, Coal Branch and elsewhere, and these have been carefully studied by competent authorities, especially by the late Sir W. Dawson, but many of the forms described by him are peculiar to New Brunswick and hence not comparable with those elsewhere. Besides, authorities are themselves at variance as to how far particular groups of fossils are charcteristic of definite horizons. Upon the one hand, a group of rocks not previously referred to in this report, found in various parts of St. John county, and in previous reports described as Devonian (partly upon the results of investigations in the field and partly from the study of the fossils by Sir Wm. Dawson) has quite recently been claimed to be Carboniferous, even though highly metamorphic and unconformably covered by undoubted Lower Carboniferous sediments. Upon the other hand, the rocks of the great central area have been variously referred to the Millstone Grit, to the middle coal formation and to the upper or Permo-Carboniferous group, while even where the Carboniferous system is much more fully represented than here, the vertical range of species and the value of them in fixing time limits are subjects of much discussion. Discrepancy of views.

The author of the present report does not feel that he is prepared to offer solutions of these vexed questions, even in the case of the coal field of New Brunswick. He proposes, therefore, merely to give here, in tabular form, lists of the species collected, especially at the localities noted above, and to draw such conclusions as may obviously be derived therefrom.

The following species have been found at Grand lake, and have been referred by Sir William Dawson to the 'middle and upper coal formation':— Fossils from Grand lake.

Calamodendron approximatum, Brongt.; Antholites rhabdocarpi, Daw; Calamites Suckowii, Brongt.; *C. Cistii, Brongt.;* C. nodosus, Schlot; *Asterophyllites grandis, Stein.; Annularia sphenophylloides, Zenker; Sphenophyllum emarginatum, Brongt.;* Cyclopteris (Nephropteris) obliqua, Brongt; C. (? Neuropteris) ingens, L. & H.; *Neuropteris rarinervis, Bunbury;* N. gigantea, Steinberg; Sphenopteris munda, Dawson; S. latior, Daw.; S. gracilis, Brongt.; S. artemisifolia, Brougt. ; Alethopteris lonchitica, Steinberg ; *Beinertia Goepperti, Daws.* : Palæopteris Hartii, Daws. ; Lepidodendron Pictoense, Daw. ; Lepidostrobus squamosus, Daws. ; Cordaites borassifolia Corda ; C. simplex, Daws. ; Cardiocarpum bisectatum, Daws. ; Halonia ?

Of the above list, those in italics occur also upon the shores of the Baie des Chaleurs, about Clifton and New Bandon. In this latter region are found a'so the following species not discovered at Grand lake :—

Fossils from Baie des Chaleurs.

Sphenophyllum saxifragifolium, Stein ; Neuropteris Loshii, Brongt. ; Odontopteris Schlotheimii, Brongt. ; Sphenoteris Canadensis, Daw. ; S. obtusiloba ? Brongt. ; Alethopteris nervosa, Brongt. ; A. muricata, Brongt. ; A. pteroides, Brongt. ; A. Serlii, Brongt. ; A. grandis, Dawson ; Cordaites simplex.

Remarking upon the above collections, Sir William Dawson (in 'Acadian Geology,' p. 241) observes that those from the Baie des Chaleurs are 'supposed to belong to the lower set of coal beds in the Middle Coal Measures'; 'those from Grand lake to the upper set of beds.'

To the above lists, as originally given by Sir William Dawson, it is now necessary to add, from the Grand lake region :—

Dadoxylon materiarium, Daws. ; D. Acadianum, Daws. ; Calamites dubius, Artis ; Alethopteris nervosa, Goeppert ; Neuropteris Loshii, Brongt. ; Pecopteris oreopteroides, Brongt. ; Lepidodendron Lepidophloris.

Fossils from Three-tree creek.

The following list of species is from collections made by the author of this report at Three-tree creek, near Fredericton Junction, and which were identified by Sir William Dawson :—

Neuropteris flexuosa, Steinberg ; N. cordata, Brongt. ; Pecopteris arborescens, Brongt. ; Pecopteris oreopteroides, Stern., or an allied species ; Pecopteris abbreviata, Brongt. ; P. allied to P. hirta ; Sphenopteris latior, Daws. Odontopteris squamosa, Lesq., or a resembling species ; Cyclopteris fimbriata, Lesquereux ; Lepidodendron Pictoense, Dawson ; Lepidostrobus ; Cordaites borassifolia, Unger ; Annularia equisetiformis, L. and H. ; Calamites Cistii ; Brongt. Rhabdocarpus ?

Sir William Dawson remarks that the above plants are of the middle coal formation, and similar to those of Grand lake.

It may be noticed that, in the collections above referred to no occurrences of Sigillaria or Stigmaria are noted. It must not, however, from this be inferred that these are absent. The omission is probably wholly accidental. It is certain, at least, that species of Sigillaria occur at Grand lake, while large tree trunks, some of which at least are sigillariae and others lepidodendra, but both poorly preserved, have been observed over many portions of the coal field. In the cliffs upon the Bay of Fundy shore, as at New Horton, Cape Enragé and Alma, the occurrence of large drifted tree trunks is especially common, and include, besides *Sigillaria, Stigmaria, Lepidodendron* and *Dadoxylon,* stems of tree-ferns of the genus *Megaphyton.* In the finer sediments or shales, upon the other hand, here occasionally met with, remains of *Naiadites* are sometimes to be found. In the sea cliffs of Owl's Head, just east of Alma, upon the Albert county coast, an interesting impression was noticed by Mr. Poole and the writer, of which the nature and origin are obscure. It is upon the flat surface of a large block of sandstone detached from the precipitous face of the bluff, and is in the form of two perfectly straight and parallel furrows, each 4 inches wide, about 16 inches apart and about 10 feet long, the space between the furrows being marked by rather regular but obscure depressions, roughly arranged in pairs nearly at right angles to the furrows. The general appearance at a distance of a few yards is that of a huge track, possibly that of a gasteropod, but the nature of the animal producing it, if really thus formed, is very problematical. Fossil track?

Of other animal remains found in the Carboniferous rocks, we have only to mention shells of *Spirorbis,* resembling *S. carbonarius,* found in the shales at Grand lake, and the remains of teeth and scales of Ganoid fishes in similar beds near Dorchester. Coprolites of fishes also occur.

Of the fish remains referred to (found on Mill brook, Fairview settlement, two miles and a half from Dorchester) Dr. Whiteaves writes in a letter to Mr. Poole :— Fish remains from near Dorchester.

'Judging by the "Acadian Geology," these would seem to be: scales and teeth of *Rhizodus,* presumably of *R. lancifer;* a tooth of *Diplodus,* apparently of *D. penetrans;* and two teeth of a *Ctenoptychius,* perhaps of *C. cristatus.*

'Similar specimens are described and figured on pages 209 to 211 of the "Acadian Geology." On page 211 of that publication teeth of *Diplodus penetrans* are said to occur in the "roof of beds of coal near and above the New Glasgow conglomerate, and on the roof of the main coal."

What the very curious and interesting cone-like organism, with larger, sculptured, imbricating scales at one end, is, I have not been able to find out, but it gives me the impression that it may be a cirrhipede allied to *Plumulites*. Some of the other organisms also I have not been able to make out.'

General Summary and Practical Suggestions.

Conclusions arrived at.

In preceding pages the coal problem of New Brunswick has been considered from a number of different standpoints. We may now summarize the conclusions which these several discussions would seem to suggest, and point out some methods of further investigation by which, it is thought, the present uncertainty as to the productive capacity of our coal-fields may be determined.

1. *Topography.*—The approximate uniformity of elevation of the rocks of the coal formation over such vast areas, including nearly one half of the superficies of the province, evidently points to corresponding uniformity of conditions of deposition over the same areas. Hence, if holding productive seams, these may be expected to have wide horizontal distribution, or, if barren at several widely separated areas, to be probably unproductive throughout. This view is in accordance with the facts observed at Grand lake, where all the openings are undoubtedly upon the same seam; and the close correspondence with the latter of the seams observed at Coal Branch in Kent, suggests the idea that these also represent about the same horizon.

Practical bearing.

From another point of view the topography of the Carboniferous tracts has a practical bearing. It is evident that the very regular triangular form of the great central basin is the result of its inclosure between two great divergent lines of pre-Carboniferous uplift, of which one coincides with or is parallel to the general trend of the great Appalachian uplifts of eastern America, while the other, turning more to the eastward, helps to form the Acadian protaxis which from early times, as now, shut in the depression of the St. Lawrence gulf. The regularity of this divergence and the absence between the two arms of any prominent intermediate elevations would favour the idea that such elevations never existed, while at the same time any minor undulations would be likely to conform in direction with that side of the triangle to which they approximated in position. Indications of the existence of such buried undulations are found in the islands of slate protruding through the Coal formation on Coal creek and the Canaan river, in Queens county, and perhaps, as pointed out by Dr. Ells, in the anticline observed along the eastern shore of Kent county and in the outline of the north shore of Prince Edward Island. The exact location of such ridges, as determined by future borings, will, as is evident, constitute an important element in the search for coal, the strata directly above them being necessarily, (as at Grand lake) quite thin, while in their lee, as would seem to have been the case in the Pictou district of Nova Scotia, were present those conditions of shelter and of subsidence which were most favourable for the production of thick beds of coal.

2. *Erosion.*—Facts given upon an earlier page indicated that the rocks of the coal measures were not only laid down upon a floor greatly eroded, but that they have themselves suffered a great diminution of their volume by a like agency. Originally continuous with strata of similar age upon the other shores of the St. Lawrence gulf, they have by submergence and denudation been disconnected with these latter. At the same time their vertical thickness has been greatly reduced, a loss which might involve an important group of coal producing strata. In the Bay of Fundy trough, it can hardly be doubted that such a loss actually occurred. Effect of erosion.

3. *Attitudes* and *Unconformities.*—Very low inclinations or absolute horizontality are the prevailing features of the great central basin; somewhat greater irregularity and higher dips are met with in the Kennebecasis and Petitcodiac troughs; great diversity and high dips distinguish the areas bordering upon the Bay of Fundy. A slow subsidence accompanied by a gradual and widespread accumulation of similar sediments are indicated in the first case. Great differential movements, accompanied by important dislocations, mark the regions nearer the coast. As these however, are later in origin then the beds affected, they had little bearing upon the amount of coal which was formed. Prevailing features of central basin

The unconformities are more important as bearing upon the question of unequal accumulation at different points, the possible thickness at any one point being (as at Grand lake) determined by the attitude as well as by the erosion of the beds below. Unconformity is indicated (1) between the Albert shales and the ordinary Lower Carboniferous sediments, (2) between the Lower Carboniferous sedimentaries and the felspathic and diabasic rocks which frequently cap them, and (3) between the preceding rocks and those of the Millstone Grit. In the central basin, however, such unconformity is usually indicated by partial removal of the lower beds and by overlap rather than by any discordance of dip.

General prevalence of coarse sediments.

Nature of Sediments.—In travelling extensively over the coal-field of New Brunswick, one cannot help being struck by the general prevalence of beds of a coarse character. Naturally these would be more prominent but not more persistent than those of a finer and softer nature, but this fact cannot altogether account for the comparative infrequency of shaly beds. Such beds do indeed occur, and upon the shore of the Baie des Chaleurs are very conspicuously developed, but as a rule, over nearly all parts of the coal-field, the beds exposed, even in river sections, are either conglomerates or coarse sandstones. Such coarse beds of irregular thickness are, of course, not favourable to the occurrence of coal, indicating the prevalence of conditions other than such as led to the formation of the latter. Conglomerates consisting largely of white quartz pebbles are especially abundant around the borders of the great central coal area, and appear to mark the base of the coal measures, though in the Pictou coal-field beds of this character are found in the upper coal-measures, over the thick coal seams.

Colour of beds.

The colour of the beds has also important bearings; first in the fact that reddish colours, as due to the non-removal of iron compounds by the reducing action of vegetation, tends to indicate the absence of the latter; and, second, because such colour is, to a large extent, distinctive of the Lower Carboniferous formation, and the newer or Permo-carboniferous as distinguished from the Millstone Grit and Coal-measures, which are gray or greenish. Upon this basis partly, but not solely, large areas in Westmoreland county have been referred to the newer or Permo-carboniferous formation.

Thickness.—From what has been stated, it will be evident that there are great possibilities of variation in this respect. Laid down upon a floor characterized by great irregularity of altitude—the result partly of physical movements marking the close of the Devonian age, and partly of erosion during the period of Lower Carboniferous submergence—the coal-measures may be thick or thin, according as they fill up deep depressions of the pre-existing surface, or merely cap the ridges by which they are separated. As a matter of fact, while the thickness at Grand lake is only a few hundred feet, or nothing at all where (as on Coal creek) older strata come to the surface, the depth of the gray series attained at Dunsinane was over a thousand feet. Other examples of pre-Carboniferous strata protruding through the coal-measures occur on the Canaan river and its tributary, Alward brook, in Queens county, and at Lutz mountain and Calhoun's mill in Westmoreland. Several of these islands are obviously in the line of prominent pre-Carboniferous ridges farther west, and the disposition of the latter thus affords a slight clue to the position of shallow and deep areas of sedimentation to the eastward. As the Carboniferous rocks are mostly wanting in western New Brunswick, and not only spread more widely, but mount higher on the flanks of the inclosing hills as one goes to the eastward, finally covering these latter as on Shepody mountain, it is a legitimate inference that the thickness of the coal formation increases in that direction or towards the Gulf of St. Lawrence, and that this is the direction in which to look for productive coal-seams. It is also to be noticed that in this direction, and closely adjacent to Nova Scotia, is the area in which the most recent or Permo-carboniferous strata are met with, suggesting, though not necessarily proving, that the productive coal measures may be found beneath.

Fossils.—It is to be regretted that such a conflict of opinion should exist as to how far the occurrence of particular species of plants should be regarded as definitely fixing the age of the strata containing them. For evidently, if the fossils found upon the shores of St. John county in highly metamorphic strata, and which are clearly separated from the ordinary coal-measure rocks by marine limestones and volcanic beds, as well as by several unconformities, and appearances of greater antiquity and alteration, can, after having so long been considered as Devonian, now be claimed as of Carboniferous age, the value of such fossils as a means of determining geological equivalency may well be considered as of little moment. In the present state of opinion, therefore, it would be useless to attempt to draw any practical deductions from the study of the fossil flora of the New Brunswick coal-measures. It is, however, worth while to note that in the several publications of the late Sir William Dawson, based upon the most extended researches and familiarity with all the conditions of the problem, the plant bearing beds of Lancaster, near St. John, were regarded as Devonian, while those of Grand lake were described as being of the Middle Coal formation. We may add that the marine Lower Carboniferous sediments rest upon the one and are overlaid by the other, in each case without conformity, and the stratigraphical relation cannot be disputed. We venture to protest against a hasty acceptance of later views, for, if some of these are carried to a conclusion it would mean the elevation of the series now described as Permo-carboniferous to still higher horizons. Finally, even if we regard the whole series of beds referred to the Carboniferous as representing the Millstone Grit, this would by no means preclude the possibility of their carrying workable beds of coal, for such beds are found in rocks of this age in Virginia and elsewhere.

Difference of opinion as to age of fossils.

Coal mining operations.

Mining and Boring Operations.—Mining for coal in New Brunswick has practically been confined to the Grand lake region and to beds but little removed from the surface. The operations there conducted prove the wide horizontal extension of the strata, but throw little direct light upon the thickness of the latter. This, however, has been tested by boring, with the result of showing that in that portion at least of the great coal basin the measures are thin, and are without other seams of coal than the one long worked near the surface. The holes ranged in depth from 170 to 400 feet, and in the deeper ones the cores brought up consisted of shales (probably Devonian) showing that underlying pre-Carboniferous rocks had been reached. At Three-Tree creek also, beds below the Coal Measures were reached at 300 feet or less. These facts, taken in connection with a study of surface outcrops and stratigraphy, seem to indicate that a large part, if not the whole of the coal-bearing rocks in Queens, Sunbury and York, are of shallow depth, and hence unlikely to contain large seams of coal. On the other hand the boring operations at Dunsinane, in Kings county, failing even at 1,200 feet to reach the base of the Carboniferous system, shows that even in small basins and at no great distance from pre-Carboniferous ridges, the coal rocks may attain considerable depth. It is not yet definitely known, however, that the increased thickness is accompanied by any large increase in the number and size of coal-seams. The remaining areas are those of the eastern counties, Northumberland, Kent and Westmorland. No mining operations of any extent have been carried on in this region and the results of borings, made only at a few points and for different objects than that of obtaining coal, are inconclusive. The tools used have been churn drills, the logs have been kept by those not fully acquainted with their nature and importance, even the terms used in the description of borings are not alike and often wrong, and the boring sites have been selected with little reference to the geological structure or characteristics of the districts in which they have been placed. This portion of the province therefore, which upon other grounds would seem to be the most promising, is that of which, as yet, the least is known.

Further borings necessary.

In view of all the facts now before us there would seem to be only one way of finally settling the still doubtful question as to the thickness and capacity of the New Brunswick coal-field, viz., by borings undertaken in those parts which have not yet been satisfactorily proved. It is not probable that much more can be gained by trials of this sort in the western section of the central coal-field, but it is at least possible that a more favourable set of conditions may be found to exist to the eastward and especially along the shores of the Gulf of

St. Lawrence. To determine this, a methodical series of borings, with a diamond drill taking up solid cores, should be made at different points between Moncton and Bathurst, with at least a few others well located in the Miramichi and Buctouche valleys. From what has been said it will be obvious that there are but few if any features at the surface which can be of much assistance in determining the most favourable location for trial. Each boring would afford presumptive evidence for a considerable area around it, and a series of such holes could hardly leave much doubt as to the general questions involved. Even if the results were wholly negative, they would be of service in removing the present doubt upon the subject, and the possible useless expenditure of large amounts of capital.

Productive character of Carboniferous area not fully investigated.

While the question of the productive character of other portious of the Carboniferous area is still awaiting investigation, it is satisfactory in the meantime to know that efforts are being made to develope upon a larger scale and in a more systematic way, the deposits already known. Thus with the aid of the provincial government a railway is in course of construction from Chipman, near Grand lake, to Fredericton, which will make it possible to bring the coal from the beds of this region much more readily to market, while much greater care will be taken in the mining and handling of the product, thus avoiding to a considerable extent the crumbling and admixture with foreign matter which has previously done so much to depreciate this coal in the eyes of consumers. In return for the aid afforded by the government, the company building the road binds itself to establish on the line of railway a plant capable of mining an average of not less than 500 tons of coal per day. Owing to the proximity of the seam to the surface—at no point does it lie beneath more than 60 feet of cover, and usually this is much less—the coal can in many cases be most readily obtained by stripping, and machinery will be employed which will allow of this being done with great rapidity. When too deep for this purpose, the coal may still be removed with comparatively little labour by simply cutting trenches from the side of which the coal is removed for a certain distance, and the undermined soil-cap then allowed to fall in. It yet remains to be seen whether the great expectations as to the total yield per year of the field will be realized, but, as pointed out by the author and his associates in 1873, the aggregate amount of coal in the field is large, and, with the present high prices prevailing, should admit of profitable working upon a scale much larger than has been heretofore attempted.

Subject of futur development.

As bearing further upon the subject of future development, I may be permitted to express here my sense of some difficulty, in the study of the Carboniferous tracts of New Brunswick and Nova Scotia arising from the unfortunate method of delineation adopted in the older survey maps, viz., the selection of arbitrary parallel lines to indicate the distinction between sub-divisions of the system. Not only is it almost impossible and very wearying to the eye to separate these, where the areas are small and irregularly associated, but the parallel barring being much more conspicuous than the boundary lines, constantly suggests lines of strike which are false and very misleading. In formations like those of the Millstone Grit and Coal-Measures, where strikes and dips are of the utmost importance to the prospector and miner, everything which would tend to lead to incorrect impressions should be carefully avoided. As the Permo-carboniferous is in these maps already distinguished by difference of tint, it would be well if a similar method could in future maps be employed for the Lower Carboniferous also, especially as this latter formation is so strongly contrasted in its natural coloration, in the nature and origin of its sediments and its relations to agriculture.

APPENDIX

PUBLICATIONS RELATING TO THE CARBONIFEROUS SYSTEM OF NEW BRUNSWICK.

Abraham Gesner. First Report on the Geological Survey of the Province of New Brunswick—St. John, 1839.

Abraham Gesner. Second Report, 1840.

" " Third Report, 1841.

" " Fourth Report, 1842.

Dawson, Sir J. W. The Albert Mine, New Brunswick. Journal of *Geological* Society of London, 1852.

Acadian Geology. 1st Edition, 1855.

" " 4th " 1891.

The Lower Carboniferous Coal Measures of British North America. Ibid. 1858.

The conditions of the Accumulation of Coal, and the Coal Flora of Nova Scotia and New Brunswick. Ibid., 1867.

Relation of the Upper Coal Measures of Nova Scotia to the Permian. Ibid., 1874.

Carboniferous Fishes from New Brunswick. Can. Naturalist, 1878.

Hand-book of Canadian Geology. Montreal, 1889.

L. W. Bailey. Report on the Mines and Minerals of New Brunswick. Fredericton, 1864.

Observations on the Geology of Southern New Brunswick, with map. Printed by Legislature of N.B. Fredericton, 1865.

On the Mineral Resources of New Brunswick. Canadian Mining and Mechanical Review, 1891.

Report on the Geology of Southern N.B., 1870-71.—Geological Survey of Canada.

On the Carboniferous System of N. B., 1872-73.—Ibid.

Report on the Lower Carboniferous Belt of Albert and Westmoreland counties, N. B. With map and section, 1876 77.—Ibid.

On the Mineral Resources of New Brunswick.—Ibid., 1899.

On Geological Contacts and Ancient Erosion in Southern and Central New Brunswick.—Pro. Royal Society of Canada, Vol. 1, 1884.

On progress of geological investigation in N.B.—Ibid., 1889.

R. W. Ells. In the Reports of the Geological Survey of Canada.

On operations in boring for coal at Newcastle creek, N.B., 1872.

On the Lower Carboniferous Belt of Albert and Westmoreland Counties, N. B., 1876-77.

On the Geology of Southern New Brunswick, in Charlotte, Sunbury, Queens, St. John and Albert counties, 1878-79.

On the Geology of Northern and Eastern New Brunswick and north side of Bay des Chaleurs, 1880-81.

On the Geology of Eastern Albert and Westmoreland Counties, N.B., and of portion of Cumberland and Colchester Counties, N.S., 1885.

A History of New Brunswick Geology, 1887.

The Carboniferous Basin of New Brunswick. Trans. Royal Society, 1901.

The Geology of the Proposed Tunnel under Northumberland Straits, N. B. Trans. Royal Society of Canada, Vol. XI, 1893.

Geo. F. Matthew. Report on the Carboniferous System of New Brunswick. Geol. Surv., Can., 1873.

Report on Geological observations in southern New Brunswick Geol. Surv., Can., 1877.

GEOLOGICAL SURVEY OF CANADA
ROBERT BELL, M.D., Sc.D. (CANTAB), LL.D., F.R.S.

REPORT

ON THE

COAL PROSPECTS

OF

NEW BRUNSWICK

BY

HENRY S. POOLE, M.A., F.G.S., F.R.S.C.,
Associate of the Royal School of Mines;
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1903

13—MM.

No. 803.

To ROBERT BELL, M.D., LL.D., SC.D. (CANTAB), F.R.S.,
Acting Director of the Geological Survey of Canada.

SIR,—I beg to submit my report on an examination made, in accordance with your instructions, in Eastern New Brunswick to ascertain the general prospects for finding workable coal seams in that region.

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

HENRY S. POOLE.

HALIFAX, December, 1902.

REPORT

ON THE PROSPECTS FOR FINDING

WORKABLE COAL SEAMS

IN EASTERN NEW BRUNSWICK

INTRODUCTION.

The subject of this report is herein considered from an entirely economic point of view, as by one proposing to explore freely and follow up indications that may give any encouragement as to the presence of coal in seams of workable thickness, such as are found in the adjoining province of Nova Scotia.

EXPLORATIONS.

In earlier reports treating on the general geology of the Carboniferous, knowledge of which is presupposed, it has been shown that the existence of coal spread over a wide area has been long known in New Brunswick, but in all cases the beds so far discovered have been small and of a quality often inferior. The people of the province have been thoroughly alive to the value of coal; and as the country, especially along the streams, has been closely traversed by lumbermen, it may be reasonably assumed that no seam of any value crops to the surface and remains unreported. Known exposures have been examined and where of a sufficient thickness, mining operations on a limited scale have been conducted, as at Grand Lake, Coal Branch and Dunsinane. Sufficient seems to have been done to assume, that if thick workable seams do occur in New Brunswick, they must be sought for in depth. In this direction explorers have not been idle, and money has been spent in boring into unexposed strata. Of the borings, some of the cores and records have been preserved by the Crown Lands Department at Fredericton, and some of the results have appeared in the reports of the Geological Survey, while the more recent have been noted in the transactions of local scientific societies, or are recorded in the concurrent report of Dr. Bailey.

STRUCTURE OF THE CARBONIFEROUS FIELD.

Division of the field.

From the coal operators' standpoint, the conditions of deposition in Nova Scotia and New Brunswick are not quite the same. In both, there are great thicknesses of carboniferous rocks spread over wide areas; in Nova Scotia with thick coals cropping to the surface, in New Brunswick with none such to be seen, being concealed if existing. Over the larger parts of New Brunswick the beds associated with coal seams are near the surface, nearly horizontal and little disturbed, the lower strata of uneven thickness and all comparatively poor in bituminous matter. On the other hand, the nearer lying coal-measures of Nova Scotia are generally inclined over fifteen degrees; in parts they are heavily faulted and the coal seams continue downwards to great depths.

For convenience of description, the area occupied in eastern New Brunswick by carboniferous rocks may be divided by a line parallel to the Intercolonial Railway from St. John to Moncton, passing through Indian Ridge some six miles from the latter town, thence eastward to the Straits of Northumberland. The northern division would include only strata slightly inclined and with very little faulting or marked unconformities. The southern division, while embracing rocks of similar character lying to the eastward of the Memramcook river and onward to the Straits, also includes the prolongation of strata which are largely developed in Nova Scotia, steeply inclined, greatly disturbed and showing definite unconformities.

Absence of unconformity.

Regarded as a unit, the carboniferous of New Brunswick examined in ascending order furnishes no data for assuming that great lapses of time were represented by the passage between any of the beds. The series appears to be consecutive, no unconformity between any of the groups in the northern division being readily detected. It is, however, known that sections taken in detail exhibit divergence, and by comparison suggest some 'wants' where contact occurs with the subjacent older formations. But studied as a part of one widespread system embracing both provinces, certain localities show a deposition of thousands of feet of barren strata, some contain thick workable beds of coal, while in others an absence of some groups and the substitution of shale and bituminous layers for sandstone suggests that periods prolific of certain sediments to the eastward are unrepresented in parts of the New Brunswick formation.

Comparison with rocks of Nova Scotia.

Again, while it cannot be said that there is always unconformity in New Brunswick about the Bay of Fundy, such as is generally met with in Nova Scotia at the passage from the red to the gray overlying series, where the demarkation of the Lower Carboniferous and Millstone Grit strata is assumed; yet the uniform position of an outflow of diabase sharply separating the gray from the red series, near Boistown, Fredericton and other places in the western and middle portions of the carboniferous is at least suggestive of some lapse of time having occurred between the deposition of these two marked series in such localities. Igneous rocks.

A reference to the issued maps of the Survey makes it plain that a wide expanse of carboniferous rocks occupies in both provinces the shores bordering the Gulf of St. Lawrence, and extends from Gaspé to Cape Breton. Within this expanse lies a hypothetical ancient coal basin retaining patches of coal-measures, now isolated, and the operated coal seams of Nova Scotia. Structural details of many portions of the greater field have been published in the Reports of Progress of the Survey. Here it is sufficient to refer only to certain features of the now disrupted and in places greatly denuded primary field, which for convenience may be styled the Gulf coal basin. Gulf coal basin.

It may be here remarked that advantage was obtained from knowledge of the dislocations, elevations and depressions that modified the country surrounding the coal field in Pictou county, N.S., in a previous study of that outlying district, * when search was made beyond the recognized narrow limits of that field for a possible extension of the thick seams. With this experience in mind it does not seem foreign to this inquiry to consider the general features of the ancient Gulf field and to contemplate conditions during the several phases of the Carboniferous period. The Pictou division.

On the eastern side of the island of Cape Breton, coal-measures form the coast of Cape Breton county from Mira bay to the Great Bras d'Or, without being seriously disturbed and with seams of coal maintaining a fairly uniform thickness and quality. These dip seaward under a shallow foreshore generally at a very light angle, and in all probability they extend seaward for many miles and beyond what now appear to be practical working limits. The Cape Breton division.

Entirely separate from them are the seams cropping on the west coast of the Island, and the changes that are noticeable in the coal deposits at their contact with Pre-carboniferous strata, suggest an original "want" of coal seams in the sedimentation of the hills of the older series which now form the backbone of the island to Cape North.

* Pictou Coal Field : Trans. of the N. S. Inst. Sc., 1893.

On the west side of the island the coal-measures occupy only patches on the coast with lower strata alternating from Margaree southward. The general dip is toward the west, at greater inclination than on the east coast, but the deposits on both sides of the island appear to have been made synchronously and under very similar conditions. South of Port Hood and within the bay formed between Cape George and the Strait of Canso, the prolongation of the Gulf field is represented about Tracadie by members of the lower measures with their coal seams. From the presence of these beds in this position it may be assumed that the southern basal contour of the Gulf field was much like what it is to-day, with a break in the Appalachian folding forming a promontory at Cape George.

Foldings and disturbances occurred after the deposition of the coal-measures off the west coast of Cape Breton and brought up members of the lower Limestone series in islands near Port Hood and in those known as the Magdalen islands. Rocks of the same age also appear in the anticline from Pugwash to Shepody in New Brunswick and on the north side of the coastal range from Lutz mountain to the river St. John and in other places under the gray series as noted in the Survey reports. The west coast of Cape Breton though distant from New Brunswick, is considered part of the Gulf basin and it was affected by the mountain-making movements to be presently referred to, and by some lines of those movements from which much of the carboniferous of New Brunswick escaped.

The Pictou division.

On rounding Cape George, carboniferous rocks again appear and extend to the escarpment made of older strata, but they are unassociated, so far as is now known, with workable coals, except inland near the escarpment where the Pictou coal field has been preserved. The features of this isolated field differ considerably from those of Cape Breton, the part that has been saved owing its preservation perhaps, as well as its origin, to the shelter given by a ridge of old rock that was a promontory or island in the carboniferous sea, and which subsequently resisted the littoral movements that exposed to denudation the immediate extension of the field seaward. The character of the deposits lends itself to this conclusion; the coal seams, which are thick and of moderate ash in the centre, become inferior and ultimately are little better than fireclays at the margins; while the intervening measures, bituminous and argillaceous in the centre, pass into arenaceous beds as they approach the older rocks.

The Cumberland basin.

The remaining districts known to yield workable seams on the confines of the great Gulf field lie still more to the westward and are included in a triangular basin of carboniferous rocks, embracing the head of the Bay of Fundy and furnishing horizons from which measurements may be made on the one side with the Joggins coal seams in Nova Scotia and on the other with the series under review, in New Brunswick. This structure it was not possible to clearly show on a small map on a scale of four miles to one inch, published in 1885, nor is a continuity of the strata across Shepody bay evinced by delineation. The method adopted on the map to distinguish the several members of the carboniferous by a series of parallel lines was detrimental to the study of the stratigraphy, for as it is, the hatching is often incorrectly suggestive of structure.

STRUCTURAL CHANGES.

Mountain displacements

It is here assumed that the orogenetic movements among the Appalachian ranges, somewhat narrowed in New England, spread out more broadly to the eastward, and that some of the lines of movement subsided in intensity or altogether ceased as they approached the Gulf, where the great Champlain and St. Lawrence fault ceases to be parallel to the mountains. Off Gaspé, the great fault is assumed to take a more eastwardly course and thus to have relieved some of the pressure on the ranges prominent to the west, in a manner often seen illustrated among the faults that coal mining in various parts of the world has extensively exposed. Some of these lines ceased to be active long before others, in the parallel series. and left undisturbed the section of country between the Baie des Chaleurs and the line through Indian Ridge, even prior to the time when the gray series of rocks succeeded the period of volcanic activity to which reference has elsewhere been made. The area thus granted repose, increased to the eastward as the ages progressed, and unbroken succeeding strata lapped Indian Ridge and the country beyond. It subsequently included the greater part of Prince Edward Island.

Erosion across the coastal range.

In the meantime, in palæozoic ages, the eastwardly trending branch of the great fault off Gaspé seems to have been paralleled by movements between Caledonia mountain on the coastal range and the small exposures* of Pre-carboniferous rocks to the eastward on the Memramcook river. In this region the Albert shales and the members of the lower carboniferous, which include the plaster, bearing series, are much disturbed, but the tilting and folding, so marked in them, subsided along these lines before the deposition of the gray series and

* See Summary Report, 1902.

their underlying purplish conglomerates. The movements eastward on the deflected course paralleled, in a general way, the series of anticlinal foldings which are so marked a feature of the Cambrian rocks of Nova Scotia along the seaboard from Yarmouth to Cape Canso. Subsequently the lateral pressure landwards involved the Devonian strata of the Cobequids with their broken extension to Cape North. It is with the faulting and folding on this deflected course that our interest in the present question has to do, and in the study of which hopes may be entertained of unravelling structure now concealed. Nothing is known that would enable it to be said that the beds of the Cumberland and Pictou coal fields were even homotaxial with those of Cape Breton; in fact, present knowledge rather tends to show that both fields owe their development to local conditions, and that they are not mere outliers of one great coal field which is still wide-spread about Cape Breton, and supposed to have at one time extended to the Baie des Chaleurs.

Parallel foldings repeated.

Slight disturbance of higher series.

The east and west orogenetic movements in New Brunswick continued on the south side of the Coastal range into the Millstone Grit period, but on the north side they seem to have ceased before the deposition of the higher members of the gray series that include the undisturbed thin coal seams of Aboushagon, Cocagne, Moncton and other places, the range itself sinking eastward under the shallow covering supplied by these later deposits. On its south side, dislocations continued into much later times. They left a strip of Millstone Grit on the flanks of the range, and affected the coal-measures and the Permo-carboniferous of that locality. This view seems to be borne out by the structure exhibited in the Cumberland coal field, as well as in that portion around the head of the Bay of Fundy included in New Brunswick, both being parts of one basin.

Along the outcrops of the Joggins coal seams from the Bay shore to Chignecto mine, the workings show minor dislocations diagonal to the dip, but parallel to the general trend of the coastal range in New Brunswick and to the strong faults on its flanks. The dislocations, so far as they are known, are downthrows to the east, and show that the influence of the great movements continued even after the deposition of the coal-measures of this locality.

Carboniferous overlap on the Cobequids.

Mr. Hugh Fletcher has pointed out that the measures on the south side of Springhill, trending westward, seem to lose their identity when they reach the Cobequids, and becoming individually indistinguishable may combine to form one continuous zone of conglomerate. He has also noted that the various beds of sandstone, shale, coal, and fireclay, distinct in the cliffs at the Joggins mines, coalesce as they extend eastward under the Styles mine, where they are represented by one very thick variable bed of conglomerate. Further along on this easterly course the continuity of the outcrop is broken ; lower carboniferous strata with limestone and plaster interrupt, and when the coal-measures again appear they have resumed their varied constituents of sandstone, shale, &c., with many interposed coal seams, of which some are much thicker than those exposed on the Joggins shore. The gradual substitution of conglomerate, under the circumstances mentioned, would appear to indicate that shores of shallow water existed at the time these deposits were laid down, not only along the north flank of the Cobequids, but also on a line towards Pugwash, now represented by rocks of Carboniferous Limestone age with plaster beds along an anticline parallel to the Cobequids.

Of particular importance is that part of the Gulf field which lies to the westward of Salt Springs, and northward of a line extended through the Cobequids across the Bay of Fundy. The deposits of the carboniferous within this area overlapped the flank of the Cobequids and overspread in the Millstone Grit period, the opposite coastal range. Partly contemporaneous and subsequently continued, the movements developed an anticlinal fold on the flank of the coastal range up the Bay of Fundy to Shepody. A branch thence on a diverted line passed by the Elysian Fields, through Pugwash as already mentioned and on its way made either land or shallow water north of Springhill during the latter part of the period. A sympathetic syncline followed on the north side of the anticline, radiating also from Shepody bay. This syncline restored to the Millstone Grit beds, lying on the northern side of the anticline, a southerly dip in strata which were contemporary with those on its south side, in what may, for convenience, be called the Cumberland coal basin. In this basin, then relieved of much of the further movements, depositions continued conformable with those of the basal and medial parts of the famous Joggins 14,000 feet section. But, and here lies a fact of great moment, on the north side of the folding, the later sediments lie unconformably on the upper Millstone Grit, while the upper beds within the Cumberland basin, although apparently contemporaneous with those on the north side, lie comformably on the coal-measures, which in turn, are invariably conformable with the Millstone Grit in Nova Scotia. Important anticline and associated syncline.

The inward dip of this basin, beginning at Cape Enragé is 75°, decreasing slightly up the bay, parallel in strike, to 60° at New Horton. Here the course of the crop is quickly deflected with a dip at Mary Portion of the Cumberland basin in New Brunswick point of 45°, continued at 50° to Cape Maringouin. On the Nova Scotian side of the water at Boss point it is 30°, which dip is maintained in the conglomerate behind the Styles mine. In the overlying coal measures, the dip to the eastward is in parts as high as 40° and 50° along the coal crops. Then follows the fault and upthrust of the limestone series and the Springhill coal field, dipping about 30°. Foldings then expose in the strata overlying the thick coals the Black River series of small seams and the extension of these upper measures to Leamington and Mapleton, as lately disclosed by Mr. Fletcher's explorations, beyond which they are lost in or against the conglomerate zone previously described. The centre of the basin is occupied by the Joggins coal dipping 19° and the overlying gray and brown sandstone series, called indiscriminately Permian and Permo-carboniferous.

Undersea coals.

It is apparently the same group of Millstone Grit beds that is seen at Boss point, Cape Maringouin, Grindstone island, Mary point, Two islands and Cape Enragé. They lie thousands of feet below the Joggins main seam, so it would appear that the westward extension of the crop of that seam continues under water in front of the headlands mentioned, all the way to Cape Enragé, but out of reach from the New Brunswick shore and therefore unworkable. It may here be noted that the axis of this syncline within the coal basin, developed by the deflection of the strike of the beds at New Horton, originates as also does the syncline trending northeastward, at the base of Shepody mountain and it has its direction towards the gap in the Cobequids now obstructed by glacial drift, through which Halfway river flows.

Subordinate basins at Shepody.

It has been mentioned that on the west side of Maringouin at Hard ledge the measures are repeated, and therefore, if the reverse dip only continued far enough, a repetition of the Joggins series, although concealed, might be looked for and search made by borehole in the direction of Grande Anse under the unconformable brown sandstone series of Permo-carboniferous age. As it happens, the overlap of these rocks which is well seen at Hard ledge, is also there accompanied with evidence of a succeeding syncline restoring the southerly dip to the Millstone Grit, and thus so far as could be seen, destroying any hopes of the series as high as the Joggins mines being found repeated to the northward in that locality.

CORRELATION.

Characteristic beds.

In a comparison of the Carboniferous of the two provinces it would probably be more easy to find the corresponding beds on the opposite sides of Cumberland Basin, at Boss point and Ferris cove, by comparing photographs of the ledges exposed at low water, than by detailed measurements of the cliff sections. The action of the sea tending to mark in groups the series of beds, sandstones, shales and fireclays, an erosion scale becomes available to an observer of cliff sections. This grouping is made more evident by the seaweeds which clothe the harder and more enduring ledges and make them easily distinguishable at a distance from the beds that break up level with the sands of the beach and the mud flats. Individual beds in these measures are by no means regular, but, as the quarrymen say, go out and come in, thicken and thin. Of the sandstones, they distinguish between the hard and the soft, the fine and coarse, those of sharp grit and the dirty. Irregularity of deposition and false bedding are common features of the gray rock series, and would make a comparison of records of cliff sections less easy than one of a grouping of ledges arranged by the sea's erosion in lengths long enough to include the varied alternations of width and quality.

Copper ore, in the form of chalcocite and carbonate, occurs in nodules and infiltrations at several places in these rocks, as along the gray conglomerate ridge extending from Dorchester inland to the copper mine, on both sides of Maringouin peninsula; again at the same horizon at Downing cove on the opposite Nova Scotia shore and also in the other direction across the bay beyond Mary point and at New Horton. At Dorchester cape the ore in nodular form occurs more abundantly in the red series some 600 feet below the basal gray conglomerate, and apparently it is at this horizon that the similar deposit occurs which was opened on the Nepisiguit river at Bathurst. Copper ore.

It is interesting to note the greater concentration of this ore at some localities among these sedimentary rocks, but the cause is not clear, as the deposits are not confined to the tissue of plants preserved in the sandstone and conglomerate beds.

Iron ore may also supply a means for correlation. At Cherry Barton, two miles east of Dorchester, on the rear lands of W. B. Mitten, a strong band of fine-grained sandstone dips S. 30 E. $<$ 10°, which in parts has coarse pebbles mingled with it It bears on its surface a bed of silicious hematite, of variable thickness, in places as much as three inches; the sandstone itself weathers to a dead white. This ridge with its hematite cap is said to extend for three miles to the eastward. A similar rock with hematite stains in streaks is seen some four miles eastward at Read's house near the reservoir of the new water-works of Sackville, and again on a brook half a mile still fur- Hematite.

ther east. In the opposite direction at Grande Anse, on the bay shore, boulders of a similar rock, bearing a layer of hematite, are numerous. At the end of New Horton cliffs nearest to Mary point is a band of what appears to be the same rock, with hematitic blotches, and possibly it is an extension of the bed that produces an iron ore near Cape Enragé.

Limestones.

Other bands with marked features can be seen in the conglomerate limestones. One, which is white, occurs in the red series of Dorchester Cape; others are gray and stained reddish, as at Alma, Maringouin, the Joggins shore and Clifton, on the Baie des Chaleurs. These are similar to the black "bastard" limestones of Sir William Logan's section, east of New Glasgow and on River John. Then there are the beds in which Dadoxylon is a prominent fossil.

Fossil Dadoxylon.

Aid from treasure seekers was unexpectedly obtained in determining the line of separation of the gray conglomerate of Aulac ridge from the 'Permian' of Jolicure. There were no natural exposures, but a remarkable mound, a glacial drumlin, where the road to Midgic turns off, had attracted attention and French gold had been dug for, with the result that the Aulac series of rocks was exposed in situ and thus proved to extend to the depression between the hills.

Substitution of strata components.

It is generally well known that elsewhere, coal seams, when followed for a distance, do often change in quality and thickness—it may be to divide into benches or plies, perhaps to separate and diverge and become distinct seams with shale and sandstone beds intervening. While some are found uniform over wide areas, others are in places deteriorated in value and in thickness, even to become worthless for working in a comparatively short distance, as for example in the thick seams of Pictou. The converse of course holds good if the strata are examined from the other end, and beds of black shale and fireclay may be quoted as turning into good coal of exceptional thickness when followed but a few thousand feet. For example the Emery seam is triple the thickness at Schooner pond that it is at Dominion No. 4. There is the patch of "low" coal in the Sydney main seam near Keating pond; the lenticular increase to five feet over a couple of acres of the top coal of the Acadia seam; the local development in the Deep seam at Stellarton of an inferior band into good cannel coal and black band ironstone. The substitution for coal of patches of bat in the Vale six-feet seam, and the presence in parts of the Phelan seam of double the average quantity of sulphur. These and similar irregularities are found to occur in coal seams, otherwise fairly uniform, without anything to indicate their presence until they are actually discovered.

In England, in the Midlands and in Kent, seams, suspected on purely theoretical grounds to lie hidden under strata unconformable and unassociated with coal, have been sought for, and in some cases large areas of very valuable coal have been discovered and exploited.

Concealed coal seams.

The question then with us is: What encouragement is there to hope that similar conditions may exist on the New Brunswick shore, and that the hypothetical Gulf coal basin may yield a field of value hidden under newer formations? To this, a counter question may be asked. What reasons have we for expecting that the western field of Cape Breton has any valuable extension, or that the Cumberland and Pictou fields are other than local deposits, which owe their development to favourable situation?

It is by no means established that the circumstances of deposition in the northern division were comparable with those south-east of the coastal range, where the carboniferous is represented by sedimentary deposits of immense thickness. All the explorations go to show that there is not a tenth of the mass to the north, where the gray series rests directly on various lower formations, without trace of intermediate strata. For instance, the bore-hole of 1901 on the north side of the Cocagne river, three miles from its mouth, which reached a depth of 857 feet passed down into the red series, and left no hope of finding workable coal in that neighbourhood.

Where search might be made.

In the district of the Albert shales, east of Caledonia mountain, where erosion has shown many exposures of the red and grey transition beds, there is an excessive development of the upper part of the former, especially of the purplish beds of conglomerate near the copper mine, in Turners' brook, close to the Dorchester penitentiary, and in less complete exposures of the district, where the monocline of the lower gray series has been cut through by water courses and the underlying beds laid bare. A corresponding diminution seems to have followed in the beds overlying to the north-eastward, and that within a few miles of the Sackville section, where search might be made if at any time a trial hole looking for the horizon of the Joggins coal seams is determined on. Here is a basin-shaped area, not so complete as that of Cumberland, where the rim is of the gray conglomerate, extending from the copper mine to Dorchester island, reappearing at Dorchester cape and with its southern boundary at Westcock. There broken, the eastwardly dip is repeated at Aulac and Mt. Whatley. Within this area a section of at least 2,000 feet of gray beds is built up, and still higher strata in the series are covered by the marshes and the newer 'Permian' formation. Then, again, search might be made from Oromocto northward for local synclines or areas circumscribed by older formations, with a prospect of finding the surface seam better developed in them than it is generally throughout the field.

It is of course possible that there may be other spots similar to that on the north side of Grand lake, where the thin surface seam may be also thickened to the same degree. If so, such spots are more likely to be discovered by boreholes systematically following the known outcrops into ground at present unknown. Experience has shown that by shallow holes much information may be gained in a cheap way, as practised of late in Cumberland county by the Geological Survey, under the direction of Mr. H. Fletcher.

Previous reports have demonstrated that the New Brunswick field is made up of several minor undulations where the carboniferous rocks are shallow and rest uncomformably on older series. It is accepted that the bright-red argillaceous measures lie below those carrying coal seams. So far as the underlying gray series have been pierced, the scattered boreholes have proved to the depths attained (the deepest 1,200 feet) an absence of a lower or second series of coal beds, or even of bituminuous shales. It may be that the conditions differ in some of these minor basins and some may favour a greater accumulation of coal, but, it is only proper here to say that nothing is at present known to encourage this generalization. The structure of the field cannot fail to arouse interest, and warrant an examination in such detail as natural exposures admit of for the comparison of sections and mapping of outcrops as accomplished in strata of the same age in Nova Scotia.*

Productive coal measures absent.

The immediate interest of the structural movements dwelt on in this report lies in the presumption that the lines of Appalachian disturbance indicated in the red series on either side of the coastal range ceased to be active prior to the deposition of the higher members of the overlying gray series; that the extension eastward of the faulting on these lines is covered to the Strait of Northumberland by measures which carry the coal seams of Coal Branch, curve around Indian ridge and Lutz mountain to Aboushagon, and underlie the dark red-coloured sandstones distinguished as Permian or Upper Carboniferous. Should this supposition be confirmed, it follows that there is a total lack of strata, or what is practically the same thing, a valueless

* It is mentioned in *Acadian Geology* that many of the plants of the coal measures found in New Brunswick differ from those known in Nova Scotia, thus suggesting a difference in surface conditions.

attenuation of deposits representing the periods when the thick coals of Cumberland county, N.S., were laid down.

It should not to be forgotten that, apart from the extension of the coal-bearing series, there is the totally distinct question of whether the equivalents of the productive coal measures of Nova Scotia may or may not be richly carbonaceous should they be found concealed anywhere beneath higher series, and be there productive of workable coal seams.

Conclusion.

The examination in short resulted in a belief that the thin coal seams worked at Grand lake were of the horizon of strata classed among lower members of the Millstone Grit:—that there were no equivalents to the Productive Coal Measures of Nova Scotia deposited north of the Coastal range, and that while there were conditions south of that range more nearly approaching those of the coal basins, the features observable could not be regarded as encouraging for the presence of thick workable coal seams.

Other references to this subject have been made in the Summary Repor for 1901, p. 204, and in that for 1902.

APPENDIX.

Borings in the Carboniferous of New Brunswick.

The accompanying logs of borings made in various places in the Carboniferous basin in New Brunswick is given as supplementary to the reports of Messrs. Bailey and Poole.

Some of these have been taken fom the original records of the logs. That of the Cocagne bore-holes was made by Mr. Poole from an examination of the cores in Moncton. The log of the deep boring at Dunsinane has been taken from the origininal log but compiled by Mr. Harold Goodrich, M. E. The logs of the borings at Newcastle are reproduced from the reports of the Geological Survey made by Dr. Ells, and published in 1872-74. The greater part of these holes were made by diamond drill.

Newcastle Bridge, 1872-3.

These logs have been somewhat condensed from the originals.

1872.

	Ft.	In.
Fine gray sandstone	4	0
Coal shales with several thin seams of coal	12	5
Coal, main seam	1	10
Shale and impure coal		10
Clay shale	4	6
Shaly sandstone	4	9
Coal shale	3	0
Shale and clay, pyritous	2	9
Sandstone and shale, green and gray	9	0
Gray micaceous sandstone	65	5
No cores	4	8
Sandstone and grit	28	3
Hard gray shales, coaly matter	9	0
Fine gray micaceous sandstone	5	
No cores	7	9
Fine gray sandstone	8	0
	171	7

Boring No. 2. 1873. Newcastle Bridge.

	Ft.	In.
Flaggy gray sandstone, with some shale	24	4
Gray sandstone with conglomerate band	52	4
Gray shales with thin sandstone bands	11	0
Gray shales with thin band of conglomerate	23	5
Gray shales and sandstone alternating	25	1
Gray sandstone, coarse and fine, occasional bands of conglomerate	58	8
Gray shale	4	5
Gray conglomerate and coarse grit	18	2
Base of Carboniferous formation.		
Gray micaceous slates with quartz veins	149	4
	366	9

Newcastle (Near Little River), Boring No. 3. 1873.

	Ft.	In.
Soil	2	0
Gray micaceous sandstone	45	0
Gray shale and clay	8	6
Red and brown shale	25	9
Gray sandstone	1	3
Red and gray shale	10	2
Gray sandstone	8	9
Black and gray shale	4	5
Gray sandstone	6	6
Brown, gray and red shale	68	6
Gray micaceous sandstone	36	7
Purple gray sandstone	43	3
Bottom of Carboniferous formation.		
Hard gray and blue sandy slates, quartz veins with calcite	138	7
	399	3

Boring at Chatham, N. B., from Record by Mr. H. Goodrich, M.E. 1899.

	Ft.	In.
Drift	33	0
Massive gray sandstone with conglomerate	194	0
Gray shale	3	0
Gray sandstone	15	0
Gray shale	5	0
Gray sandstone	40	0
Gray shale	10	0
Possibly base of Millstone grit?		
Red marl or clay shale, probably with sandstone beds	100	0
	400	0

BORING AT COCAGNE, ABOUT THREE MILES WEST OF THE LOWER BRIDGE.

In the absence of the journal kept at the time of boring the hole in 1901, near the Cocagne river on the north side of its estuary, the following abstract has been made from an examination of the cores and the measurements given on them. It is, however, only an approximate record in descending series.

H. S. POOLE.

	Ft.	In.
Gray marly shale with coal 4 inches thick		
Light gray shaly sandstone		
Light purple sandstone, marly shale		
Gray and red shale, total	63	0
Purple mottled fine gray grit	12	0
Fine gray purple tinted micaceous grit	26	0
Fine gray sandstone	6	0
Fine banded gray grit	8	0
Coarse gray grit	5	0
Fine gray conglomerate	2	0
Coarse graystone sandstone	9	0
Sharp gray sandstone	3	0
Purple shale	4	0
Purple and greenish-gray sandstone	9	0
Fine greenish-gray shaly sandstone	5	0
Reddish and dark gray mottled shales, coal streak	15	0
Shaly gray fireclay	6	0
Purple and gray shales and sandstone	16	0
Coarse gray grit, sharp	18	0
Coarse gray grit with finer bands	10	0
Gray banded sandstone	28	0
Gray banded sandstone with 2 feet gray shale	9	0
Coarse gray grit with shale pebbles	44	0
Gray and purple shales	12	0
Purple marls and shales	27	0
Gray marls and shales	22	0
Gray coarse and fine sandstone	5	0
Coarse gray grits	10	0
Fine gray sandstone	25	0
Dark gray marly shales	10	0
Coarse gray sandstone, green shale bands	12	0
Gray sandstone	25	0
Grey sandstone and grits	23	0
Gray and mottled purple shales	31	0
Gray and purple tinted shales	10	0
Gray shales with 2 feet gray sandstone	10	0
Fine gray micaceous sandstone, shale bands	11	0
Dark gray marly shales	12	0
Compact gray grit	47	0
Gray sandstone with conglomerate band	24	0
Very coarse gray grit, band of gray shale	14	0

	Ft.	In.
Dark gray shales	14	0
Gray grit and coarse sandstone	43	0
Fine gray sandstone.	35	0
Gray sandstones	95	0
Purplish and mottled shales and sandstones	23	0
Purple marly shales with thin gray bands	12	0
Very hard greenish sandstone, compact fine white 15 inch. band of hard quartzite, with coarser grit and purplish mottled hard sandstone	7	0
	857	0

Dunsinane.

Several holes have been bored at Dunsinane, which is near the line of the Intercolonial railway, about midway between Anagance and Penobsquis stations. A thin seam of coal has been known to occur here and notes on it are given in a report by Mr. Matthew in connection with Professor Bailey's report to the New Brunswick Government, 1865. In all the logs of five borings with the diamond drill are to hand. One of these reached a depth of 1,292 feet. The cores which are in the Crown Lands Office, Fredericton, were examined by Mr. Harold Goodrich, who summarized the borings in tabular form, the results of which are given, rather than the lengthy logs kept by the driller at the time of boring.

From Mr. Goodrich's summary the record for the deep well is as follows :—

	Ft.	Ft.
Soil and drift	..	38
White sandstone	2	40
Purple shales and fine sandstone	10	50
Purple shales, mottled green	34	84
Fine purple sandstone.	2	86
Purple clay shales thin bands of purple sandstone	44	130
Gray clay shales, sometimes purplish	20	150
Dark purple mottled shales	48	198
Purple and dark gray shales, plants	38	236
Coal ¾ inch, shale 2 inches		
Coal 7 inches, fire-clay and shale	17	238¼
Gray clay shale	31¾	270
Gray sandstone and conglomerate	12	282
Gray sandstone and conglomerate, thin shales	58	340
Blackish gray fossiliferous shale	15	355
Fine and coarse sandstone	5	360
Gray shales	6	366
Gray micaceous sandstone	12	378
Gray conglomerate	4	382
Coarse sandstone with coaly matter	11	393
Gray shale	2	395
Gray micaceous sandstone, with beds of conglomerate and bands of shale	897	1,292

Dunsinane, No. 2, Condensed by Mr. Goodrich from Examination of the Cores.

DUNSINANE, No. 2.

	Feet.	Feet.
Drift and fine sandstone	10	...
Gray clay shale	10	20
Gray coal shale, thin seams of coal and plant stems	7	27
Grey micaceous sandstone, fine and coarse, with thick beds of gray conglomerate	73	100
Purple and gray shales	15	115
Gray and micaceous sandstones, with heavy bed of grey conglomerate	73½	188½

In the boring log the thickness of two seams of coal near the top is given at 9 inches and 12 inches.

DUNSINANE, No. 3.

(Condensed from official log.)

	Feet.	Feet.
Drift	..	21
Red marl	3	24
Sandstone and conglomerate	8	32
Red marl	25	57
Sandstone	4	61
Red shale and sandstone	22	83
Blue gray shale	2	85
Shale and sandstone mixed	29	114
Sandstone	10	124
Red marl and standstone	10	134
Sandstone	9	143
Grey shale and sandstone	11	154
Sandstone	10	164
——— (not given)	5	169
Coal with half inch parting	2	171
Sandstone	8	179
Coal	2 2 in.	184 2 in.
Fine sandstone	2	191 2 "

DUNSINANE, No. 4.

(350 feet S. E. of No. 3.)

	Feet.	Feet.
Drift	..	41
Blue shale	2	43
Reddish and gray sandstone	13	56
Reddish marly shales	33	85
Sandstone	1	90
Red and blue marly shales	5	95

	Feet.	Feet.
Sandstone	3	98
Blue and red shales	9	107
Sandstone	3	110
Red and gray shales	4	114
Very hard sandstone	12	126
Blue shale	2	128
Coal 1 ft. 4 in.	..	...
Blue shale 8 "	2	130
Sandstone	1	131
Blue shale	3	134
Sandstone	3	137
Soft blue shale	3	140
Coal 8 in.	..	...
Soft fire-clay 4 "	1	141
Hard blue shales	1	142

DUNSINANE, No. 5.

(About half a mile N.W. of No. 3.)

	Feet.	Feet.
Drift	..	22
Fine sandstone	1	23
Red shales	9	32
Hard fine sandstone	4	36
Red and blue shale with fire clay	11	47
Hard and soft red sandstone	13	60
Red shale and fire clay	9	69
Fine red sandstone	9	78
Red conglomerate	3	81
Soft and hard red sandstone	9 10 in.	90 10 in.
Red and blue shale	7 2 "	98
Red sandstone, hard and soft	12 8 "	110 8 "
Blue and red shale	7 4 "	118
Sandstone	3	121
Red and black shale	2 4 "	123 4 "
Sandstone	8 8 "	132
Shale and fire clay	3 4 "	135 4 "
Coal 1 ft. 8 in.	..	...
Gray shale 1 " 6 "	..	...
Coal 6 "	3 8 "	139
Black and gray shale	5	144
Fine sandstone	3	147
Blue and red shale	5	152
Red sandstone 8 in.	..	...
White clay 4 "	1	153
Red and blue shale	6	159
Coarse sandstone	13 2 "	172

Lutz Mountain, Harris' Land, No. 3.

1897.

	Feet. in.	Feet.
Light brick-coloured fine sandstone changing to gray		60
Purple fine sandstone	8 0	68
Medium-grained gray sandstone	9 0	77
Fine and medium whitish-gray sandstone, coaly matter.	51 0	128
Gray micaceous shale and mottled clay shale	15 0	143
Mottled clay shale, purple	29 0	172
Fine and medium gray sandstone	15 2	187
Sandstone and conglomerate	11 0	198
Purple fine conglomerate	4 2	202
Very fine reddish purple sandstone	18 0	220
Purple and green clay shale	25 0	245
Fine to medium purple sandstone	20 2	265
Medium whitish-gray sandstone	11 0	276
Gray and purple shale	22 0	298
Gray and reddish sandstone	15 0	313
Purple clay shale	27 0	340
Gray sandstone shading into purple	10 0	350
Dark and reddish purple clay shale	88 0	438
Very fine red shaly sandstone	19 0	457
Mottled fine red sandstone	11 0	468
Purple shale	2 0	470
Coarse gray sandstone and conglomerate	8 0	478
Gray and purple sandstone	77 0	555
Medium gray micaceous sandstone, much coaly matter	38 0	593
Very fine gray sandstone	44 0	637
Medium and fine white and gray sandstone	5 2	642
Sandstone and conglomerate	7 0	649
Medium sandstone	21 0	670
Massive gray sandstone	7 0	677
Green marly shales	28 0	705
Purple clay shales	30 0	735

Lutz Mountain, Peter Wilson's Lot.

1897.

	Feet.	Feet.
Clay and drift		18
Gray clay shale with coaly matter	2	20
Mottled gray and purple clay shales	5	25
Gray and green mottled clay shales	5	30
Medium gray sandstones with shale inclusions	10	40
Gray micaceous sandstone	10	50
Gray and green sandstone	48	98
Purple clay shales passing into purple sandstone	15	113
Reddish purple shale	2	115
Purple and gray shale	5	120
Fine reddish sandstone	25	145
Purple to brick-red shale	1	146

	Feet.	Feet.
Coarse gray micaceous sandstone	9	155
Medium " "	30	185
Purple and gray clay shale	15	200
Medium gray micaceous sandstone	3	203
Purple and mottled clay shale	7	210
Yellow and purple mottled shale	12	222
Brick-red clay shale	2	224
Brown purple shale	9	235
Fine purple sandstone	10	245
Dark purple shale	11	256
Fine red sandstone	11	267
Medium red sandstone	10	277
Very fine red sandstone	7	284
Fine and coarse gray sandstone	9	293
Conglomerate sandstone	10	303
Fine grey sandstone	20	323
Mottled purple and greenish shale	11	334
Coarse gray felspathic sandstone	2	336
Soft gray clay shale	24	360
Medium gray sandstone	30	390
Green-gray mottled sandstone and shale	2	392
Brick-red marl or shale	10	402
Brick-red and green mottled shale	7	409
Fine purple micaceous sandstone	11	420
Green micaceous sandstone, coaly matter	5	425
Dark purple shales	8	443
Medium reddish sandstone	4	447
Brick-red marls or shales	8	455
Fine micaceous sandstone	18	473
Brick-red marls or shales	9	482
Slightly red sandstone	27	510
Coarse gray micaceous sandstone, coaly streaks	50	560
Coarse and fine red sandstone	4	564
Dark red purple shale	4	568
Red shale	9	577
Compact red shale	23	600
Red marly shales with few quartz pebbles	17	617
Fine red sandstone shading to purple	5	622
Fine red sandstone	2	624

GEOLOGICAL SURVEY OF CANADA
ROBERT BELL, M.D., D.Sc. (Cantab.), LL.D., F.R.S.

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 KING'S MOST
EXCELLENT MAJESTY
1903

13—R

No 821

To

ROBERT BELL, M.D., D.Sc. (CANTAB.), LL.D., F.R.S.
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 more than half, a considerable number of mineral determinations, qualitative examinations, and partial quantitative analyses, the results of which have 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, 18th April, 1903.

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REPORT

OF THE

SECTION OF CHEMISTRY AND MINERALOGY

MISCELLANEOUS MINERALS.

1. Chrompicotite.

This variety of chromite—a mineral hitherto found in but one locality, namely, at Dun Mountain, in New Zealand—has been somewhat recently met with, in considerable quantity, in veins or dykes in the volcanic series of the Miocene Tertiary, on Scottie creek—a stream flowing into the Bonaparte—about nine hundred feet west of its first tributary on the south side, and some seven miles east of Mundorff, in the district of Lillooet, province of British Columbia.

The mineral, which is massive, with a fine to somewhat coarse granular structure, is associated with a pale yellow serpentine, small quantities of white to grayish-brown quartz and of white felspar, and a very small quantity of a green chromiferous silicate. It has a velvet-black colour, and is opaque; in very thin sections, however, it is translucent, and brownish-red by transmitted light. The lustre is sub-metallic. It breaks with an uneven fracture; is very brittle; and affords a grayish, inclining to blackish-brown, streak. It is non-magnetic. Its specific gravity, at 15·5° C., is 4·239. Before the blowpipe, both in the outer and inner flame, it remains unchanged. With borax, it gives a bead which, in the oxidising flame, is yellow while hot, and pure green when cold; and in the reducing flame, is of a fine emerald-green colour, both hot and cold. With salt of phosphorus it yields a limpid glass which, in the oxidising flame, while hot, appears yellowish, and on cooling, assumes a fine green colour; whilst in the reducing flame, the bead is greenish while hot, and bright emerald-green when cold. It is not acted upon by acids.

The mean of two very closely concordant analyses, conducted by Mr R. A. A. Johnston, showed this mineral to have the following composition :—

Chromium sesquioxide	55·90
Alumina	13·83
Ferrous oxide	14·64
Magnesia	15·01
Silica	0·60
	99·98

The presence of the silica would indicate that, notwithstanding the great care exercised by Mr. Johnston in the preparation of the material employed by him for analysis—a matter attended with considerable difficulty, even with the aid of heavy solutions—the same was, nevertheless, not absolutely free from all traces of some of the associated minerals.

The above mentioned occurrence may, not improbably, mark the site of a focus of volcanic activity similar to that—some thirty miles in an east-south-east direction from it—recorded in the Annual Report of this Survey for 1894, vol. 7, p. 157 B, et *seq.*, as having been observed in connection with the large magnetite deposit at Cherry Bluff, on the south side of Kamloops lake, in the adjoining district of Yale.

2. Faujasite.

This species, which was alluded to in my last report—see Annual Report of this Survey for 1899, vol. 12, part R, pp. 17 and 18—as being one of the mineral associations of the datolite found at the Daisy mica mine, on the ninth lot of the first range of the township of Derry, Ottawa county, in the province of Quebec, is there met with in the form of simple octahedral crystals implanted upon the walls of small cavities in the quartz or intimately associated with the fluorite, both of which enter largely into the composition of the matrix of the datolite. The crystals vary in size from such as are of almost microscopic minuteness to others having a diameter of about two millimetres. They are mostly milk-white—with, in some instances, a faint greenish tinge—in colour, and opaque, occasionally, however, colourless and translucent, and have a vitreous lustre. Its specific gravity, at 15·5° C., determined by Mr. R. A. A. Johnston, is 2·07. In the closed tube the mineral yields much water. Before the blowpipe, it intumesces and fuses to a white blebby enamel. It is decomposed by hydrochloric acid without gelatinisation.

Its analysis afforded Mr. Johnston the following results :—

Silica	48·7
Alumina	17·0
Lime	4·6
Soda	3·2
Water (ignition)	26·0
	99·5

3. Native Antimony.

Some very good specimens of this mineral have been obtained by Mr. R. L. Broadbent at what is known as the Dufferin iron mine, on the eighteenth lot of the first concession of the township of Madoc, Hastings county, in the province of Ontario.

As there met with, it occurs in the form of bright tin-white lamellar masses—of which, two of the largest yet found weigh, respectively, thirty-seven and forty-nine grammes,—showing brilliant cleavage surfaces, irregularly scattered through veins of calcite traversing a body of very fine-granular, compact, massive, grayish-black magnetite, as also in the form of delicate stringers and small patches and isolated particles in the magnetite itself which is in immediate contact with the walls of the calcite veins.

Its analysis afforded Mr. R. A. A. Johnston the following results :—

Antimony	99·89
Arsenic	0·02
Iron	trace.
	99·91

4. Edenite.

Some very fine specimens—one of which weighs close on eighteen pounds, of what on examination by Mr. R. A. A. Johnston proved to be this variety of amphibole, have been obtained, together with others illustrating its various mineral associations, by Mr. R. L. Broadbent from what is apparently a vein, on the property of Mr. Donald McPhee, on the fifteenth lot of the ninth range of the township of Grenville, Argenteuil county, in the province of Quebec.

Its associates in the veinstone—of which it is one of the most important constituents, are a grayish-white crystalline-granular pyroxene—which is the predominant mineral; white and greenish-white cleavable calcite; yellowish-gray, smoke-gray and clove-brown sphene—both massive and in the form of distinct crystals; white and light greenish-gray massive scapolite; pale pink, reddish-gray and grayish-brown garnet; small crystals and small granular masses of pale green apatite, and a little graphite.

The mineral occurs in the form of somewhat finely laminated masses, having two very perfect prismatic cleavages with angular intersections of 56° and 124°, and a third moderately perfect cleavage in a direction normal to that of the principal axis; the colour is brownish-red with a hyacinthine tinge, and the pleochroism somewhat strongly marked; it is subtransparent to transparent; has a vitreous lustre, on cleavage-faces; and breaks with a subconchoidal fracture. Its hardness was found by Mr. Johnston to be a little over 6 or nearly 6·5, and its specific gravity, at 15·5°C., 3·108. Before the blowpipe, it fuses at 3. The finely pulverised fused mineral gelatinises with hydrochloric acid.

The mean of two very closely concordant analyses, conducted by Mr. Johnston, showed it to have the following composition:—

Silica	46·09
Alumina	12·93
Ferric oxide	0·79
Ferrous oxide	none.
Manganous oxide	0·36
Lime	12·91
Magnesia	20·82
Soda	2 36
Potassa	1·84
Water, at 100°C	0·18
Water, above 100°C	0·48
Fluorine	2·84
	101·60
Less oxygen, equivalent to fluorine	1·19
	100·41

This mineral would appear to be well adapted for an ornamental stone or for use in jewellery.

5. Magnesite.

What, on examination, proved, as here shown, to be this species' has been met with in considerable abundance, as a rock forming mineral, both in situ and in the form of drift boulders, in some parts of the township of Grenville, Argenteuil county, in the province of Quebec, where it may, not improbably, hitherto have been mistaken for dolomite, which it much resembles in appearance.

An outcropping of the mineral has been observed by Mr. R. L. Broadbent on the north-half of the eighteenth lot of the eleventh range of the township, which is about ninety feet long by some twenty feet in breadth; and some two miles and a half south-south-east of this, on the north-half of the fifteenth lot of the ninth range, Mr. W. B. McAllister has met with another outcrop which, as he informs the writer, has a width of about one hundred feet and is traceable for a distance of a quarter of a mile, more or less. The first mentioned exposure is, it may be mentioned, cut, about midway its length, by an almost vertical dyke of grayish-black diorite-porphyrite. Drift boulders of the mineral have been found on the south-halves of lots fourteen and fifteen of the ninth range of the township—where they are quite numerous, as well as on the north-half of lot ten, of the same range, whilst others have been met with on the south-half of the eleventh and north-halves of the twelfth and thirteenth lots of the eighth range. The boulders vary greatly, both in form and size. The largest yet met with, occurs on the property of Mr. H. Cooke, on the north-half of the tenth lot of the eighth range. This measures sixteen by twelve by eight feet, and is computed to weigh something in the neighbourhood of one hundred and forty tons.

On the occasion of his visit to the locality in question, Mr. Broadbent collected a great number of specimens from the exposure on the eighteenth lot of the eleventh range of the township, as likewise from the various drift boulders, which he closely followed up; and Mr. McAllister, who also spent some time in the locality, in like manner collected numerous specimens from the outcrop on the north-half of the fifteenth lot of the ninth range, and from other not far distant points. The whole of these specimens have been examined, and with the undermentioned results:—

Partial analyses, by Mr. F. G. Wait, of nine samples of the mineral taken from various parts of the outcropping, of what is most probably a bed, on the eighteenth lot of the eleventh range of the township in question, consisted, respectively, of—

1.—A fine to somewhat coarsely crystalline-granular, massive, bluish-white magnesite, containing—magnesium carbonate, 77·62; calcium carbonate, 16·07; magnesia, present in other form than that of carbonate, 3·50 per cent.

2.—A finely crystalline-granular, massive, bluish-white to white magnesite, containing—magnesium carbonate 74·68; calcium carbonate, 18·89; magnesia, present in other form than that of carbonate, 3·71 per cent.

3.—A finely crystalline-granular, massive, milk-white magnesite with a few small inclusions of yellowish-green serpentine, containing—

magnesium carbonate, 78·08; calcium carbonate, 15·57; magnesia, present in other form than that of carbonate, 4·18 per cent.

4.—A finely crystalline-granular, massive, milk-white magnesite through which was distributed, in parts, a trifling quantity of wax-yellow serpentine, containing—magnesium carbonate, 77·16; calcium carbonate, 10·78; magnesia, present in other form than that of carbonate, 6·14 per cent.

5.—A finely crystalline-granular, massive, bluish-white magnesite holding, in parts, a little yellowish-green serpentine, containing—magnesium carbonate, 76·09; calcium carbonate, 16·00; magnesia, present in other form than that of carbonate, 4·29 per cent.

6.—A finely crystalline-granular, massive, grayish-white, in parts reddish-white, magnesite, containing—magnesium carbonate, 76·97; calcium carbonate, 13·14; magnesia, present in other form than that of carbonate, 5·87 per cent.

7.—A finely crystalline-granular, massive, grayish-white dolomite with some magnesite, through which was distributed small quantities of yellow and yellowish-brown serpentine, containing—magnesium carbonate, 49·71; calcium carbonate, 30·14; magnesia, present in other form than that of carbonate, 9·17 per cent.

8.—A finely to somewhat coarsely crystalline-granular, massive, grayish-white, in parts reddish-white, magnesite with a few small inclusions of wax-yellow serpentine, containing—magnesium carbonate, 75·69; calcium carbonate, 19·71; magnesia, present in other form than that of carbonate, 3·08 per cent.

9.—A somewhat coarsely crystalline-granular, massive, grayish-white magnesite, containing—magnesium carbonate 82·72; calcium carbonate, 12·36; magnesia, present in other form than that of carbonate, 2·53 per cent.

A fair average sample prepared from equal weights of numerous fragments of the mineral taken from as many different parts of the exposure, and which, taken as a whole, were regarded by the collector as fairly representative of the mass of the material of the outcrop, was found by Mr. R. A. A. Johnston to contain—magnesium carbonate, 77·07; calcium carbonate, 16·28; magnesia, present in other form than that of carbonate, 3·22 per cent.

Picked specimens from this exposure or outcrop have, it may be mentioned, been examined by Mr. Wait, which contained a larger percentage of magnesium carbonate than either of the foregoing specimens, for instance, one, a very pretty, somewhat coarsely crystalline-granular, massive, bluish-white, translucent magnesite, was found to contain—magnesium carbonate, 85·00; and calcium carbonate, 10·80 per cent; whilst another, a rather coarsely crystalline-granular, massive, snow-white, subtranslucent to translucent magnesite, was found to contain as much as 95·50 per cent of magnesium carbonate, with but a very small proportion of calcium carbonate.

The material of the exposure on the fifteenth lot of the ninth range of the township—represented by fifty-seven specimens, taken by Mr. McAllister from various parts of the outcropping, and in such wise as to fairly represent the mineral composing it—closely resembled that of the exposure on the eighteenth lot of the eleventh range, above referred to. In other words, the specimens consisted, respectively, of a snow-white, a milk-white, a grayish-white, a reddish-white, and a greenish-white, finely to somewhat coarsely crystalline-granular, massive magnesite with, in some instances, inclusions of greenish-yellow and yellowish-green serpentine. A very carefully prepared average sample of the fifty-seven specimens—composed of equal weights of the finely ground material of each, was found by Mr. Johnston to contain—magnesium carbonate, 81·27; calcium carbonate, 13·64; magnesia, present in other form than that of carbonate, 3·66 per cent.

The drift boulders, referred to at the commencement of this article, were found to be composed of material differing but little, if indeed at all, from that of the aforementioned outcroppings. Several of these have been examined by Mr. Johnston. A fair average sample of one from the McPhee property, on the south-half of the fifteenth lot of the ninth range of the township (Grenville), consisting, for the most part, of a moderately fine crystalline-granular, bluish-white magnesite, with which was associated a small proportion of moderately fine crystalline-granular, grayish-white dolomite—the former containing a few, and the latter numerous, inclusions of yellowish-brown to brownish-yellow serpentine, afforded him—magnesium carbonate, 78·33; calcium carbonate, 15·50; magnesia, present in other form than that of carbonate, 4·13 per cent. Another, from the property of Mr. McPhee, on the south-half of the fourteenth lot of the ninth range of this township, consisting of a somewhat finely crystalline-granular, massive, milk-white magnesite, with an occasional small inclusion of wax-yellow serpentine, was found by him to contain—magnesium carbonate, 89·92; calcium carbonate, 4·39; magnesia, present in other form than that of carbonate, 4·85 per cent. Yet another, from the Campbell property, on the north-half of the twelfth lot of the eighth range of the township, consisting of a somewhat finely crystalline-granular, massive, grayish-white magnesite, with a few inclusions of wax-yellow serpentine, afforded him—magnesium carbonate, 66·28; calcium carbonate, 23·96; magnesia, present in other form than that of carbonate, 4·85 per cent. Mr. Johnston has likewise examined material from the exceptionally large boulder—previously referred to, occurring on the property of Mr. H. Cooke, on the north-half of the tenth lot of the eighth range of the township. From this, Mr. Broadbent broke off fragments from the sides and top, some five in all. They consisted, respectively, of—1) a moderately coarse crystalline-granular, milk-white dolomite; 2) a somewhat coarse cleavable bluish-white dolomite holding a few crystals of red garnet and a few minute scales of graphite; 3) a moderately coarse crystalline-granular, white to pale brownish-white dolomite; 4) a rather fine to somewhat coarsely crystalline-granular, milk-white, in parts yellowish-white, calcareous magnesite; and (5) a rather coarsely crystalline-granular, pale bluish-white calcareous magnesite. A fair average sample prepared by carefully mixing equal weights of the finely powdered material of each of these five specimens, was found by him to contain—magnesium carbonate, 71·15; calcium carbonate, 24·11; magnesia, present in other form than that of carbonate, 2·32 per cent.

The material from many other boulders, occurring in this locality, has been examined, and with the following results—that of two met with on Mr. McHardy's property, on the north-half of the thirteenth lot of the eight range, consisted, in both instances, of a moderately coarse crystalline-granular, grayish-white dolomite with, here and there, a few inclusions of wax-yellow serpentine; that of another, occurring on Mr. Campbell's property, on the south-half of the eleventh lot of the eight range, also consisted of a finely crystalline-granular, grayish-white dolomite; whilst that of two others, both on the McPhee property, on the south-half of the fourteenth lot of the ninth range, consisted—that of the one, of a moderately coarse crystalline-granular, white magnesite, with a few small inclusions of pale greenish-yellow serpentine, containing but a very small quantity of calcium carbonate; and that of the other, of a somewhat finely crystalline-granular grayish-white, in parts faint reddish and greenish-white, magnesite, containing little more than traces of calcium carbonate.

The carbonic acid was, in all instances, determined directly. The magnesia, here throughout referred to as 'present in other form than that of carbonate', manifestly indicates the presence of one or more associated magnesian minerals, such as serpentine—which was indeed observable in most of the specimens, and just possibly periclase or its alteration product brucite, or yet again, hydromagnesite, derived from the alteration of the latter.

Magnesite, it is almost unnecessary to add, is a mineral of some economic importance, it being used in the preparation of magnesium salts—such as Epsom salts, magnesia, et-cetera; and in the manufacture of paint, paper and fire-brick. For the last named purpose it answers admirably, particularly where a highly refractive material is called for, as in the so-called basic process of iron smelting.

6. Clay, var. Fuller's Earth.

From Rock creek, about nine miles up from its entry into the Klondike river, Yukon district, North-west Territory. Collected by Mr. R. G. McConnell.

This material—not hitherto recognised as occurring in Canada,—which constitutes the underclay of a seam of lignite at the locality mentioned, is massive; has a light greenish-gray colour; a dull lustre; a greasy feel; breaks with an earthy fracture; scarcely adheres to the tongue; when immersed in water falls into a pulpy impalpable powder; is only slightly plastic, but may be formed into a soft adhesive mass with water which, however, on drying disintegrates. It is but slightly acted on by hydrochloric or sulphuric acid. When heated before the blowpipe, it swells up and fuses, with slight intumescence, at about 4, to a white glass.

Its analysis afforded Mr. R. A. A. Johnston the following results:—

Silica	60·64
Alumina	19·28
Ferric oxide	3·24
Ferrous oxide	0·51
Lime	1·64
Magnesia	2·66
Soda	1·86
Potassa	0·34
Water (ignition)	10·23
	100·40

This clay possesses all the properties of a fuller's earth. It readily decolorises mineral oils. A dark reddish-brown petroleum slowly percolated through a column of the same, ground to the requisite fineness, came out water-white.

MINERALOGICAL NOTES.

1.—Asbestus. Fine specimens of a faint greenish-white, silky-fine, fibrous actinolite, the fibres of which are flexible, and readily separable by the fingers, have been obtained by Mr. R. G. McConnell at a point on the Klondike river, about a mile and a half from its entry into the Yukon, Yukon district, North-West Territory.

2.—Azurite. Very pretty specimens of a fine berlin-blue azurite in the form of crystalline incrustations and small spherical crystal aggregates, have been obtained at the King Solomon mine, in Copper camp, at the head of Copper creek, which is a tributary of Deadwood creek—a stream flowing into Boundary creek, Yale district, in the province of British Columbia, where it occurs associated with malachite, melaconite, cuprite, lampadite, chalcocite, native copper, and hematite.

3.—Bismuthinite. This mineral has been met with at the Blue Bell claim, in Summit camp, near the head of Fisherman creek, a tributary of the north fork of Kettle river, Yale district, in the province of British Columbia. Specimens of the same, collected by Mr. R. W. Brock, consist of an association of a massive fibro-lamellar bismuthinite—which has been found by Mr. R. A. A. Johnston to contain traces of cadmium, with chalcopyrite, in a gangue composed of a greenish-gray andradite and a little white calcite.

4.—Copper, Native. Small irregular shaped particles of native copper are found more or less freely scattered through a granular massive cuprite and an accompanying ferruginous quartz occurring, with malachite, azurite, melaconite, chalcocite, hematite and lampadite, at the King Solomon mine, in Copper camp, at the head of Copper creek—a stream flowing into Deadwood creek, which is a tributary of Boundary creek, Yale district, in the province of British Columbia.

5.—Cuprite. This species has been found, in some abundance, associated with malachite, azurite, melaconite, chalcocite, native copper, hematite and lampadite, at the King Solomon mine, in Copper camp, at the head of Copper creek—a stream flowing into Deadwood creek, which is a tributary of Boundary creek, Yale district, in the province of British Columbia. As there met with, it occurs in the form of reddish-brown granular masses containing, as was well exemplified by specimens of the same collected by

Mr. R. W. Brock, occasional small fissures or cavities lined with minute, translucent, cubic crystals of the mineral, having a fine crimson-red colour by transmitted light, which are in some instances elongated to very slender prisms.

6.—LAMPADITE, or cupreous manganese. A variety of wad not previously recognised as occurring in Canada, has been found, in some little quantity, at the King Solomon mine, in Copper camp, at the head of Copper creek—a stream flowing into Deadwood creek, which is a tributary of Boundary creek—Yale district, in the province of British Columbia, where it occurs in the form of brownish-black, compact, amorphous masses associated with melaconite, malachite, azurite, chalcocite, cuprite, native copper and hematite.

7.—MALACHITE. This species occurs, in some quantity, in the form of an earthy coating, also as a fine velvety incrustation, as likewise in small spherical crystal aggregates, and occasionally in small groups of verdigris-green and emerald-green, radiating, slender acicular prisms, associated with azurite, melaconite, cuprite, lampadite, chalcocite, native copper and hematite, at the King Solomon mine, in Copper camp, at the head of Copper creek—a stream flowing into Deadwood creek, which is a tributary of Boundary creek,—Yale district, in the province of British Columbia.

8.—MELACONITE. The earthy, black, massive variety of cupric oxide—melaconite, has been sparingly met with, accompanying chalcócite, cuprite, malachite, asurite, native copper, lampadite and hematite, at the King Solomon mine, in Copper camp, at the head of Copper creek—a stream flowing into Deadwood creek, which is a tributary of Boundary creek,—-Yale district, in the province of British Columbia.

9.—RUTILE. Good specimens of a dark reddish-brown, subtranslucent, compact, massive rutile, have been obtained by Mr. R. G. McConnell from small quartz veins or stringers traversing igneous schists on Thistle creek, a stream entering the Yukon some eight miles above the mouth of White river, Yukon district, North-west Territory.

10.—TELLURIUM, NATIVE. This species, not previously known, to occur in Canada, has been detected by Mr. R. A. A. Johnston in a sample of ore from a small quartz vein at the Commodore claim, situate some three miles from Van Anda, north-east side of Texada island, Strait of Georgia, province of British Columbia. The ore consisted of a white quartz carrying small quantities of galena and of copper-pyrites and, here and there, a little of the mineral in question.

11.—Tremolite. Very pretty specimens of a white, fine-fibrous, tremolite, in the form of plumose aggregates, embedded in a light bluish-gray calcite, have been obtained by Mr. R. W. Brock at the Morrison mine, in Deadwood camp, on the west side of Boundary creek, from three to four miles north-west of Greenwood city, Yale district, in the province of British Columbia.

12.—Uvarovite. This variety of garnet has been observed in a sample of material, which was sent to the Survey for examination, from near the southern end of Upper Arrow lake, on the west side, and between Despatch island and point opposite Nakusp,—on the east side of the lake, in the West Kootenay district of the province of British Columbia. The material consisted of an association of white translucent quartz with small quantities of gray, grayish-green, and grayish-brown pyroxene and white scapolite, through which was distributed aggregations of small, bright emerald-green, tranparent, imperfect crystals of chrome-garnet, together with a few scales of graphite and particles of pyrrhotite and of magnetite.

ROCKS.

1. Altered Felsite.

From within half a mile of the stage stables at Hay cove, Red Islands, Richmond county, province of Nova Scotia. Geological position—Pre-Cambrian. Received from Mr. M. L. MacNeil.

A pale yellowish-greenish, light purplish-brown weathering, shale. Before the blowpipe, it fuses with difficulty, being only slightly rounded on the edges when in very fine splinters. It has a hardness of 3·5; and a specific gravity, at 15·5° C., of 2·66.

Its composition was found by Mr. F. G. Wait to be as follows :

Silica	78·06
Alumina	12·88
Ferric oxide	0·74
Ferrous oxide	0·73
Lime	0·44
Magnesia	0·86
Potassa	2·67
Soda	1·55
Water, at 100° C	0·25
Water, above 100° C	1·88
	100·06

This material, when reduced to powder and moistened with water affords a slightly plastic mass, which when burnt assumes a light reddish-brown colour. The burnt mass is difficultly fusible at a high temperature. It would make a fairly refractory fire-brick.

COALS AND LIGNITES.

[Continued from page 31R of the last Annual Report of this Survey—(vol. xii) for 1899.]

100.—LIGNITE.—From Lepine creek, a stream flowing into Rock creek which is tributary of the Klondike, Yukon district, North-west Territory.

An analysis, by fast coking, gave :

Hygroscopic water	14·38
Volatile combustible matter	34·26
Fixed carbon	42·80
Ash	8·56
	100·00
Coke, per cent	51·36
Ratio of volatile combustible matter to fixed carbon	1 : 1·25

It communicates a dark brownish-red colour to a boiling solution of caustic potash ; yields, by fast coking, a non-coherent coke ; and on incineration, leaves a reddish-brown ash.

101.—COAL.—Said to have been taken from a seam at or near White Horse, Yukon district, North-west Territory.

An analysis, by fast coking, gave:

Hygroscopic water	3·83
Volatile combustible matter	15·84
Fixed carbon	47·81
Ash	32·52
	100·00
Coke, per cent	80·33
Ratio of volatile combustible matter to fixed carbon.	1: 3·02

It yields, by fast coking, a non-coherent coke; colour of the ash, purplish-brown.

102.—SEMI-ANTHRACITE.—From near Blairmore, district of Alberta, North-west Territory.

An analysis, by fast coking, gave:

Hygroscopic water	1·22
Volatile combustible matter	11·70
Fixed carbon	75·67
Ash	11·41
	100·00
Coke, per cent	87·08
Ratio of volatile combustible matter to fixed carbon.	1: 6·47

It communicates a faint brownish-yellow colour to a boiling solution of caustic potash; yields, by fast coking, a non-coherent coke; and on incineration, leaves a white ash.

103.—ANTHRACITE.—Said to have been taken from a seam at White Horse, Yukon district, North-west Territory.

An analysis, by fast coking, gave:

Hygroscopic water	1·76
Volatile combustible matter	5·69
Fixed carbon	68·59
Ash	23·96
	100.00
Coke, per cent	92·55
Ratio of volatile combustible matter to fixed carbon	1:12·05

It communicates only a very faint brownish-yellow colour to a boiling solution of caustic potash; yields, by fast coking, a non-coherent coke; and on incineration, leaves a light reddish-white ash.

Although this fuel was said to have come from White Horse, it is not improbable that the seam from which it was taken is that occurring about ten miles west of Dugdale station, on the line of the White Pass and Yukon railway, specimens of the material of which were collected by Mr. R. G. McConnell, and by him handed to the writer for analysis, the results of which are given in the Annual Report of this Survey (vol. xii, page 30 R) for 1899.

Some partial analyses of coals from localities in the district of Alberta, North-west Territory; and from Kettle river, Yale district, province of British Columbia, are given beyond under 'Miscellaneous Examinations'.

Carbonaceous Shale.

The material in question, and which has, indifferently, by some been referred to as 'bituminous shale', by others as 'coal', and yet others as 'anthracite', is found about a mile up Harris brook —a tributary of Baddeck river, or some four and a half miles west by north of the town of Baddeck, in the district known as Hunter's Mountain, Victoria county, province of Nova Scotia, where it occurs associated with the Carboniferous conglomerate.

The surface of the freshly fractured shale is dull and earthy and of a grayish-black colour, that of what would appear to be bedding planes as likewise that of jointage planes, however, is velvet-black, smooth and lustrous. It does not soil the fingers.

An analysis, by fast coking, gave as follows:

Hygroscopic water	1·18
Volatile combustible matter	14·73
Fixed carbon	28·45
Ash	55·64
	100·00

It yields, by fast coking, and that notwithstanding the large amount of ash, a coherent, but very tender, coke. Colour of the ash, very light reddish-brown.

The occurrence of a very similar material, to that above described, at Hunter's Mountain, has been referred to by Mr. Hugh Fletcher, in his report on the geology of that part of Cape Breton Island—see Report of Progress of this Survey for 1876-77, p. 454. Mr. H. S. Poole also, in his report on the inspec tion of mines in Nova Scotia for the year 1877, refers to the occurrence of a bituminous shale, by courtesy called coal, at this place, and in so doing states that material of similar character has been exposed on the flanks of several hills in the province, but nowhere has its quality improved in depth to warrant its extraction, even were it more favourably situated for working. Nor does this spot—namely, Hunter's Mountain, hold out any better inducements.

LIMESTONES AND DOLOMITES.

[Continued from page 35 R of the last Annual Report of this Survey (vol. xii), 1899.]

1.—LIMESTONE. From a quarry—originally opened by Mr. C. B. Wright and now owned by Mr. E. W. Clark—on the thirty-fourth lot of concession A of Ottawa Front, township of Nepean, Carleton county, province of Ontario. Geological position—Chazy formation, Cambro-Silurian.

The material, which was examined for Mr. D. Divers, was collected by him in such wise as to represent a fair average of a vertical exposure of the upper ten feet of the working. It consisted of a bluish-gray, for the most part very fine-crystalline, limestone. Its composition was found by Mr. F. G. Wait, to be as follows:—

(After drying at 100° C.—Hygroscopic water = 0·16 per cent.)

Calcium carbonate			60·45
Magnesium carbonate			16·17
Ferrous carbonate			1·61
Manganous carbonate			trace.
Calcium sulphate		0·37	
Calcium phosphate		0·41	
Alumina		0·20	
Silica, soluble		0·51	21·50
Insoluble matter, consisting of			
Silica	14·98		
Alumina with a little ferric oxide	3·70		
Lime	trace.	20·01	
Magnesia	0·30		
Alkalies, by difference	1·03		
			99·73

2.—DOLOMITE. From Walkerton, township of Brant, Bruce county, province of Ontario.

A faintly brownish light-gray, very fine-crystalline, almost compact dolomite, intersected by numerous thin laminae of gypsum. An analysis by Mr. Wait, afforded the following results :—

Calcium carbonate		54·96
Magnesium carbonate		42·10
Ferrous carbonate, very small quantity		undet.
Calcium sulphate	1·96	} 2·96
Insoluble matter	1·00	
		100·02

3.—Dolomite. From the same locality as the preceding specimen, but taken from a different bed.

A faintly brownish light-gray, very fine-crystalline, almost compact dolomite. Its analysis afforded Mr. Wait the following results :—

Calcium carbonate	54·41
Magnesium carbonate	45·23
Ferrous carbonate, very small quantity	undet.
Insoluble matter	0·45
	100·09

4.—Dolomite. From the north-east side of the Narrows leading to Chief's Bay, Lake Nepigon, district of Thunder Bay, province of Ontario. This, and the following specimen were collected by Dr. A. W. G. Wilson.

A light yellowish-greenish-gray dolomite. Determinations, by Mr. Wait, of the chief constituents gave the following results:—

Calcium carbonate	27·70
Magnesium carbonate	27·90
Insoluble matter	40·00

The insoluble portion of this stone consisted of a mixture of argillaceous and siliceous matters of which the latter constituted, approximately, 6·67 per cent of the whole.

5—Dolomitic Limestone. From Poshkokagan river, a stream flowing into Chief's Bay, Lake Nepigon, district of Thunder Bay, province of Ontario.

It was of a faintly yellowish-greenish-grayish colour. A partial analysis, by Mr. Wait, showed it to contain :

Calcium carbonate	47·00
Magnesium carbonate	31·70
Insoluble matter	20·00

The insoluble portion of this stone, like that of the preceding specimen, consisted of argillaceous and siliceous matters. The siliceous constituent, in this instance, amounting to, approximately, 5 per cent of the whole.

CALCAREOUS MARLS.

[Continued from page 32 R of the Annual Report of this Survey (vol. vii) for 1894.]

13.—From Marl lake, township of Flos, Simcoe county, province of Ontario. It covers the bottom of the lake, and is also said to extend over a considerable area of the immediately surrounding land. The twenty-fifth and twenty-sixth lots of the seventh and eighth concessions of the township would, it was stated, be about the centre of the deposit. Little is, as yet, known in regard to the thickness of the deposit in the lake, beyond this, that it had been probed to a considerable depth without reaching the bottom. Received from Mr. Chas. Cameron. Examined for Mr. Geo. Moberly.

The air-dried material is earthy, somewhat coherent; and has a light yellowish-gray colour. It contains a few shells, and some root-fibres.

An analysis, by Mr. F. G. Wait, showed it to have the following composition:

(After drying at 100° C.—Hygroscopic water = 0·47 per cent.)

Lime	47·92
Magnesia	0·84
Alumina	0·39
Ferric oxide	0·34
Manganous oxide	trace.
Potassa	0·04
Soda	0·10
Carbonic anhydride	38·65
Phosphoric anhydride	0·02
Silica, soluble	0·37
Insoluble mineral matter	9·81
Organic matter, viz., vegetable fibre in a state of decay, and products of its decay, such as humus, humic acid, &c.,—and, possibly, a little combined water	1·42
	99·90

Assuming the whole of the lime to be present in the form of carbonate, trifling quantities of which are, however, present in other forms of combination, the amount found would correspond to 85·57 per cent calcium carbonate.

The insoluble mineral matter, consisting of arenaceous and argillaceous matters, was found to consist of :

Silica	6·97
Alumina	1·55
Ferric oxide	0·48
Manganous oxide	traces.
Lime	0·27
Beryllia	traces.
Magnesia	0·15
Potassa	0·19
Soda	0·20
Titanium dioxide	traces.
	9·81

The arenaceous portion of the insoluble matter consisted of grains of white quartz—which constituted, approximately, eighty per cent, by weight, of the whole; grains of red and yellow garnet and of black hornblende—both abundant; some grains of black tourmaline, and a few others of magnetite.

IRON ORES.

The following partial analyses of iron ores were all—with the exception of Nos. 10, 11 and 12, which were carried out by Mr. R. A. A. Johnston—conducted by Mr. F. G. Wait.

1.—MAGNETITE. From the farm of John Hatley, Cleveland, Annapolis county, province of Nova Scotia. This, and the three following specimens were examined for Mr. Geo. E. Corbitt.

A fine-grained, massive magnetite. It was found to contain —metallic iron 44·13 per cent, insoluble siliceous matter 32·85, titanium dioxide, none.

2.—MAGNETITE. From Baker's farm, pit No. 1, Nictaux iron mines, Annapolis county, province of Nova Scotia.

A fine-grained, massive magnetite. It contained—metallic iron 53·61 per cent, insoluble siliceous matter 12·89, titanium dioxide, none.

3.—MAGNETITE. From McConnell's farm, pit No. 2, Nictaux iron mines, Annapolis county, province of Nova Scotia.

A fine-grained, massive magnetite, which was found to contain —metallic iron 55·45 per cent, insoluble siliceous matter 13·03, titanium dioxide, none.

4.—MAGNETITE. Also from McConnell's farm, but from a different opening, namely, pit No. 4.

A fine-grained, massive magnetite. Determinations gave—metallic iron 55·69 per cent, insoluble siliceous matter 15·48, titanium dioxide, none.

5.—MAGNETITE. Described as coming from Chicoutimi county,—precise locality not stated, in the province of Quebec.

A somewhat coarse-crystalline, massive magnetite, with which was associated a rather small quantity of gangue composed, mainly, of quartz with some hornblende. It was found to contain—metallic iron, 39·21 per cent.

6.—MAGNETITE. From the first lot of the eight range of Wolfstown, county of Wolfe, province of Quebec.

Magnetite, with which was associated a little copper pyrites, and a small quantity of gangue composed of chloritic-schist and quartz, together with some calcite and a very little mica-schist. It contained—metallic iron 59·92 per cent, insoluble matter 7·20, titanium dioxide, none.

7.—MAGNETITE. From the fifteenth lot of the fifth concession of the township of Oso, Frontenac county, province of Ontario.

A titaniferous magnetite, with which was associated a somewhat large quantity of gangue composed, essentially, of pyroxene with a little calcite and a very little quartz. Determinations of the more important constituents gave the following results:—metallic iron 37·18 per cent, titanium dioxide 8·00, phosphorus, none; sulphur 0·18, silica 19·65. Manganese was found to be present, but only in small quantity and was, therefore, not determined.

8.—MAGNETITE. From the thirty-first lot of the twelfth concession of the township of Grattan, Renfrew county, province of Ontario.

A somewhat coarse-crystalline, massive magnetite, through which was distributed a large proportion of gangue—composed of hornblende, felspar, and quartz, together with a little iron-pyrites. It was found to contain—metallic iron 22 per cent, insoluble matter 57·23, titanium dioxide, none.

9.—MAGNETITE. From the same locality as the preceding specimen, but taken from a different part of the deposit.

The material consisted of a more or less intimate association of magnetite, hornblende, felspar and quartz, through which was scattered a few particles of iron-pyrites. Determinations gave —metallic iron 19·25 per cent, insoluble matter 61·52, titanium dioxide, none.

10.—MAGNETITE. From near the west end of Turtle lake, north of the north-eastern extremity of the north-east arm of Lake Temagami, district of Nipissing, province of Ontario. Collected by Dr. A. E. Barlow.

An intimate association of a fine-granular magnetite and white quartz, traversed by layers of red jasper. It contained—metallic iron 36·56 per cent, insoluble siliceous matter 46·69, titanium dioxide, none.

11.—MAGNETITE. From an extensive exposure on Iron lake, north of the north-east arm of lake Temagami, district of Nipissing, province of Ontario. This, and the following specimen were collected by Dr. A. E. Barlow.

The description given of the preceding specimen applies also to this one. It was found to contain—metallic iron 51.40 per cent, insoluble siliceous matter 27·83, titanium dioxide, none.

12.—MAGNETITE. From a short distance north of the north-east arm of lake Temagami, district of Nipissing, province of Ontario.

The material of this specimen was of very much the same character as that of the two preceding ones. Determinations gave—metallic iron 46·56 per cent, insoluble siliceous matter 30·47, titanium dioxide, none.

13.—MAGNETITE. From a deposit of considerable extent near Flying Post, Mattagami river, district of Algoma, province of Ontario.

It consisted of a more or less intimate association of magnetite with a somewhat large proportion of gangue composed, mainly, of quartz with some hornblende. A carefully prepared average sample of three large fragments of the ore was found to contain —metallic iron 43·93 per cent, insoluble siliceous matter 33·82, titanium dioxide, none.

14.—MAGNETITE. From mountain north of Whitefish lake, three miles north of the west line of the township of Strange, district of Thunder Bay, province of Ontario. This, and the following specimen were collected by Mr. W. McInnes.

A very fine-grained, compact, massive magnetite, through which was distributed a somewhat large proportion of gangue composed, essentially, of hornblende with some quartz. It contained—metallic iron 46·54 per cent, insoluble matter 27·71, titanium dioxide, none.

15.—MAGNETITE. From about half a mile west of Whitefish station, on the Port Arthur, Duluth and Western Railway, township of Strange, district of Thunder Bay, province of Ontario.

An exceedingly fine-grained, compact, massive magnetite, through which was distributed a somewhat large proportion of gangue composed, mainly, of hornblende with some quartz. Determinations gave—metallic iron 45·75 per cent, insoluble matter 27·24, titanium dioxide, none.

16.—MAGNETITE. From the outcrop of a deposit on Sutton lake, west side of James Bay, district of Keewatin. This, and the following two specimens were collected by Mr. D. B. Dowling.

The material, which was taken from the uppermost bed, consisted of a very fine-granular, massive, dark-gray, laminated magnetite. It was found to contain—metallic iron 33·40 per cent, insoluble siliceous matter 48·49, titanium dioxide, none.

17.—MAGNETITE. From the same deposit as the preceding specimen, but from a depth of thirty-five feet below where that was taken.

A massive, very fine-granular to almost compact, dark-grayish, laminated magnetite. It contained—metallic iron 68·62 per cent, insoluble siliceous matter 4·21, titanium dioxide, none.

18.—MAGNETITE. From the same deposit as the two preceding specimens, but taken from a depth of ninety feet from the surface.

An association of a very fine-granular, grayish-black magnetite with a chestnut-brown coloured jasper. Determinations gave—metallic iron 27·72 per cent, insoluble siliceous matter 61·12, titanium dioxide, none.

19.—HEMATITE. From the farm of Lachlan McQuarrie, on the west side of Middle river, Victoria county, province of Nova Scotia. Examined for Mr. John McLeod.

An association of micaceous iron ore with a little earthy hematite. It was found to contain—metallic iron 67·88 per cent, insoluble siliceous matter 1·30.

20.—HEMATITE. From the township of Sarawak, Grey county, province of Ontario. Examined for Mr. John Mackenzie.

The material, which was in the form of irregular shaped nodules, was found to contain—metallic iron 37·57 per cent, insoluble siliceous matter 41·34, titanium dioxide, none.

21.—HEMATITE. From a deposit south of Waboose lake, district of Thunder Bay, province of Ontario. Collected by Dr. A. W. G. Wilson.

An earthy, purplish-red hematite through which was disseminated a few scales of specular iron. Determinations gave—metallic iron 57·11 per cent, insoluble siliceous matter 11·96.

22.—LIMONITE. From the Lower Mattagami river,—where it is said to occur in considerable quantity, district of Algoma, province of Ontario. Collected by Mr. J. M. Bell.

A compact, massive limonite, which, on examination was found to contain—metallic iron 50·99 per cent, insoluble siliceous matter 9·70.

23.—LIMONITE, var. bog ore, from a deposit at Port Kells, south side of the Fraser, district of New Westminster, province of British Columbia. The material which was received from, and examined for, Mr. Geo. de Wolf, was found to contain—metallic iron 44·04 per cent, insoluble siliceous matter 15·89.

NICKEL AND COBALT.

Estimation of, in certain ores from the undermentioned localities in the provinces of Nova Scotia, Quebec, Ontario, and British Columbia. Continued from page 38 R. of the Annual Report of this Survey (vol. xii) for 1899.

1.—PYRRHOTITE. From a point described by the sender as near Boularderie Centre, Victoria county, province of Nova Scotia. Examined for Mr. William Haggerty.

A massive pyrrhotite, through which was distributed a few particles of copper-pyrites and a small quantity of gangue composed, mainly of hornblende with a little quartz. An analysis by Mr. F. G. Wait showed it to contain:

Nickel	0·07 per cent.
Cobalt	trace.

The gangue constituted 12·41 per cent, by weight, of the whole. The metalliferous portion of the ore contained, therefore, 0·08 per cent of nickel.

2.—PYRRHOTITE. From the fourteenth lot of the fifth range of the township of Masham, Ottawa county, province of Quebec. Examined for Mr. W. L. Marler.

A massive pyrrhotite, through which was disseminated a very small quantity of quartz. Mr. Wait found it to contain:

Nickel	0·11 per cent.
Cobalt	none.

3.—PYRRHOTITE. From the same locality as the preceding specimen, but taken from a different part of the deposit.

It consisted of pyrrhotite, with which was associated a little iron-pyrites and a very small quantity of gangue composed, essentially, of black garnet and pyroxene with a very little quartz. Determinations by Mr. Wait gave:

Nickel	0·10 per cent.
Cobalt	none.

4.—PYRRHOTITE. From a cutting on the Whitney and Opeongo Railway, about seven and a quarter miles from its junction with the Canada Atlantic Railway, township of Sproule, district of Nipissing, province of Ontario. Examined for Mr. A. H. N. Bruce.

A compact, massive pyrrhotite, through which was distributed a few particles of copper-pyrites and a small quantity of gangue composed, mainly, of quartz and felspar with a very little garnet. It was found by Mr. Wait to contain:

Nickel	0·19 per cent.
Cobalt	traces.

5.—PYRRHOTITE. From the seventeenth lot of the second concession of the township of Westmeath, Renfrew county, province of Ontario.

An association of pyrrhotite with very small quantities of copper-pyrites, apatite, and black hornblende. It was found by Mr. R. A. A. Johnston to contain:

Nickel	faint traces.
Cobalt	none.

6.—PYRITE. From the north-half of the fourth lot of the fourth concession of the township of Graham, district of Algoma, province of Ontario, where it occurs associated with pyrrhotite, copper-pyrites, and some danaite.

A massive iron-pyrites, through which was distributed a very small quantity of rock matter—not more than 1·04 per cent. Determinations by Mr. Wait gave :

Nickel	0·49 per cent.
Cobalt	trace.

7.—PYRRHOTITE. From the south-half of the eighth lot of the fourth concession of the township of Dowling, district of Algoma, province of Ontario.

A massive pyrrhotite with which was associated a little copper pyrites, and a somewhat large proportion of gangue. The pyrrhotite freed from the copper pyrites and all gangue was found by Mr. Wait to contain :

Nickel	0·26 per cent.
Cobalt	trace.

8.—PYRRHOTITE. From the west-half of the tenth lot of the fourth concession of the township of Olden, Frontenac county, province of Ontario. Examined for Mr. J. Bawden.

A granular, massive pyrrhotite, with which was associated a very little copper-pyrites, and a small quantity of gangue composed, essentially, of felspar with a little quartz and hornblende. An analysis by Mr. Wait showed it to contain :

Nickel	0.98 per cent.
Cobalt	trace.

The gangue constituted 3·32 per cent, by weight, of the whole. The metalliferous portion of the ore contained, therefore, 1·02 per cent of nickel.

9.—PYRRHOTITE. From the mountain west of Ice river, about six miles from the forks of Ice and Beaverfoot rivers, East Kootenay district, province of British Columbia. Examined for Mr. James Walker.

A compact, massive pyrrhotite, through which was distributed a trifling quantity of siliceous gangue—not more than 0·20 per cent. Determinations by Mr. Wait gave :

Nickel	0·12 per cent.
Cobalt	none.

10.—PYRRHOTITE. From the north bank of the Thompson, about five miles above Lytton, Yale district, province of British Columbia. Examined for Mr. Geo. de Wolf.

An association of a fine-granular, massive pyrrhotite with some iron-pyrites and very little copper-pyrites, through which was distributed a somewhat large quantity of gangue composed, mainly, of hornblende and quartz. It was found by Mr. Wait to contain:

Nickel	0·08 per cent.
Cobalt	trace.

The gangue constituted 17·72 per cent, by weight, of the whole. The metalliferous portion of the ore contained, therefore, 0·097 per cent of nickel.

11.—Pyrrhotite. From Shuswap lake, Yale district, province of British Columbia. Examined for Mr. J. T. Edwards.

An association of a compact, massive pyrrhotite with a little copper-pyrites, through which was scattered a somewhat large quantity of quartzose gangue. Determinations by Mr. Wait gave:

Nickel	trace.
Cobalt	none.

The gangue constituted 15·75 per cent, by weight of the whole.

GOLD AND SILVER ASSAYS.

These were all conducted by Mr. R. A. A. Johnston.

As explanatory of the many instances in which no trace of either gold and silver was found, it may be mentioned that in nearly all these cases the assay was carried out by special request.

Province of New Brunswick.

1.—From what was described, in a general way, as the Tobique waters. Examined for Mr. F. H. Hale.

An association of white sub-translucent quartz, more or less stained with hydrated peroxide of iron, with small quantities of greenish-gray chloritic schist.

It contained neither gold nor silver.

2.—From the same locality as the preceding specimen.

A white sub-translucent quartz, more or less stained with hydrated peroxide of iron, with which was associated small quantities of a greenish-gray chloritic schist.

It contained neither gold nor silver.

3.—From the same locality as the two preceding specimens.

A more or less rust-stained, white sub-translucent quartz with which was associated small quantities of a greenish-gray chloritic schist.

It contained neither gold nor silver.

Province of Quebec.

4.—From the land of Mr. Landreville, in the third range of the township of Acton, near the village of Actonvale, county of Bagot.

A light gray to grayish-white crystalline limestone with which was intimately associated some grayish-white quartz carrying very small quantities of copper-pyrites and pyrrhotite. The sample, consisting of two fragments, weighed two ounces and a half. It was found to contain:

Gold.................. none.
Silver, at the rate of... 0·466 of an ounce to the ton of 2,000 lbs.

5.—From a small island in Upper Abitibi lake, about fourteen miles west of the Hudson Bay Company's Post. Collected by Mr. W. J. Wilson.

A white translucent quartz, more or less coated with hydrated peroxide of iron, carrying small quantities of iron-pyrites. The sample, consisting of nine fragments, weighed three pounds eleven ounces.

It contained neither gold nor silver.

6.—From a quartz vein at Kewagama lake, some seventy-five miles south-east of Abitibi Post, Lake Abitibi. Collected by Mr. J. F. E. Johnston.

A white translucent quartz carrying somewhat large quantities of iron-pyrites. The sample, a single fragment, weighed twelve ounces. Assays gave:

Gold, at the rate of....0·117 of an ounce to the ton of 2,000 lbs.
Silver.................none.

Province of Ontario.

7.—From Lake Temiscamingue, district of Nipissing. Examined for Mr. Joseph Beaubien.

An association of quartz, felspar and a little mica, in parts stained with hydrated peroxide of iron and green carbonate of copper, through which was distributed very small quantities of copper-pyrites.

It contained neither gold nor silver.

8.—From the second lot of the first concession of the township of Rayside, district of Algoma. Examined for Mr. A. J. Fraser.

A white translucent quartz, stained and coated with hydrated peroxide of iron and a little green carbonate of copper, carrying small quantities of iron-pyrites and copper-pyrites. The sample, consisting of two-fragments, weighed ten ounces. Assays showed it to contain:

Gold....................none.
Silver, at the rate of....0·058 of an ounce to the ton of 2,000 lbs.

9.—From the thirtieth lot of the first concession of the township of Miller, Frontenac county. Examined for Mr. L. B. Simons.

A white translucent quartz, in parts coated with hydrated peroxide of iron, carrying somewhat large quantities of iron-pyrites. The sample, consisting of numerous small fragments, weighed ten pounds.

It contained neither gold nor silver.

10.—From the west-half of the seventeenth lot of the third concession of the township of Galway, Peterborough county. Examined for Mr. R. Elliott.

A massive iron-pyrites with which was associated a small quantity of a quartzose gangue.

It contained neither gold nor silver.

District of Keewatin.

11.—From a gold-prospect on Lake Jasper. Collected by Prof. A. W. G. Wilson.

An association of greenish-gray mica-schist with a little white translucent quartz, carrying small quantities of iron-pyrites. The sample, consisting of several fragments, weighed fourteen ounces.

It contained neither gold nor silver.

North-west Territory.

12.—From Great Slave lake, district of Mackenzie. Examined for Mr. R. H. Harding.

A coarse-crystalline galena, with which was associated a small quantity of calcareous gangue. The sample, a single fragment, weighed an ounce and a half. It was found to contain :

Gold..none.
Silver..distinct trace.

13.—From Lepine creek, which flows into Rock creek a tributary of the Klondike, Yukon district. This, and the four following specimens were collected by Mr. R. G. McConnell.

A light gray, slightly calcareous, quartzo-felspathic schist, through which was disseminated fine particles of iron-pyrites. The sample, a single fragment, weighed fifteen ounces.

It contained neither gold nor silver.

14.—From Lone Mountain, Macmillan river, Yukon district.

A dark-gray, contorted schist, holding small quantities of iron-pyrites. The sample, a single fragment, weighed one pound two ounces.

It contained neither gold nor silver.

15.—From mountain opposite Cache creek, Macmillan river, Yukon district.

A grayish-white quartz, in parts coated with hydrated peroxide of iron. The sample, a single fragment, weighed fourteen ounces.

It contained neither gold nor silver.

16.—From Macmillan Mountain, Macmillan river, Yukon district.

A milk-white quartz, slightly coated with hydrated peroxide of iron. The sample, a single fragment, weighed fifteen ounces.

It contained neither gold nor silver.

17.—From Dromedary Mountain, Macmillan river, Yukon district.

A gray, laminated quartz, through which was distributed numerous fine particles of iron-pyrites. The sample, a single fragment, weighed eight ounces.

It contained neither gold nor silver.

18.—From about forty miles north-east of Dawson, in the Ogilvie Range, Yukon district. Examined for C. A. Celene.

The material was made up of three distinct samples consisting, respectively, of—(*a*) galena, iron-pyrites, and brown zinc-blende in a gangue of weathered rock matter; (*b*) a white subtranslucent quartz, more or less coated with hydrated peroxide of iron, carrying a somewhat large quantity of iron-pyrites; and (*c*) of an association of a fine grained granite with some white quartz and a little calcite, in parts coated with hydrated peroxide of iron, carrying small quantities of coarsely crystalline galena and of iron-pyrites. A fair average of the three foregoing samples was found, on assay, to contain:

Gold, at the rate of.... 0·117 of an ounce to the ton of 2,000 lbs.
Silver, at the rate of....18·725 ounces " "

19.—Also from a point some forty miles north-east of Dawson, in the Ogilvie Range, Yukon district. Received from Mr. C. A. Celene.

The material consisted of nineteen small samples of finely crushed rock matter in which, in some instances, galena and iron-pyrites were distinctly visible. Weight of the whole, two pounds fourteen ounces. A fair average of the same was found to contain.

Gold, at the rate of.... 0·175 of an ounce to the ton of 2,000 lbs.
Silver, at the rate of.... 7·700 ounces " "

20.—From Miller creek, a tributary of Sixty-mile river, Yukon district.

A small nugget of native gold from this stream, collected by Mr. R. G. McConnell, was found to have the following composition—Gold 79·564, silver 12·221, quartz 8·215 = 100·00; or, excluding the associated quartz, gold 86·685, silver 13·315 = 100·00.

21.—This, and the two following specimens are from a point on the McQuestan, about one hundred and twenty miles above its entry into the Stewart, Yukon district. Examined for W. E. Brown.

It consisted of an association of white quartz with a very little greenish-white ferriferous serpentine, holding a few particles of iron-pyrites. The sample, a single fragment, weighed two pounds nine ounces. Assays showed it to contain:

Gold, at the rate of.... 2·100 ounces to the ton of 2,000 lbs.
Silver.... .... none.

22.—A weathered siliceous rock, carrying small quantities of iron-pyrites. The sample, a single fragment, weighed one pound five ounces. It contained:

Gold .... trace.
Silver.......................... .... none.

23.—A gray quartz carrying small quantities of iron-pyrites. The sample, a single fragment, weighed fifteen ounces. Submitted to assay, it was found to contain:

Gold, at the rate of .. 0·117 of an onnce to the ton of 2,000 lbs.
Silver... .... none.

24.—From the head of Gold Bottom creek, a tributary of Hunker creek, Yukon district. This, and the five following specimens were collected by Mr. R. G. McConnell.

An association of greenish-gray chloritic schist and white subtranslucent quartz, incrusted with a little blue carbonate of copper, and pitted with a brownish-black earthy substance resulting from the weathering of copper-pyrites. The sample, a single fragment, weighed ten ounces. Assays gave :

Gold.................. none.
Silver, at the rate of.... 0·292 of an ounce to the ton of 2,000 lbs.

25.—From Sixty-mile river, a tributary of the Yukon, one mile below Twelve-mile creek, Yukon district.

A white quartz, in parts stained with hydrated peroxide of iron, holding a few scales of yellowish white mica. The sample, a single fragment, weighed one pound one ounce. Assays showed it to contain :

Gold, at the rate of.... 0·058 of an ounce to the ton of 2,000 lbs.
Silver................ none.

26.—From Sixty-mile river, six miles above its entry into the Yukon, Yukon district.

A light brownish-gray drusy quartz. The sample consisting of two fragments, weighed one pound eleven ounces. It contained :

Gold, at the rate of 0·117 of an ounce to the ton of 2,000 lbs.

27.—From German creek, a tributary of the South Fork of the Salmon, Yukon district.

A white subtranslucent quartz. The sample, a single fragment, weighed fifteen ounces.

It contained neither gold nor silver.

28.—From Gold Run creek, opposite claim thirty-three, Yukon district.

A white subtranslucent quartz stained with hydrated peroxide of iron. The sample, a single fragment, weighed eight ounces. It was found to contain :

Gold, at the rate of.... 0·350 of an ounce to the ton of 2,000 lbs.
Silver................ none.

29.—From the Lone Star claim, at the head of Victoria gulch, Bonanza creek, Yukon district.

An association of white subtranslucent quartz with a little yellowish-white mica, carrying small quantities of iron-pyrites, copper-pyrites, and galena. The sample, a single fragment, weighed one pound one ounce. Assays gave :

Gold, at the rate of.... 2·625 ounces to the ton of 2,000 lbs.
Silver at the rate of... 3·267 ounces " "

Province of British Columbia.

30.—From a claim on Ice river, a tributary of the Beaverfoot, East Kootenay district. This, and the two following specimens were examined for Mr. James Walker.

A white translucent quartz, in parts coated with blue and green carbonates of copper, carrying small quantities of copper-glance. The sample, consisting of three fragments, weighed eight ounces. Assays showed it to contain :

Gold.................. distinct trace.
Silver, at the rate of... 4·200 ounces to the ton of 2,000 lbs.

31.—Also from a claim on Ice river—the locality referred to in connection with the preceding specimen.

A white translucent quartz, here and there coated with blue and green carbonates of copper, holding small quantities of galena and copper-glance and a few small crystals of iron-pyrites. Submitted to assay, it was found to contain :

Gold.................. distinct trace.
Silver, at the rate of... 2·158 ounces to the ton of 2,000 lbs.

32.—From a claim on the North Fork of the Beaverfoot, East Kootenay district.

An association of a white quartz with a white dolomite, through which was distributed a few particles of copper-pyrites. The sample, a single fragment, weighed fifteen ounces. Assays gave :

Gold.................. none.
Silver, at the rate of... 0·117 of an ounce to the ton of 2,000 lbs.

33.—From the Eureka claim, one of the Adair group, on Laforme creek, Columbia river, about twenty miles north of Revelstoke, West Kootenay district. Examined for Mr. J. F. Hutchison.

An association of a white subtranslucent quartz with a little black graphitic schist, carrying small quantities of copper-pyrites, and trifling quantities of zinc-blende and galena. The sample, consisting of several fragments, weighed one pound three ounces. It contained:

Gold.................. trace.
Silver, at the rate of... 2·683 ounces to the ton of 2,000 lbs.

34.—From Midge creek, a stream flowing into the lower end of Kootenay lake from the west, West Kootenay district.

A granular-massive association of iron-pyrites and white quartz. The sample, consisting of several fragments, weighed five ounces.

It contained neither gold nor silver.

35.—From the same locality as the preceding specimen.

An intimate association of a slightly weathered iron-pyrites and white quartz. The sample, a single fragment, weighed three ounces. It was found to contain:

Gold.................. none.
Silver, at the rate of... 0·058 of an ounce to the ton of 2,000 lbs.

36.—Also from Midge creek—above referred to.

A gray quartz, more or less coated with hydrated peroxide of iron, carrying very small quantities of iron-pyrites. The sample, a single fragment, weighed two ounces. Assays gave:

Gold.................. none.
Silver, at the rate of... 0·058 of an ounce to the ton of 2,000 lbs.

37.—From the Jacobs Ladder claim, West Kootenay district. Examined for Dr. G. W. Thomas.

An association of white quartz and gray chloritic schist, in parts coated with hydrated peroxide of iron. The sample, consisting of six fragments, weighed one pound fourteen ounces. It contained:

Gold.................. none.
Silver, at the rate of... 0·233 of an ounce to the ton of 2,000 lbs.

38.—From a shaft, of some ten feet in depth, sunk on a vein situate between the Forks of Five-mile creek, a stream flowing into the West Arm of Kootenay lake, West Kootenay district. This, and the following specimen were examined for Mr. C. J. Robertson.

An association of pyrrhotite, brown zinc-blende and white quartz. The sample, consisting of six fragments, weighed one pound five ounces. Assays showed it to contain:

Gold.................. none.
Silver, at the rate of.... 6·825 ounces to the ton of 2,000 lbs.

39.—From the same shaft as the preceding specimen, but taken at a greater depth, namely, twenty feet.

It consisted of an association of pyrrhotite, iron-pyrites, and brown zinc-blende in a gangue of white translucent quartz. The sample, consisting of eight fragments, weighed one pound eight ounces. It was found to contain:

Gold.................. none.
Silver, at the rate of....14·117 ounces to the ton of 2,000 lbs.

40.—From the Wellington claim on Roche river, a tributary of the South Similkameen, Yale district. This, and the following specimen were examined for Mr. J. B. Wood.

An association of white translucent quartz with a little white dolomite, in parts coated with hydrated peroxide of iron and a little green carbonate of copper, carrying trifling quantities of specular iron and copper-glance. The sample, consisting of several fragments, weighed eight ounces.

It contained neither gold nor silver.

41.—From the Sailor Jack claim, same locality as the preceding specimen.

A white translucent quartz, coated with hydrated peroxide of iron and green carbonate of copper, carrying small quantities of copper-glance. The sample, consisting of several fragments, weighed eight ounces. Submitted to assay, it was found to contain:

Gold, at the rate of.....0·292 of an ounce to the ton of 2,000 lbs.
Silver, at the rate of....0·758 " " "

42.—From two miles south-east of the foot of Christina lake, Yale district. This, and the two following specimens were collected by Mr. R. W. Brock.

An association of white quartz with white felspar, small quantities of white calcite, black hornblende and fine scaly kaolinite, carrying small quantities of iron-pyrites and magnetite. The sample, consisting of several fragments, weighed two pounds eleven ounces.

It contained neither gold nor silver.

43.—From the Seattle claim, on the North Fork of Kettle river, Yale district.

An association of magnetite with a dark gray felspathic rock and a very little iron-pyrites. The sample, consisting of several fragments, weighed one pound four ounces.

It contained neither gold nor silver.

44.—Also from the Seattle claim.

A massive copper-pyrites with which was associated a very small quantity of magnetite. The sample, a single fragment, weighed three ounces. Assays showed it to contain :

Gold.... ....distinct trace.
Silver, at the rate of....0·700 of an ounce to the ton of 2,000 lbs.

45.—From a prospecting tunnel on a group of claims on the west side of the Fraser, south of Chilcotin river, and opposite to Dog creek and Little Dog creek, Lillooet district.

An association of white quartz with an altered white felspar, carrying somewhat large quantities of copper-pyrites. The sample, a single fragment, weighed nine ounces. Assays gave :

Gold..................none.
Silver, at the rate of....1·750 ounce to the ton of 2,000 lbs.

46.—From a vein, of some six feet in width, near Watson Bar creek and about four miles west of the Fraser, Lillooet district

An association of brownish-black zinc-blende, mispickel, pyrrhotite and copper-pyrites, in a gangue of white sub-translucent quartz. The sample, a single fragment, weighed one pound nine ounces. It was found to contain:

Gold, at the rate of.....0·700 of an ounce to the ton of 2,000 lbs.
Silver, at the rate of....0·467 " " "

47.—From the head-waters of Texas creek, on the west side of the Fraser, some eight or ten miles below the town of Lillooet, Lillooet district.

A massive copper-pyrites, coated with hydrated peroxide of iron and green carbonate of copper. The sample, consisting of two fragments, weighed two ounces. Assays showed it to contain:

Gold..trace.
Silver...none.

48.—From a vein about half way down, and about a mile and a half back from, Seton lake, Lillooet district.

An association of grayish-white quartz with a very little white calcite, carrying somewhat large quantities of iron-pyrites and of mispickel. The sample, a single fragment, weighed ten ounces. Submitted to assay, it was found to contain:

Gold, at the rate of....0·583 of an ounce to the ton of 2,000 lbs.
Silver. ....none.

49.—From a vein of some ten feet in width north-west of Anderson lake, Lillooet district.

A grayish-white translucent quartz, in parts coated with green carbonate of copper, carrying small quantities of copper-pyrites. The sample, a single fragment, weighed four ounces. It contained:

Gold................ ..distinct trace.
Silver, at the rate of....1·050 ounce to the ton of 2,000 lbs.

50.—From a vein near Dog creek, on the east side of the Fraser, Lillooet district.

An association of a black schistose rock with a little white quartz, carrying small quantities of iron-pyrites. The sample, a single fragment, weighed two ounces. Assays gave:

Gold...................none.
Silver, at the rate of....0·117 of an ounce to the ton of 2,000 lbs.

51.—From the Cassiar district.

A gray quartz, through which was distributed some iron-pyrites and copper-pyrites. The sample, consisting of eight fragments, weighed one pound thirteen ounces. Assays showed it to contain:

Gold..... .... distinct trace.
Silver, at the rate of.... 2·800 ounces to the ton of 2,000 lbs.

52.—This, and the three following specimens were described as coming from the vicinity of Mission city, Fraser river, New Westminster district.

It consisted of a white, granular quartz carrying small quantities of tetrahedrite. The sample, a single fragment, weighed ten ounces. It was found to contain:

Gold................... none.
Silver, at the rate of....140·992 ounces to the ton of 2,000 lbs.

53.—A gray felspathic rock carrying small quantities of iron-pyrites.

The sample, consisting of two fragments, weighed eight ounces Assays gave:

Gold................... none.
Silver, at the rate of.... 0·525 of an ounce to the ton of 2,000 lbs.

54.—A dark gray to grayish-white quartz carrying small quantities of iron-pyrites. The sample, a single fragment, weighed ten ounces. It contained :

Gold.................. none.
Silver, at the rate of.... 0·233 of an ounce to the ton of 2,000 lbs.

55.—A coarse grained granite through which was disseminated a few grains of iron-pyrites. The sample, a single fragment, weighed five ounces. Assays showed it to contain :

Gold.................. none.
Silver, at the rate of.... 0·117 of an ounce to the ton of 2,000 lbs.

56.—From the vein worked at Brown Jug claims numbers one, two, and three, of the Brown Jug group, on Hesquoit lake, west coast of Vancouver island. Examined for Mr. A. L. Smith.

The material consisted of an association of a fine scaly, white mica, and white calcite, holding small quantities of iron-pyrites and brown zinc-blende. The sample, consisting of two fragments, weighed fourteen ounces. Assays gave :

Gold, at the rate of.... 0·058 of an ounce to the ton of 2,000 lbs.
Silver, at the rate of.... 0·758 " " "

57.—Another sample of material from the vein referred to in connection with the preceding specimen, and which was said, by Mr. A. L. Smith, to represent a better average of the vein, consisted of a light gray granitic rock carrying small quantities of brownish-black zinc-blende and a very little iron-pyrites. The sample, consisting of four fragments, weighed thirteen ounces. This, on being submitted to assay was found to contain :

Gold, at the rate of.... 0·583 of an ounce to the ton of 2,000 lbs.
Silver, at the rate of.... 3·092 ounces " "

NATURAL WATERS.

1.—Water from a cold spring in Pine creek valley, a shallow depression immediately behind the town of Atlin, on the east side of Atlin lake, Cassiar district, province of British Columbia. Collected by Mr. W. J. B. Pinder.

Agreeably with the observations of Mr. J. C. Gwillim, who has worked out the general geology of this part of the district of Cassiar, the spring is situate some three hundred yards north-north-west of the town of Atlin, where it is found issuing from the highest point of a slightly raised and gently sloping deposit of a white, more or less firmly compacted, yet readily friable material—more specifically referred to beyond, of about an acre in extent. There are several other deposits of a similar material, the largest of which has an area of from three to four acres, in this portion of the valley, the rocks underlying which are essentially magnesian, consisting chiefly of peridotite, serpentine, and magnesite.

The water as it issues from the spring is, as Mr. Pinder informs me, quite clear and colourless, is just perceptibly aerated, and has a temperature, as recorded by a very accurate thermometer, of 33° F., that of the atmosphere, in the shade, being at the time 65° F. This observation was made on the 10th of June, 1901. Another was made by him about a year later, namely, on the 5th of June, 1902, and with precisely the same results; hence the temperature of the water of this spring would appear to remain constant. He has also very carefully computed the discharge from this spring, and found the same to be three imperial gallons a minute; there are, however, several smaller springs bubbling out a little below and around this—the main one, the combined flow from which he estimated to be about two gallons a minute, thus making a total outflow of five gallons a minute or seven thousand two hundred gallons per diem.

It may be mentioned that the water employed for analysis was collected by Mr. Pinder in stoppered glass bottles of the kind technically known as 'Winchester Quarts,' and that in such a careful manner, and with so close an observance of all the necessary precautions, as to lead him to infer that the loss of carbonic acid incurred during the operation, if indeed there was any, would be quite inappreciable. It was forwarded while the weather was comparatively cool; arrived in excellent condition; was immediately placed in a cool dark cellar, and there kept pending its analysis.

At the time of examination, it was found to be perfectly clear and appeared, when seen in a clear glass vessel of about a pint capacity, quite colourless; when viewed in a column two feet in length, however, it was found to have a pale brownish-yellow hue. It was quite odourless; had, at the ordinary temperature, an agreeably acidulous taste which, however, soon gave place to a faintly bitter one; reacted very faintly acid, when evaporated to a small volume, however, slightly alkaline. Its specific gravity, at 15·5° C., was found to be 1007·91. On being poured into an open vessel, there ensued a slight effervescence, the water became cloudy, subsequently turbid, and ultimately deposited carbonate of magnesium. Boiling produced a copious precipitate consisting, chiefly, of magnesium carbonate with some calcium carbonate and a very litte ferric hydrate.

Conformably with the results of an analysis by Mr. F. G. Wait, 1000 parts, by weight, of this water, at 15·5° C., contained :

Potassa	0·0145
Soda	0·0796
Lime	0·1635
Magnesia	1·9204
Alumina	0·0065
Ferrous oxide	0·0087
Sulphuric anhydride	0·0501
Phosphoric anhydride	trace.
Boric anhydride	trace.
Carbonic anhydride	5·9360
Chlorine	0·0015
Silica	0·0825
Organic matter	trace.
	8·2633
Less oxygen, equivalent to chlorine	·0003
	8·2630

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.)

Potassium sulphate	0·0268
Sodium chloride	0·0025
" sulphate	0·0671
" carbonate	0·0838
" phosphate	trace.
" biborate	trace.
Calcium carbonate	0·2920
Magnesium carbonate	4·0328
Ferrous carbonate	0·0140
Alumina	0·0065
Silica	0·0825
Organic matter	trace.
	4·6080
Carbonic anhydride, half-combined	2·2810
" free	1·3740
	8·2630

Total dissolved solid matter, by direct experiment, dried at 180° C., =4·428.

An imperial gallon of the water, at 15.5° C., would contain:

(The carbonates being calculated as anhydrous bicarbonates, and the salts without their water of crystallization.)

	Grains.
Potasssium sulphate	1·8908
Sodium chloride	0·1764
" sulphate	4·7341
" bicarbonate	8·3676
" phosphate	trace.
" biborate	trace.
Calcium bicarbonate	29·6677
Magnesium bicarbonate	433·5644
Ferrous bicarbonate	1·3617
Alumina	0·4586
Silica	5·8206
Organic matter	trace.
	486·0419
Carbonic anhydride, free	96·9403
	582·9822

Lithia, baryta, strontia, bromine and iodine, were sought for, and with negative results.

In order to obtain some idea of the nature of the material deposited by this spring, Mr. Pinder made a cutting, of about three feet in width and some six feet in depth, in the deposit close to where the spring bubbles out; took measurements of the various layers exposed; and having collected samples from each, forwarded the same to me for examination. By this means it was ascertained that—the uppermost layer of the deposit consists of a grayish-white hydromagnesite, having a thickness of from eighteen to twenty-four inches; immediately under which there is a comparatively thin layer of a grayish-white to light-gray and bluish-ash coloured, somewhat magnesian, calcareous tufa; followed by a layer of some three inches of a yellowish-brown to light and dark brown ferruginous, calcareous tufa; which is succeeded by a thin layer of a light brownish-yellow, ferruginous, slightly magnesian, calcareous tufa; and under this again, there is a layer of four feet and more—how much, was not ascertained, the cutting not having been carried to a greater depth,—of a brownish-red, ferruginous, somewhat magnesian, calcareous tufa.

As already mentioned, there are several other deposits of a like material not far removed from that in question, in the same part of the valley. In alluding to these, Mr. Gwillim remarks

—' these are quite dry during the summer season, but in spring, it is said, springs issue all along their course'.

There can, I think, be little doubt but that all these deposits of hydromagnesite occurring at the back of Atlin town-site, owe their origin to the water of springs of very similar, if not precisely the same, composition as that of which the analysis is given above. It is also not improbable that the large deposits of hydromagnesite, situate some six hundred and seventy-five miles south-east of those just referred to, in the immediate vicinity of the 108-mile House, on the Cariboo road, ninety-three miles north of Ashcroft, in the district of Lillooet, and of which mention is made in one of my previous reports—see Annual Report of this Survey for 1898, vol. xi, p. 10 R,—have a similar origin.

The material of these deposits, as likewise the water of the spring in question, will, most probably, in the near future receive the attention they deserve, as a source of magnesia.

2.—Water from a spring on the St. Georges farm, on Gamache or Ellis Bay, which is on the south side and near the west end of the island of Anticosti, Gulf of St. Lawrence, province of Quebec. The spring rises, either from the lowest division of the Anticosti group, or the immediately underlying Hudson River or Loraine formation. It was sent by, and examined for Dr. Jos. Schmitt.

The sample received, contained a very trifling quantity of light-brown, flocculent matter in suspension, which was removed by filtration. The filtered water was clear, bright and, apparently, colourless; when viewed in a column two feet in length, however, it exhibited a pale brownish-yellow colouration. It was odourless, and devoid of any marked taste. It reacted neutral, but after evaporation to a small volume the reaction was rather strongly alkaline. The specific gravity, at 15·5° C., was found to be 1000·66. Boiling produced a small precipitate, consisting of calcium carbonate with a little magnesium carbonate.

One thousand parts, by weight, of the filtered water, at 15·5° C., were found by Mr. F. G. Wait to contain:

Potassa	0·0105
Soda	0·3000
Lime	0·0559
Magnesia	0·0359
Ferrous oxide	trace.
Sulphuric anhydride	0·0550
Carbonic anhydride	0·2523
Chlorine	0·2235
Silica	0·0165
Organic matter	trace.
	0·9496
Less oxygen, equivalent to chlorine	0·0503
	0·8993

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 monocarbonates, and all the salts estimated as anhydrous.)

Sodium chloride	0·3683
Potassium sulphate	0·0194
Sodium sulphate	0·0818
Sodium carbonate	0·1183
Calcium carbonate	0·0998
Magnesium carbonate	0·0754
Ferrous carbonate	trace.
Silica	0·0165
Organic matter	trace.
	0·7795
Carbonic anhydride, in excess of that required to form monocarbonates	0·1198
	0·8993

Total dissolved solid matter, by direct experiment, dried at 180° C., = 0·750.

An imperial gallon of the water, at 15·5° C., would contain:

(The carbonates being calculated as anhydrous bicarbonates, and the salts without their water of crystallization.)

	Grains.
Sodium chloride	25·798
Potassium sulphate	1·359
Sodium sulphate	5·730
Sodium bicarbonate	11·726
Calcium bicarbonate	10·066
Magnesium bicarbonate	8·048
Ferrous bicarbonate	trace.
Silica	1·156
Organic matter	trace.
	63·883
Less carbonic anhydride employed in excess of that actually found	0·890
	62·993

The amount of carbonic anhydride found was, it will be seen, somewhat less than that required for the conversion of all the monocarbonates into bicarbonates; hence, it is apparent that the bases represented as carbonates cannot all exist in the form of bicarbonates, although it has been deemed best, on this occasion, to so represent them. A like deficiency of carbonic anhydride has, it may be remarked, often been noted in some of the waters of other Canadian springs.

There was not enough of the water to allow of its being examined for baryta, strontia, boric acid, bromine and iodine.

This water belongs to the fourth class of Dr. T. Sterry Hunt's classification of mineral waters.

3.—Water from a spring on the farm of Angus Cameron, on the west side of Margaree river, about a mile and a half below Scotsville, Inverness county, province of Nova Scotia. Examined for Mr. J. H. Cameron.

The sample of water received for examination contained a trifling quantity of white, flocculent, organic matter in suspension. This was removed by filtration. The filtered water was clear, bright, and had a faint brownish-yellow colour. It was odourless, had a mildly saline taste, and reacted neutral, both before and after concentration. Its specific gravity, at 15·5° C., was found to be 1002·5. The total dissolved saline matter, dried at 180° C., amounted to 4·50 parts per 1000,—equivalent to 315·7 grains per imperial gallon.

A qualitative analysis, by Mr. Wait, showed it to contain:

Potassa	very small quantity.
Soda	somewhat large quantity.
Lime	rather small quantity.
Magnesia	very small quantity.
Sulphuric anhydride	rather small quantity.
Carbonic anhydride	small quantity.
Chlorine	somewhat large quantity.
Silica	trace.
Organic matter	faint trace.

Boiling produced a slight precipitate, consisting essentially of calcium carbonate with a very little magnesium carbonate.

4.—Water from a well in the town of Lunenburg, Lunenburg county, province of Nova Scotia.

This, when received contained a trifling quantity of white, flocculent, organic matter in suspension, which, having been removed by filtration, left the water clear, bright, and, apparently colourless, although when viewed in a column two feet in length it was found to have a faint brownish-yellow colouration. It was odourless, devoid of any marked taste, and reacted neutral, both before and after concentration. The total dissolved saline matter, dried at 180° C., amounted to 0·26 parts per 1000, which would be equivalent to 18·2 grains per imperial gallon.

A qualitative analysis, by Mr. Wait, indicated the presence of:

Soda	very small quantity.
Ammonia	trace.
Lime	small quantity.
Magnesia	very small quantity.
Ferrous oxide	trace.
Sulphuric anhydride	very small quantity.
Carbonic anhydride	small quantity.
Chlorine	very small quantity.
Silica	trace.
Organic matter	very small quantity.

Boiling produced a slight precipitate, consisting of calcium carbonate with a very little magnesium carbonate.

5.—Water from a spring occurring four miles from Andover, and on what is known as the Indian Reserve, Victoria county, province of New Brunswick. Examined for Mr. J. E Stewart.

The sample of water sent for examination, contained a trifling quantity of light-brown, flocculent matter in suspension. After removal of this by filtration, the water was found to be clear, bright, and of a faint brownish-yellow colour. It was devoid of odour, and did not possess any marked taste. Reaction, neutral; when evaporated to a small volume, however, faintly alkaline. Its specific gravity, at 15·5° C., was found to be 1000·5. It contained 0·166 parts of dissolved saline matter, dried at 180° C., in 1000 parts, by weight, of the water,—equivalent to 11·63 grains per imperial gallon.

A qualitative analysis, by Mr. Wait, showed it to contain:

Soda	very small quantity.
Lime	small quantity.
Magnesia	very small quantity.
Sulphuric anhydride	very small quantity.
Carbonic anhydride	rather small quantity.
Chlorine	very small quantity.
Silica	trace.
Organic matter	faint trace.

Boiling produced a small precipitate, consisting, mainly, of calcium carbonate with a little magnesium carbonate.

6.—Water from a boring at Ramsay's Corners, on the eighteenth lot of the seventh concession of the township of Gloucester, Carleton county, province of Ontario. It was taken at a depth of eight hundred and sixty-one feet from the surface, and issues, according to Dr. H. M. Ami, from limestones of the Trenton formation, Cambro-Silurian. Examined for Mr. John Cunningham.

It contained a small quantity of a slightly calcareous, earthy sediment, which was removed by filtration. The filtered water was perfectly clear and bright, and of a faint brownish-yellow colour. It had a faint odour of petroleum; tasted mildly saline; and reacted neutral, both before and after concentration. Its specific gravity, at 15·5° C., was found to be 1014. The total dissolved saline matter, dried at 180° C., amounted to 17·87 parts per 1000, by weight, of the water,—equivalent to 1252·9 grains per imperial gallon.

A qualitative analysis, conducted by Mr. Wait, gave as follows:

Potassa	very small quantity.
Soda	rather large quantity.
Ammonia	strong traces.
Lime	somewhat large quantity.
Magnesia	very small quantity.
Ferrous oxide	very small quantity.
Carbonic anhydride	small quantity.
Chlorine	large quantity.
Bromine	trace.
Iodine	trace.
Silica	trace.
Organic matter	trace.

Boiling produced a small precipitate, consisting of ferric hydrate with some calcium carbonate.

7.—Water from a spring on the farm of Mr. J. W. Brumwell, on the first lot of the first concession of the township of Scarborough, York county, province of Ontario.

It contained a small quantity of light-brown flocculent matter in suspension, which, on removal by filtration, was found to consist of organic matter with a little ferric hydrate. The filtered water was clear, bright, and when seen in small volume colourless, but when viewed in a column two feet in length it was found to have a brownish-yellow hue. It had a faint unpleasant odour, as of decaying vegetable matter, and, what may be best described as a flat taste. Reaction, neutral; when evaporated to a small volume, however, faintly alkaline. Its specific gravity, at 15·5° C., was found to be 1001·5. The total dissolved saline matter, dried at 180° C., amounted to 1·024 parts per 1000, which would be equivalent to 71·82 grains per imperial gallon.

A qualitative analysis, by Mr. Wait, indicated the presence of:

Potassa	trace.
Soda	small quantity.
Lime	small quantity.
Magnesia	very small quantity.
Ferrous oxide	trace.
Carbonic anhydride	rather small quantity.
Chlorine	rather small quantity.
Silica	trace.
Organic matter	very small quantity.

In addition to the foregoing—a small quantity of ammonia, as likewise of nitrites, and traces of nitrates, were also found to be present. A determination of the oxygen consuming power, showed an absorption of not less than 22·8 parts per million.

Boiling produced a small precipitate, consisting of calcium carbonate with a little magnesium carbonate and a very little ferric hydrate.

8.—Water from a well in the village of St. Joseph, township of Hay, Huron county, province of Ontario.

The sample received for examination, was slightly turbid, but otherwise free from suspended matter. After filtration it was perfectly clear, bright, and apparently colourless; when viewed in a column two feet in length, however, it was seen to have a faint brownish-yellow tint. It was odourless, devoid of any marked taste, and reacted neutral, both before and after concentration. Its specific gravity, at 15·5° C., was found to be 1000·5. The total dissolved saline matter, dried at 180° C., amounted to 0·63 parts per 1000,—equivalent to 44·1 grains per imperial gallon.

A qualitative analysis, by Mr. Wait, showed it to contain:

Soda	very small quantity.
Lime	small quantity.
Magnesia	trace.
Ferrous oxide	trace.

Sulphuric anhydride..............	small quantity.
Carbonic anhydride.............	very small quantity.
Chlorine........................	very small quantity.
Silica..........................	trace.
Organic matter..................	trace.

Boiling produced a very small precipitate, consisting of calcium carbonate.

9.—Water from a small spring bubbling out of the hillside at Chilcotin, about twenty-three miles from Chimney Creek ferry, Cariboo district, province of British Columbia.

It was perfectly clear, bright, and colourless ; devoid of odour ; and had a slight, agreeably acidulous taste. Reaction, neutral ; both before and after concentration. The total dissolved saline matter, dried at 180° C., amounted to 2·84 parts per 1000, which would be equivalent to 198·8 grains per imperial gallon.

Mr. Wait found it to contain :

Soda............................	small quantity.
Lime............................	rather small quantity.
Magnesia........................	rather small quantity.
Sulphuric anhydride.............	small quantity.
Carbonic anhydride..............	rather large quantity.
Chlorine........................	small quantity.
Silica..........................	trace.

Boiling produced a copious precipitate, consisting of calcium carbonate and magnesium carbonate, the former, apparently, preponderating.

The quantity of water sent for examination, was too limited to allow of more than the above partial qualitative analysis.

10.—Water from a spring above West Pinchbeck, Risky creek—a tributary of the Fraser, district of Cariboo, province of British Columbia. Examined for Mr. J. Isnardy.

The sample of this water which was sent for examination, was faintly turbid and contained a trifling quantity of brown, flocculent matter in suspension. This was removed by filtration. The filtered water was clear, colourless and bright. After exposure to the air for a short time, however, it became rapidly turbid from separation of sulphur, calcium carbonate, magnesium carbonate, and a very little ferric hydrate, and then presented a brownish-yellow colour. It had a slightly saline taste, and a faint odour of sulphuretted hydrogen. It reacted neutral ; after evaporation to a small volume, however, decidedly alkaline. Its specific gravity, at 15·5° C., was found to be 1003·5. The total dissolved saline matter, dried at 180° C., amounted to 2·81 parts per 1000,—equivalent to 197·4 grains per imperial gallon.

A qualitative analysis, by Mr. Wait, showed it to contain:

Soda	rather small quantity.
Lime	rather small quantity.
Magnesia	rather small quantity.
Ferrous oxide	trace.
Sulphuric anhydride	small quantity.
Carbonic anhydride	somewhat large quantity.
Chlorine	very small quantity.
Silica	trace.
Organic matter	faint trace.

Boiling produced a rather copious precipitate, consisting of calcium carbonate and magnesium carbonate with a little ferric hydrate.

The sulphuretted hydrogen—above referred to, had doubtless been formed by the reducing action of organic matter—the water having been put up in an ordinary corked bottle,—which coverts the sulphates into sulphurets; these, in their turn, being decomposed by carbonic acid, with the seperation of sulphuretted hydrogen.

11.—Water from a spring found issuing from an extensive body of a dark olive-green chloritic rock—derived apparently from the alteration of a massive andradite—which occurs about four miles back from the west bank of the Fraser river and nearly opposite the mouth of Big Bar creek, Lillooet district, province of British Columbia.

The sample of water received for examination, contained a somewhat large quantity of dark green, earthy matter in suspension. On removal of this by filtration, the water was found to be quite clear, and of a brownish-yellow colour. It was odourless, and devoid of any marked taste; reacted neutral, but when reduced to a small volume, faintly alkaline. It contained 0·506 parts of dissolved saline matter, dried at 180° C., in 1000 parts by weight, of the water—equivalent to 35·42 grains per imperial gallon.

A qualitative analysis, by Mr. Wait, indicated the presence of:

Potassa	trace.
Soda	very small quantity.
Lime	small quantity.
Magnesia	very small quantity.
Ferrous oxide	trace.
Sulphuric anhydride	very small quantity.

Carbonic anhydride	rather small quantity.
Chlorine..........................	trace.
Silica.	trace.
Organic matter..................	trace.

Boiling produced a small precipitate, consisting, essentially, of calcium carbonate with a little magnesium carbonate and a trace of ferric hydrate.

BRICK AND POTTERY-CLAYS.

1.—From near the top of the range of hills known as Marble Mountain, in a valley facing towards the south or Bras d'Or lake, Inverness county, province of Nova Scotia, where it forms a deposit which is covered by several feet of soil. Examined for Mr. A. Bain.

A non-calcareous, strongly plastic clay, containing but very little gritty matter. When burnt it assumes a light reddish-brown colour. The burnt mass, which is exceptionally hard and firm, is readily fusible at a somewhat elevated temperature. It is well adapted for the manufacture of ordinary building brick, drain tiles, and all kinds of common earthenware.

2.—From the left bank of the Miramichi, about eighteen miles from its entrance into Miramichi Bay, Northumberland county, province of New Brunswick. Examined for Mr. R. C. Call.

A light reddish-brown, somewhat calcareous, plastic clay, containing a large proportion of arenaceous matter. When burnt it assumes a reddish-brown colour. It is somewhat easily fusible at an elevated temperature. It affords a very strong brick.

3.—From the farm of John Ken, Summer Hill, parish of Gagetown, Queens county, province of New Brunswick. Examined for Mr. C. D. Jones.

A purplish-bluish-ash coloured, slightly calcareous, somewhat ferruginous, rather strongly plastic clay, containing but a very small proportion of gritty matter. When burnt it assumes a purplish-brown colour. It is somewhat difficultly fusible at an elevated temperature. This clay might—the colour of the burnt material not being considered objectionable,—be advantageously employed for the manufacture of ordinary building brick, and all kinds of common earthenware.

4.—From the mouth of Savage river, tributary of the Patapedia, Bonaventure county, province of Quebec. Examined for Mr. J. Robinson.

A light to dark bluish-gray, yellowish-gray, brownish-yellow, and reddish-brown—mottled, non-calcareous, more or less ferruginous, rather strong plastic, somewhat readily fusible clay, containing little or no gritty matter, and which when burnt assumes a very pleasing bright reddish-brown colour. It is well adapted for the manufacture of ordinary building brick, and all kinds of common earthernware.

5.—From lot four hundred and fifty-nine of the first range north-east, on the Chaudière, in the seigniory of St. Joseph, Beauce county, province of Quebec.

This clay has, in the moist condition, a dark purplish-brown—when air-dried, however, a light, slightly reddish, gray colour. It is slightly calcareous; contains only a very small quantity of very fine grit, and is highly plastic. When burnt it assumes a light reddish-brown colour. It fuses somewhat readily at an elevated temperature to a brownish-gray enamel. It might advantageously be employed for the manufacture of ordinary building brick and common pottery.

6.—From the thirty-fourth lot of the sixth concession of the township of Lancaster, Glengarry county, province of Ontario. Examined for Mr. D. B. McDonald.

A light greenish-gray, non-calcareous, highly plastic, somewhat readily fusible clay, containing but a very small proportion of gritty matter. When burnt it assumes a light reddish-brown colour. It constitutes an excellent clay for the manufacture of ordinary building brick, and all kinds of common earthenware.

7.—From the ninth lot of the eleventh concession of the township of Greenock, Bruce county, province of Ontario.

An ash-gray, calcareous, plastic, somewhat readily fusible clay. Of two samples, taken from different parts of the deposit, one contained, approximately, 18·5 per cent of carbonate of lime, and the other 20·8 per cent of carbonate of lime. Both afforded a strong brick of a light reddish-brown colour.

8.—From the same locality as the preceding specimen, but from a different part of the deposit. Examined for Mr. J. W. McNab.

An arenaceous clay, containing a somewhat large proportion of minute rounded grains of quartz, a small proportion of fine particles of limestone and of dolomite, a few particles of felspar, of mica and of a chloritic mineral, together with a trifling quantity of organic matter (vegetable fibre), and an occasional speck of iron-pyrites. It is but feebly plastic, and readily fusible at a somewhat elevated temperature. The burnt mass is quite tender, hence this material is quite unsuited for the manufacture of bricks.

9.—From a point on the Red Deer river, district of Alberta, North-west Territory, where it occurs immediately underlying a small seam of lignite. Examined for Mr. F. E. Wilkins.

A light to dark bluish-gray, more or less highly calcareous, slightly ferruginous, somewhat strongly plastic, rather readily fusible clay, almost free from gritty matter. It affords a strong brick, of a pale dull yellow colour.

10.—From one mile west of the junction of the South Fork and Little South Fork of Old Man river, district of Alberta, North-west Territory. Received from Mr. J. E. Woods, D.L.S.

A dark brownish-red indurated clay, which proved to be non-calcareous, and highly plastic. It is somewhat difficultly fusible at an elevated temperature. It affords a strong brick of a bright reddish-brown colour. This clay might advantageously be employed for the manufacture of ordinary building brick, drain-tiles, and all kinds of common earthenware.

11.—From a deposit on Arrow lake, in the West Kootenay district of the province of British Columbia. Examined for Mr. T. McNaughton.

A light bluish-ash coloured, non-calcareous, slightly ferruginous, laminated clay traversed by an occasional very thin layer of, intimately associated, minute grains of quartz, felspar and hornblende, and fine scales of mica. It forms with water a somewhat strongly plastic mass. Is readily fusible at a somewhat elevated temperature to a black, shining, vitrified mass. It affords a strong brick, of a reddish-brown colour.

12.—From Texada island, Strait of Georgia, province of British Columbia, where it occurs in the Cretaceous. Received from Mr. Walter Harvey.

A highly ferruginous clay, which, when reduced to powder, forms with water a strongly plastic mass. This, when burnt, retains the original brownish-red colour, is very hard and firm, and difficultly fusible at an elevated temperature. It would make an excellent building brick, and might likewise, after having been ground to powder and mixed with oil or water, be used as a cheap pigment.

MISCELLANEOUS EXAMINATIONS.

1.—Bog manganese. From about half a mile back from Jones Forks —a tributary of the Keswick, parish of Douglas, York county, province of New Brunswick, where it occurs in the form of nodules imbedded in the soil. The nodules, which are exteriorally of a clove-brown, and interiorally of a blackish-brown colour, have a varying diameter of from ten to twenty-three millimetres. A partial analysis of the same, by Mr. Wait, showed them to contain —peroxide of manganese 27·04; peroxide of iron 4·50; insoluble matter consisting of quartz grains, argillaceous matter, etc., 36·37; water, hygroscopic and combined, and organic matter 28·11.

2.—Coal. From section 24, township 6, range 23, west of the fourth principal meridian, district of Alberta, North-west Territory. Thickness of seam, about eight feet. Examined for Mr. F. C. Potts.

It was found to contain 4·75 per cent of water, and on incineration left 4·05 per cent of a brownish-red ash. By fast coking, it gave a firm, coherent coke.

3.—Coal. From the Coal creek, Michel, and Morrissey mines, Crow's Nest coal-field, district of Alberta, North-west Territory. The specimens, in question, were collected by Mr. T. C. Denis. These in the condition in which they were received, were found to contain as follows—

Coal from the Coal creek mine, No. 1 working, 0·53 per cent of water and 19·20 per cent of a grayish-white ash; No. 2 working, 0·49 per cent of water and 5·93 per cent of a yellowish-white ash; No. 3 working, 0·47 per cent of water and 7·72 per cent of a reddish-white ash.

Coal from the Michel mine, No. 3 working, 0·62 per cent of water and 4·16 per cent of a reddish-white ash; No. 4 working, 0·57, per cent of water and 5·80 per cent of a faint reddish-white ash; No. 8 working, 0·62 per cent of water and 3·68 per cent of a light reddish-white ash.

Coal from the Morrissey mine, No. 1 working, 0·56 per cent of water and 16·38 per cent of a faint reddish-white ash; No. 4 working, 0·56 per cent of water and 13·78 percent of a faint reddish-white ash; No. 5 working, 0·50 per cent of water and 21·21 per cent of a faint reddish-white ash.

It may fairly be assumed that the above samples of fuel had all lost a certain proportion of their water during the interval of their collection and examination. They all yield, by fast coking, a firm dense coke.

4.—COAL. From near the head of Kettle river, Yale district, province of British Columbia. Examined for Mr. G. E. Corbould.

The specimen sent for examination contained 1·58 per cent of water, and on incineration left 34·79 per cent of a light reddish-brown ash. It gave, by fast coking, a firm compact coke.

5.—COAL, Lignitic. From the same locality as the preceding specimen.

The particular sample examined contained 12·89 per cent of water, and left on incineration 1·62 per cent of a very light reddish-brown coloured ash. It gave, by fast coking, a firm coherent coke.

6.—GRAPHITE. From the west-half of the ninth lot of the tenth concession of the township of Ross, Renfrew county, province of Ontario.

The sample sent for examination was found to contain 58·65 per cent of graphite.

7.—GRAPHITE, Disseminated. Said to have been found in the vicinity of Rivers Inlet, province of British Columbia. Examined for Messrs. Mutrie & Brown.

The material sent for examination contained 20·22 per cent of graphite. It closely resembled that found by Mr. W. Downie, in 1860, at Alkow Harbour, Dean Canal, in the same province, a sample of which, collected by him, was found to contain 23·17 per cent of graphite.

8.—MANGANITE. A sample of material consisting apparently, of a mixture of manganite and limonite, from Soldier Cove, Bras d'Or lake, Richmond county, province of Nova Scotia, has been examined by Mr. F. G. Wait, and found to contain—manganese 36·64 = manganese sesquioxide 52·62, iron 18·72 = iron sesquioxide 26·74, insoluble matter 6·11, and water 13·18 per cent.

9.—PEAT. From the thirty-fourth lot of the sixth concession of the township of Lancaster, Glengarry county, province of Ontario. Examined for Mr. D. B. McDonald.

Its analysis afforded Mr. Johnston as follows—fixed carbon 17·6, volatile matter 75·4, ash of a light reddish-brown colour 7·0 = 100.

10.—PEAT. From a deposit some sixty-seven miles up from the mouth of the Kwataboahegan—a tributary of the Moose, district of Algoma, province of Ontario. Collected by Mr. W. J. Wilson.

The particular sample examined contained 7·28 per cent of water, and on incineration left 56·05 per cent of a light reddish-brown ash.

11.—PYRITE. From the fourteenth lot of the fifth range of the township of Masham, Ottawa county, province of Quebec.

The material examined consisted of a massive pyrite through which was distributed a small quantity of siderite, a few flakes of molybdenite, and a little gangue composed, mainly, of hornblende and quartz with a few scales of mica and a few minute crystals of apatite. A fair average of the sample, which weighed five pounds, was found by Mr. Wait to contain—46·32 per cent of sulphur.

12.—QUARTZ, Ferruginous. From the south-east corner of Black Sturgeon lake, about fifteen hundred paces east of the lake, district of Thunder Bay, province of Ontario. Collected by Dr. A. W. G. Wilson.

A brownish-red ferruginous quartz containing, in parts, a little specular iron. Determinations, by Mr. Wait, showed it contained —7·27 per cent of metallic iron.

13.—QUARTZ CONGLOMERATE, Ferruginous. From Georges river, Cape Breton county, province of Nova Scotia, where it is said to constitute a large deposit.

A fair average of a sample of this material was found by Mr. Wait to contain—15·11 per cent of metallic iron.

14.—SAND, AURIFEROUS. A sample of auriferous black sand from Adams Hill, near Bonanza creek, Yukon district, North-west Territory, has been examined by Mr. Wait for platinum, and with negative results. The sand consisted mainly of small, feebly magnetic, grains of titanic iron, with a few particles of magnetite, garnet and quartz, and an occasional grain of native gold.

15.—SAND, BLACK. A small sample of a black sand received from Mr. W. Perkins, White Horse, Yukon district, North-west Territory, was found, on examination by Mr. Johnston, to be composed of grains of a black ferriferous spinel and of a pale reddish coloured garnet, with a few grains of white quartz and an occasional particle of wood-tin. The spinel, which constituted, approximately, seventy per cent, by weight, of the sand, was found by Mr. Johnston to have a specific gravity, at 15·5° C., of 3·935, and is most probably hercynite.

16.—Sand, Siliceous. The following are the results of an examination, by Mr. R. A. Johnston, of carefully collected samples of this material from the large accumulations of the same which form, respectively, what is known as the Traverse Spit, at the foot of the Island of Orleans, and the Ste. Croix and Champlain shoals, between Three Rivers and Quebec, in the Lower St. Lawrence, province of Quebec.

To facilitate a comparison, the results are here given in a tabular form—Table 1, showing the nature and amount of the mineral constituents entering into the composition of the sands in question; and Table 2, the percentage amounts of the various sized grains composing said sands,—see beyond, pp. 66 67.

17.—Sandstone, Nodules of. From the vicinity of Sorel, Richelieu county, province of Quebec. Received from Mr. W. M. Seaborn.

An examination of these showed them to be composed of minute, more or less rounded, siliceous grains—chiefly of quartz, cemented together by calcium carbonate with a small quantity of magnesium carbonate and a little oxide of iron; a little calcium phosphate being also present. A partial analysis, by Mr. Wait, gave—insoluble siliceous matter 62·58, calcium carbonate 33·36, magnesium carbonate 2·39, calcium phosphate 0·31; with small quantities of soluble silica, alumina and peroxide of iron, undetermined.

18.—Shale, Bituminous. A dark brown, highly calcareous, bituminous shale or pyroschist, from Chambord, township of Metabetchouan, Chicoutimi county, province of Quebec, has been examined by Mr. Wait, and with the following results—hygroscopic water 0·59, volatile combustible matter 8·73, fixed carbon 11·20, ash, of a light yellowish-gray colour, 79·48 = 100·00.

19.—Shale, Calcareous. From Arnold, in the province of Manitoba. Collected by Mr. D. B. Dowling. There were two specimens. Of these, one, a dark bluish-gray shale, was found by Mr. Wait to contain 57·27 per cent of calcium carbonate; and the other, a brownish-yellow shale, 56·27 per cent of calcium carbonate.

TABLE 1.

SHOWING the composition of the sand forming the Traverse Spit, at the foot of the island of Orleans, and of that forming the Ste. Croix and Champlain shoals, between Three Rivers and Quebec, in the Lower St. Lawrence, province of Quebec.

Sand,—whence obtained.	Constituents, per cent.			Remarks.
	Grains of Quartz.	Grains of black tourmaline and of red garnet.	Grains of magnetite.*	
From the highest point of surface of Traverse Spit..	95·7	4·0	0·3	Contained a few splinters of pale blue cyanite.
" the surface of Traverse Spit......	86·4	13·0	0·6	
" 15 inches below the surface of Traverse Spit...	89·0	10·0	1·0	
" 8 to 10 feet " " " " ..	94·9	4·0	0·2	Contains 0·9 p. c. of clay and numerous scales of mica.
" 22 to 27 feet " " " " ..	89·2	10·0	0·8	
" 28 to 33 feet " " " " ..	93·6	6·0	0·4	
" the Ste. Croix shoal.........................	81·0	16·0	3·0	Contains a few splinters of pale blue cyanite.
" the Champlain shoal......................	91·8	7·2	1·0	Contains a few splinters of pale blue cyanite.

* See foot-note to Table 2.

TABLE 2.

SHOWING the size of the grains of sand forming the Traverse Spit, at the foot of the island of Orleans, and of that forming the Ste. Croix and Champlain shoals, between Three Rivers and Quebec, in the Lower St. Lawrence, province of Quebec.

Sand,—whence obtained.	Percentage of grains consecutively separated by sieves having, respectively, the undermentioned number of holes to the linear inch.						
	100.	80.	60.	40.	20.	16.	Rejected by sieve having 16 holes to the linear inch.
From the highest point of surface of Traverse Spit..	12·6	17·4	58·0	11·8	0·2	—	
" the surface of Traverse Spit..........	16·1	22·0	48·9	12·5	0·5	—	A few grains only.
" 15 inches below the surface of Traverse Spit...	29·3	27·8	42·6	0·2	0·1	—	
" 8 to 10 feet " " " " ..	33·1	33·2	32·7	0·4	0·6	—	A few flakes of mica.
" 22 to 27 feet " " " " ..	8·8	10·7	33.4	42·8	4·1	0·2	
" 28 to 33 feet " " " " ..	4·8	5·0	16·0	37·2	35·4	1·3	0·3
" the Ste. Croix shoal.........................	3·5	5·0	17·5	50·9	22·3	0·5	0·3
" the Champlain shoal............	0·6	0·4	1·5	5·4	87·1	3·4	1·6

NOTE.—It was found that the sand rejected by the sieve having sixty holes to the linear inch was, in all cases, practically free from magnetite.

GEOLOGICAL SURVEY OF CANADA
ROBERT BELL, M.D., D.Sc., LL.D., F.R.S.

SECTION OF MINES

ANNUAL REPORT

FOR

1900

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Associate of the Royal School of Mines, England, Mining Engineer to the Geological Survey of Canada.

ASSISTANT

J. McLeish, B.A.

OTTAWA
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1901

744.

To the DIRECTOR,
Geological Survey of Canada.

SIR,—Herewith I beg to hand you the detailed annual report of the Section on the mineral industries of Canada for 1900. The preliminary summary statement for that year which was completed on the 16th of March, is of course replaced by the revised statement herein contained.

The work of the Section as in the past, has consisted not only in the preparation of the annual report but in the collection, recording, &c., of technical information and in making investigations into a great variety of matters pertaining to the economic mineral resources and the mineral industries of the country as well as in answering the numerous inquiries on these subjects constantly coming to hand.

By the transference, early in the year, of Mr. Theo. Denis, to other work in the department, the Section was left short handed and the greater part of my own time was occupied preparing the illustrations and report on my special investigation of the iron ore deposits of the Kingston and Pembroke Railway district and in putting the same through press. Appreciative acknowledgment is made of the important aid in the whole work of the Section rendered by Mr. J. McLeish and Mrs. W. Sparks.

Thanks are also due to those who, although too numerous to mention individually, by answering our circulars or letters, provided much valuable material. Our acknowledgments are also due to the provincial Mining Bureaus of Nova Scotia, Quebec, Ontario and British Columbia, as well as to the Dominion Customs and Inland Revenue Departments for aid received.

I am, sir,
Your obedient servant,

ELFRIC DREW INGALL.

SECTION OF MINES,
18th October, 1901.

EXPLANATORY NOTES.

YEAR AND TON USED.

The year used throughout this report is the calendar year, except for the figures of imports, which refer to the fiscal year ending June 30. The ton is that of 2,000 pounds, unless otherwise stated.

EXPORTS AND IMPORTS.

The figures given throughout the report referring to exports and imports are compiled from data obtained from the books of the Customs Department, and will occasionally show discrepancies, which, however, there are no means of correcting.

The exports and imports under the heading of each province do not necessarily represent the production and consumption of the province, e.g., material produced in Ontario is often shipped from Montreal and entered there for export, so falling under the heading, Quebec.

NOTE.—N.E.S.=Not elsewhere specified.

VALUES ADOPTED.

The values of the metallic minerals produced, as per returns to this department, are calculated on the basis of their metallic contents at the average market price of the metal for the current year. Spot values have been adopted for the figures of production of the non-metallic minerals.

GENERAL NOTES.

As in the past, care is taken to avoid interference with private interests in the manner of publishing results, and all returns of production of individual mines are treated as confidential, unless otherwise arranged with those interested. The confidence of the mining community thus gained, has resulted in an increasingly general response to our circulars, although to complete our data personal application is still necessary in a small number of instances, and a yet more prompt response on the part of all applied to, will help still further towards an earlier publication of the material.

In view of criticisms of these statistics which have been made recently, and from time to time in the past, it may be well to take this opportunity to explain the working methods adopted, in order to prevent the misunderstandings which underlie such criticisms and suggestions, and to correct the impression which they might convey to the public that the reports are unreliable.

The figures given throughout the reports are based, as far as possible, upon returns obtained direct from the various operators, or from official data, and the totals have for some years been checked by comparison with railway shipments, exports, and all other available sources of information. It can be therefore fairly claimed, that they are as accurate as it is possible to make such figures.

After investigation of the subject we have, however, found that in the nature of things, export and railway figures can only be taken as approximately correct in most instances. In the case of the export figures, entries are made, as a rule, by those having no technical knowledge of mineral substances, and in the case of the railways, but few of the shipments are actually weighed, so that car-load lots, for instance, may differ considerably from the theoretical load of the car.

The lists of operators given throughout the report are not put forward as complete in every case, only those reporting their production being included. Producers finding their names omitted are invited to communicate with the office that they may be included in the next issue.

CORRECTIONS—ALTERATIONS.

Corrections and alterations have been made throughout this report wherever they seemed to be called for, according to more complete and reliable data available since previous issues.

The tabulated statement given in the folded sheet at the beginning of the report, represents a compilation of all the similar statements found in previous reports, re-modelled and further revised wherever possible.

INTRODUCTION.

The corrected grand total for the mineral production of Canada for 1900, as given in the accompanying table, amounts in value to almost sixty four and a half million of dollars, an increase of almost fifteen million dollars worth as compared with 1899, or 30 per cent. MINERAL PRODUCTION OF CANADA.

It is gratifying to note that the per capita value of the country's income from mineral products still continues to grow steadily, as seen in the figures given in the following table, and that Canada now approaches very closely this standard of the great mineral producing country to the south of us.

Year.	Canada.		United States.	
	Increase per cent in Grand Total.	Production per capita.	Increase per cent in Grand Total.	Production per capita.
	p.c.	$ cts.	p.c.	$ cts.
1900	30·06	11 99	10·10	14 02
1899	28·13	9 33	39·86	12 84
1898	34·89	7 32	10·61	9 38
1897	26·90	5 52	1·33	8 66
1896	8·79	4 40	·21	8 73
1895	....	4 09	....	8 90
1890	64·00 (1886–1890)	3 50	38·97 (1886–1890)	9 89
1886		2 23		7 76

The production by provinces is given below:

The Yukon gold output accounts for all except about $1,000,000 of the item entitled 'Manitoba and North-west Territories, &c.' Leaving this special feature out of consideration, it will be seen that British Columbia leads by a large margin. With the Yukon counted in, the western portion of Canada is to be credited at present with over 62 per cent of the total output.

MINERAL PRODUCTION OF CANADA.

PRODUCTION BY PROVINCES, 1900.

Province.	Value of production.	Per cent.
	$	
Nova Scotia	9,521,874	14·8
New Brunswick	439,060	·7
Quebec	3,292,383	5·1
Ontario	11,127,868	17·2
Manitoba and North-west Territories including Yukon	23,452,330	36·4
British Columbia	16,654,522	25·8
Total	64,488,037	100·0

The proportionate values of the different mineral products is given in the following table. It will be seen that gold with coal and coke, together contribute about 65 per cent of the total. The metals, other than pig iron, contained in the ores, taken together, total up to nearly 63 per cent. Nickel, which occupied fifth place last year, now ranks third, and lead has moved from the ninth to the fifth place.

PROPORTIONATE VALUE OF DIFFERENT MINERAL PRODUCTS, 1900.

Products.	Contributing over 10 p.c.	Contributing between 10 and 1 p. c.	Contributing under 1 p.c.	Total.
1. Gold	43·28			
2. Coal and coke	21.62			
3. Nickel		5·16		
4. Copper		4·75		
5. Lead		4·28		
6. Silver		4·25		
7. Bricks (estimated)		3·53		
8. Building stone (estimated)		2·36		
9. Petroleum		1·78		
10. Lime (estimated)		1·24		
11. Asbestus		1·16		
12. Cement		1·00		
13. Pig iron (from Canadian ore)			·90	
14. Natural Gas			·65	
15. Salt			·43	
16. Terra cotta			·40	
17. Gypsum			·40	
18. Sundry under 1 p.c.			2·81	
Total	64·90	29·51	5·59	100·00

GEOLOGICAL SURVEY OF CANADA.

MINES SECTION.

Mineral Production of Canada, Calendar Years 1886 to 1900.

PRODUCTS.	1886.		1887.		1888.		1889.		1890.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
METALLIC.		$		$		$		$		$
Antimony ore ... Tons.	665	31,490	584	10,860	345	3,696	55	1,100	26½	625
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
Gold (d) ... Oz.	66,061	1,365,496	57,465	1,187,804	53,150	1,098,610	62,658	1,295,159	55,625	1,149,776
Pig Iron (n) ... Tons.										
Iron ore (a) ... "	69,708	126,982	76,330	146,197	78,587	152,068	84,181	151,640	76,511	155,380
Lead (e) ... Lbs.			204,800	9,216	674,500	29,813	165,100	6,488	105,000	4,704
Mercury ... "										
Nickel (f) ... "							(l) 830,477	498,286	1,435,742	933,232
Platinum ... Oz.			1,400	5,600	1,500	6,000	1,000	3,500		4,500
Silver ... "	*210,141	*209,090	355,083	347,271	437,232	410,998	383,318	358,785	400,687	419,118
Zinc ... Lbs										
Total value, Metallic		*2,118,608		2,073,746		2,628,292		3,251,299		3,614,488
NON-METALLIC.		(a)		(a)		(a)		(a)		(a)
Actinolite ... Tons.										
Arsenic (white) ... "	120	5,460	30	1,200	†30	†1,200			25	1,500
Asbestus ... "	3,458	206,251	4,619	226,976	4,404	255,007	6,113	426,554	9,860	1,260,240
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
Coke (g) ... "	*35,396	*101,940	40,428	135,951	45,373	134,181	54,539	155,043	56,450	166,298
Corundum ... "										
Felspar ... "									700	3,500
Fire-clay ... "		(b)		(b)		(b)	*400	*4,800		
Graphite ... "	500	4,000	300	2,400	150	1,200	242	3,160	175	5,200
Grindstones ... "	*4,020	*46,545	5,292	64,008	5,764	51,129	3,404	30,863	4,884	42,340
Gypsum ... "	162,000	178,742	154,008	157,277	175,887	179,393	213,273	205,108	226,509	194,033
Limestone for flux ... "		(b)	*17,171	*17,500	16,857	16,533	22,122	21,909	18,478	18,361
Lithographic stone ... "										
Manganese ore ... "	1,789	41,499	1,245	43,658	1,801	47,944	1,455	32,737	1,328	32,550
Mica ... Lbs.	*20,361	*29,008	22,083	29,816	29,025	30,207	36,529	28,718	770,959	68,074
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
Mineral waters ... Galls.		(b)		(b)	*124,850	*11,456	424,600	37,360	561,165	66,031
Molybdenite ... Lbs.	150	*156								
Moulding sand ... Tons.		(b)	*160	*800	169	845	170	850	320	1,410
Natural gas ...										
Peat ... Tons.										
Petroleum (h) ... Brls.	584,061	525,655	713,728	556,708	695,203	713,695	704,690	653,600	795,030	902,734
Phosphate (Apatite) ... Tons.	20,495	304,338	23,690	319,815	22,485	242,285	30,988	316,662	31,753	361,045
Precious stones ...										700
Pyrites ... Tons.	42,906	193,077	38,043	171,194	63,479	285,656	72,225	307,292	49,227	123,067
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
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
Building stone ... C. yd.	*165,777	*642,509	262,592	552,267	411,570	641,712	341,337	913,691	382,563	964,783
Cement, natural ... Brls. } " Portland ... " }		(b)	*69,843	*81,909	50,668	35,593	90,474	69,790	102,216	92,405
Flagstones ... Sq. ft.	*70,000	*7,875	116,000	11,600	64,800	6,580	14,000	1,400	17,865	1,643
Granite ... Tons.	*6,062	*63,309	21,217	142,506	21,352	147,305	10,197	79,624	13,307	65,985
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
Marble ... Tons.	*501	*9,900	242	6,224	191	3,100	83	980	780	10,776
Miscellaneous clay products (i) ...		*112,910		182,150				239,385		
Pottery ...		(j)		(j)		*27,750		(j)		195,242
Roofing cement ... Tons.		(b)		(b)		(b)		(b)	*1,171	*6,502
Sands and gravels (k) ... "	*124,865	*24,226	180,860	30,307	260,929	38,398	283,044	52,647	342,158	65,518
Sewer pipe ...		(j)		(j)		*266,320		(j)		*348,000
Slate ... Tons.	*5,345	64,675	7,357	89,000	5,314	90,689	6,935	119,160	6,368	100,250
Terra-cotta ...		(j)		(j)		*49,800		(j)		*90,000
Tiles ... M.	*12,416	*142,617	14,658	230,068	7,518	114,057	10,526	134,265	10,521	140,877
Talc ... Tons.										
Tripolite ... "										
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
All other non-metallic		*5,627,271		6,290,006		6,842,601		7,264,940		9,137,594
Total value, non-metallic		*7,852,647		8,997,585		9,640,602		10,512,614		12,898,865
" metallic		*2,118,608		2,073,746		2,628,292		3,251,299		3,614,488
Estimated value of products unspecified or not reported (m)		*250,000		†250,000		†250,000		†250,000		†250,000
Grand total		*10,221,255		11,321,331		12,518,894		14,013,913		16,763,353

PRODUCTS.	1891.		1892.		1893.		1894.		1895.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
METALLIC.		$		$		$		$		$
Antimony ore ... Tons.	10	60								
Copper (c) ... Lbs.	8,928,921	1,149,598	7,087,275	818,580	8,109,856	871,809	7,708,789	736,960	7,771,639	836,228
Gold (d) ... Oz.	45,022	930,614	43,909	907,601	47,247	976,603	54,605	1,128,688	100,806	2,083,674
Pig Iron (n) ... Tons.										
Iron ore (a) ... "	68,979	142,005	103,248	263,866	125,602	299,368	109,991	226,611	102,797	238,070
Lead (e) ... Lbs.	88,665	3,857	808,420	33,064	2,135,023	79,636	5,703,222	187,636	16,461,794	531,716
Mercury ... "									5,431	2,343
Nickel (f) ... "	4,626,627	2,775,976	2,413,717	1,399,956	3,982,982	2,071,151	4,907,430	1,870,958	3,888,525	1,360,984
Platinum ... Oz.		10,000		3,500		1,800		950		3,800
Silver ... "	414,523	409,549	310,651	272,130	422,158	330,128	847,697	534,049	1,578,275	1,030,299
Zinc ... Lbs										
Total value, Metallic		5,421,659		3,698,697		4,630,495		4,685,852		6,087,114
NON-METALLIC.		(a)		(a)		(a)		(a)		(a)
Actinolite ... Tons.										
Arsenic (white) ... "	20	1,000					7	420		
Asbestus ... "	9,279	999,878	6,082	390,462	6,331	310,156	7,630	420,825	8,756	368,175
Chromite ... "							1,000	20,000	3,177	41,300
Coal ... "	3,577,749	7,019,425	3,287,745	6,363,757	3,783,499	7,359,080	3,847,070	7,429,468	3,478,344	6,739,153
Coke (g) ... "	57,084	175,592	56,135	160,249	61,078	161,790	58,044	148,551	53,356	143,047
Corundum ... "										
Felspar ... "	685	3,425	175	525	575	4,525				(k) 2,545
Fire-clay ... "	250	750	1,991	4,467	540	700	539	2,167	1,329	3,492
Graphite ... "	260	1,560	167	3,763			3	223	220	6,150
Grindstones ... "	4,479	42,587	5,283	51,187	4,600	38,379	3,757	32,717	3,475	31,932
Gypsum ... "	203,605	206,251	241,048	241,127	192,568	196,150	223,631	202,031	226,178	202,608
Limestone for flux ... "	11,376	11,547	22,967	21,492	27,797	27,519	35,101	34,347	34,579	32,916
Lithographic stone ... "							180	30,000		2,000
Manganese ore ... "	255	6,694	115	10,250	213	14,578	74	4,180	125	8,464
Mica ... Lbs.		71,510		104,745		75,719		45,581		65,000
Mineral pigments—										
Baryta ... Tons.			315	1,260			1,081	2,830		
Ochres ... "	900	17,750	390	5,800	1,070	17,710	611	8,690	1,339	14,600
Mineral waters ... Galls.	427,485	54,268	640,380	75,348	725,096	108,347	767,460	110,040	739,382	126,048
Molybdenite ... Lbs.										
Moulding sand ... Tons.	230	1,000	345	1,380	4,370	9,086	6,214	12,428	6,765	13,530
Natural gas ...				150,000		376,233		313,754		423,032
Peat ... Tons.										
Petroleum (h) ... Brls.	755,298	1,010,211	779,753	984,438	798,406	874,255	829,104	835,322	726,138	1,086,738
Phosphate (Apatite) ... Tons.	23,588	241,603	11,932	157,424	8,198	70,942	6,861	41,166	1,822	9,565
Precious stones ...		1,000		†1,000		1,500		†1,500		
Pyrites ... Tons.	67,731	203,193	59,770	179,310	58,542	175,626	40,527	121,581	34,198	102,594
Quartz ... "					100	500				
Salt ... "	45,021	161,179	45,486	162,041	62,324	195,926	57,199	170,687	52,376	160,455
Soapstone ... "			1,374	6,240	717	1,920	916	1,640	475	2,138
Structural materials and clay products—										
Bricks ... M.	176,533	1,061,536	202,147	1,251,934	290,000	1,800,000		†1,800,000	308,836	1,670,000
Building stone ... C. yd.	187,685	708,736		609,827		1,100,000		1,200,000		1,095,000
Cement, natural ... Brls.	93,473	108,561	88,187	94,912	126,673	130,167	108,142	144,637	128,294	173,675
" Portland ... "			29,221	52,751	31,924	63,848				
Flagstones ... Sq. ft.	27,300	2,721	13,700	1,869	40,500	3,487	152,700	5,298	80,005	6,687
Granite ... Tons.	13,637	70,056	24,302	89,326	22,521	94,393	16,392	109,936	19,238	84,838
Lime ... Bush.	1,829,824	251,215	2,260,640	411,270	6,750,000	900,000		†900,000	5,225,000	700,000
Marble ... Tons.	240	1,752	340	3,600	590	5,100			200	2,000
Miscellaneous clay products (i) ...										
Pottery ...		258,844		265,811		213,186		162,144		151,588
Roofing cement ... Tons.	1,020	4,810	800	12,000	951	5,441	815	3,978		3,153
Sands and gravels (k) ... "	243,724	59,501	297,878	85,329	329,116	121,795	324,656	86,940	277,162	118,359
Sewer pipe ...		227,300		367,660		350,000		250,325		257,045
Slate ... Tons.	(l) 5,000	65,000	5,180	69,070	7,112	90,825		75,550		58,900
Terra-cotta ...		113,103		97,239		55,704		65,600		195,123
Tiles ... M.	11,839	141,399	15,689	190,857		200,000		†200,000	19,200	210,000
Talc ... Tons.										
Tripolite ... "										
Whiting ... Brls.							500	750		
Total structural materials and clay products		3,074,534		3,603,455		5,133,946		5,004,408		4,726,368
All other non-metallic		10,230,423		9,076,265		10,020,641		9,990,898		9,585,482
Total value, non-metallic		13,304,957		12,679,720		15,154,587		14,995,306		14,311,850
" metallic		5,421,659		3,698,697		4,630,495		4,685,852		6,087,114
Estimated value of products unspecified or not reported (m)		†250,000		†250,000		†250,000		†250,000		†250,000
Grand total		18,976,616		16,628,417		20,035,082		19,931,158		20,648,964

PRODUCTS.	1896.		1897.		1898.		1899.		1900.		PRODUCTS.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
METALLIC.		$		$		$		$		$	METALLIC.
Antimony ore ... Tons.					1,344	20,000					Antimony ore.
Copper (c) ... Lbs.	9,393,012	1,021,960	13,300,802	1,501,660	17,747,136	2,134,980	15,078,475	2,655,319	18,937,138	3,065,922	Copper (c).
Gold (d) ... Oz.	133,274	2,754,774	291,582	6,027,016	666,445	13,775,420	1,028,620	21,261,584	1,350,176	27,908,153	Gold (d).
Pig Iron (n) ... Tons.									35,387	583,158	Pig Iron (n).
Iron ore (a) ... "	91,906	191,557	50,705	130,290	58,343	152,788	74,617	240,542	5,527	13,511	Iron ore (o).
Lead (e) ... Lbs.	24,199,977	721,159	39,018,219	1,396,853	31,915,319	1,206,399	21,862,436	977,250	63,169,821	2,760,521	Lead (e).
Mercury ... "	4,437	1,940	688	324							Mercury.
Nickel (f) ... "	3,397,113	1,188,990	3,997,647	1,399,176	5,517,690	1,820,838	5,744,000	2,067,840	7,080,227	3,327,707	Nickel (f).
Platinum ... Oz.		750		1,600	100	1,500	55	825			Platinum.
Silver ... "	3,205,343	2,149,503	5,558,446	3,323,395	4,452,333	2,593,929	3,411,644	2,032,658	4,468,225	2,740,362	Silver.
Zinc ... Lbs					788,000	36,011	814,000	46,805	212,800	9,342	Zinc.
Total value, Metallic		8,030,633		13,780,314		21,741,865		29,282,823		40,408,676	
NON-METALLIC.		(a)		(a)		(a)		(a)		(a)	NON-METALLIC.
Actinolite ... Tons.			* 205	* 1,845							Actinolite.
Arsenic (white) ... "							57	4,872	303	22,725	Arsenic.
Asbestus ... "	12,250	429,856	30,442	445,368	23,785	491,197	25,536	485,849	29,141	748,431	Asbestus.
Chromite ... "	2,342	27,004	2,637	32,474	2,021	24,252	2,010	21,842	2,335	27,000	Chromite.
Coal ... "	3,745,716	7,226,462	3,786,107	7,303,597	4,172,582	8,222,878	4,925,051	10,283,497	5,608,666	13,290,429	Coal.
Coke (g) ... "	49,619	110,257	60,686	176,457	87,600	286,000	100,820	350,022	157,134	649,140	Coke (g).
Corundum ... "									3	300	Corundum.
Felspar ... "	972	(k) 2,583	1,400	3,290	2,500	6,250	3,000	6,000	318	1,112	Feldspar.
Fire-clay ... "	842	1,805	2,118	5,759	670	1,680	599	1,295	1,245	4,130	Fire-clay.
Graphite ... "	139	9,455	436	16,240		13,698	1,310	24,179	1,922	31,040	Graphite.
Grindstones ... "	3,713	33,310	4,572	42,340	4,935	44,775	4,511	43,265	5,539	53,450	Grindstones.
Gypsum ... "	207,032	178,061	239,691	244,531	219,256	232,515	244,566	257,329	252,101	259,009	Gypsum.
Limestone for flux ... "	37,462	36,140	31,273	30,258	33,913	31,153	51,826	44,286	52,966	39,332	Limestone for flux.
Lithographic stone ... "											Lithographic stone.
Manganese ore ... "	123½	(k) 3,975	15¼	1,166	50	1,600	1,581	20,004	30	1,800	Manganese ore.
Mica ... Lbs.		60,000		76,000		118,375		163,000		166,000	Mica.
Mineral pigments—											*Mineral pigments—*
Baryta ... Tons.	145	715	571	3,060	1,125	5,533	720	4,402	1,337	7,605	Baryta.
Ochres ... "	2,362	16,045	3,905	23,560	2,226	17,450	3,919	20,000	1,966	15,398	Ochres.
Mineral waters ... Galls.	706,372	111,736	749,691	141,477	555,000	100,000		† 100,000		75,000	Mineral waters.
Molybdenite ... Lbs.											Molybdenite.
Moulding sand ... Tons.	5,739	11,478	5,485	10,931	10,572	21,038	13,724	27,430	6,181	12,316	Moulding sand.
Natural gas ...		276,301		325,873		322,123		387,271		417,094	Natural gas.
Peat ... Tons.									400	1,200	Peat.
Petroleum (h) ... Brls.	726,822	1,155,647	709,857	1,011,546	758,391	1,061,747	808,570	1,202,020	710,498	1,151,007	Petroleum (h).
Phosphate (Apatite) ... Tons.	570	3,420	908	3,984	733	3,665	3,000	18,000	1,415	7,105	Phosphate (Apatite).
Precious stones ...											Precious stones.
Pyrites ... Tons.	33,715	101,155	38,910	116,730	32,218	128,872	27,687	110,748	40,031	155,164	Pyrites.
Quartz ... "	10	50			284	570	600	1,260			Quartz.
Salt ... "	43,960	169,693	51,348	225,730	57,142	248,639	59,339	254,390	62,055	279,458	Salt.
Soapstone ... "	410	1,230	157	350	405	1,000	450	1,960	420	1,365	Soapstone.
Structural materials and clay products—											
Bricks ... M.		1,600,000		† 1,600,000		1,900,000		2,195,000		2,275,000	Bricks.
Building stone ... C. yd.		1,000,000		† 1,000,000		1,300,000		1,500,000		1,520,000	Building stone.
Cement, natural ... Brls.	70,705	60,500	85,450	65,893	87,125	73,412	141,387	119,308	125,428	99,994	Cement natural
" Portland ... "	78,385	141,151	119,763	209,380	163,084	324,168	255,366	513,983	283,124	545,816	" Portland.
Flagstones ... Sq. ft.		6,710		7,190		4,250		7,600		5,250	Flagstones.
Granite ... Tons.	18,717	106,709	10,345	61,934	23,897	81,073	13,418	90,542		80,000	Granite.
Lime ... Bush.		650,000		† 650,000		†650,000		800,000		†800,000	Lime.
Marble ... Tons.	224	2,405									Marble.
Miscellaneous clay products (i) ...											Miscellaneous clay product (i).
Pottery ...		163,427		129,629		214,675		185,000		200,000	Pottery.
Roofing cement ... Tons.	86	430									Roofing cement.
Sands and gravels (k) ... "	224,769	80,110	152,963	76,729	165,954	90,498	242,450	101,640	197,558	101,666	Sands and gravels (k).
Sewer pipe ...		153,875		164,250		181,717		161,546		231,525	Sewer pipe.
Slate ... Tons.		53,370		42,800		40,791		33,406		12,100	Slate.
Terra-cotta ...		83,855		155,595		167,902		220,258		259,450	Terra-cotta.
Tiles ... M.		225,000		† 225,000		†225,000		† 225,000		†225,000	Tiles.
Talc ... Tons.									1,000	5,000	Talc.
Tripolite ... "	664	9,960	15	150	1,017	16,660	1,000	15,000	336	1,950	Tripolite.
Whiting ... Brls.											Whiting.
Total structural materials and clay products		4,327,542		4,388,550		5,270,146		6,168,283		6,355,801	Total sructural materials and clay products.
All other non-metallic		9,976,338		10,242,566		11,385,010		13,832,921		17,423,560	All other, non-metallic.
Total value, non-metallic		14,303,880		14,631,116		16,655,156		20,001,204		23,779,361	Total value, non-metallic.
" metallic		8,030,633		13,780,314		21,741.865		29,282,823		40,408,676	" metallic.
Estimated value of products unspecified or not reported (m)		†250,000		† 250,000		300,000		† 300,000		†300,000	Estimated value of products unspecified or not reported (m).
Grand total		22,584,513		28,661,430		38,697,021		49,584,027		64,488,037	Grand total.

(a) Value at mine, quarry or works.
(b) Not reported.
(c) Copper contents of ore, matte, &c., 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, &c., 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.
(n) Previous to 1900 the production of iron has been entered as ore, the figures for pig iron for these years are given however in the body of the report.
(o) In 1900 exports only.

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, &c., 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 year not being available.

The table of increases and decreases below, illustrates the growth of the various industries. It is very encouraging to note that nearly all show either large or very large increases, only one, viz., petroleum, exhibiting a falling off, although in this case higher values somewhat mitigated the decrease in quantity. By comparison of this with the previous table, they will largely explain each other. It will be noted for instance that there is a much greater increase in the value of the nickel than in the quantity, which would largely account for its advanced position in the previous table. Greatly enhanced prices are also in evidence in asbestus, coal, coke and petroleum, the opposite features being presented in the case of copper, gypsum, cement and lead. In the case of the last mentioned, however, the very large augmentation in the quantity produced more than offsets this, and has won it a much higher position as a contributor to the total mineral output of the country. MINERAL PRODUCTION OF CANADA.

TABLE OF INCREASES AND DECREASES OF THE VARIOUS MINERALS IN 1900, AS COMPARED WITH 1899.

PRODUCTS.	QUANTITY.		VALUE.	
	Increase.	Decrease.	Increase.	Decrease.
	p. c.	p. c.	p. c.	p. c.
Metallic—				
Copper	25·59	....	15·46	....
Gold	31·26	....	31·26	....
Lead	188·94	....	182·48	....
Nickel	23·26	....	60·93	....
Silver	30·97	....	34·82	....
Non-metallic—				
Asbestus and asbestic	14·12	....	54·05	....
Coal	13·88	....	29·24	....
Coke	55·85	....	85·46	....
Gypsum	3·08	....	·65	....
Natural gas	....	....	7·70	....
Petroleum	....	12·13	....	4·24
Salt	4·58	....	9·85	....
Cement	2·97	....	1·98	....

The following tables give the exports of minerals and mineral products, together with the destinations of a large portion of them, as well as the imports of the same class of goods.

MINERAL PRODUCTION OF CANADA.

Exports.

EXPORTS.

MINERALS AND MINERAL PRODUCTS OF CANADA DURING CALENDAR YEAR 1900.

Products.	Value.	Products.	Value.
Antimony ore..	$ 3,441	Manufactures of metals other than iron or steel..	$ 101,557
Asbestus, first class......	252,653	Mica......................	146,750
" second class.....	182,459	Mineral pigments.........	7,154
" third class.......	237,993	Mineral waters...........	2,695
Bricks....	4,528	Nickel....................	1,031,030
Cement..................	3,296	Oil crude....	2
Chromite................	8,259	Oil refined...............	2,394
Clay, manufactures of.....	756	Ores unspecified..........	110,355
Coal......................	4,839,587	Plumbago, crude..........	40,132
Coke......................	131,278	" manufactures of	6,065
Copper...................	1,741,885	Pyrites..................	41,182
Felspar...........	1,116	Salt........	8,997
Gold......................	25,451,355	Sand and gravel	101,666
Grindstones...............	37,877	Silver...........	2,341,872
" rough.........	4,251	Stone unwrought..........	115,711
Gypsum, crude...........	201,912	" wrought..........	5,933
" ground...	19,834	Other articles............	73,275
Iron and steel...........	1,570,013		
Iron ore..................	13,511	Total.	$40,843,036
Lead	1,917,690		
Lime.........	80,852		
Manganese ore...........	1,720		

EXPORTS

DESTINATION OF PRODUCTS OF THE MINE, DURING THE FISCAL YEAR 1899-1900.

Destination.	Value.	Destination.	Value.
United States.	$23,698,606	Japan....................	$ 9,556
Newfoundland............	248,847	British Guiana...........	7,738
Great Britain.............	193,746	Cuba.........	6,433
Hawaii...................	130,532	France	3,388
Germany..	86,099	Hong Kong	1,080
Belgium.	82,286	Holland..	1,020
St. Pierre................	23,549	Denmark................	600
Australia......	20,937	Sweden & Norway...... .	330
British West Indies.......	20,624	Porto Rico........... ...	225
" Africa...........	19,407		
China................ ..	15,275	Total.	$24,580,266
Mexico	9,988		

MINERAL PRODUCTION OF CANADA.

Imports.

IMPORTS.

MINERALS AND MINERAL PRODUCTS, FOR FISCAL YEAR 1899-1900.

Products.	Value.	Products.	Value.
Alum and aluminous cake	$ 47,491	Lead and mfrs. of	$ 366,061
Aluminium	5,623	Lime	11,211
Antimony	20,001	Litharge	29,176
Arsenic	11,035	Lithographic stone	6,294
Asbestus and mfrs. of	43,455	Manganese, oxide of	4,155
Asphaltum	68,748	Marble and mfrs. of	94,017
Bismuth	207	Mercury	51,987
Blast furnace slag	3,933	Metallic alloys—	
Borax	78,445	Brass and mfrs. of	851,606
Bricks, tiles and sewer pipe, &c	145,914	Bronze, german silver, pewter, &c	120,407
Bricks, fire	344,279	Mineral and bituminous substances, N.E.S	28,986
Buhrstones	1,546	Mineral and metallic pigments, paints and colours	926,092
Building stone and granite	121,635	Mineral waters	66,331
Cement	517,640	Nickel	6,988
Chalk	6,842	Nitrate of soda, &c	33,567
Clays	122,965	Ores of metals, N.E.S	282,191
Coal	11,012,225	Paraffine wax	3,529
" tar and pitch	73,874	" candles	3,671
Coke	506,839	Petroleum and products of	872,033
Copper and mfrs. of	1,271,270	Phosphate (fertilizer)	6,485
Copperas	3,640	Phosphorus	852
Cryolite	2,721	Platinum	57,910
Crucibles, clay or plumbago	20,571	Precious stones	605,682
Earthenware	959,526	Pumice	5,604
Emery	44,927	Salt	325,433
Felspar, quartz, flint, &c	23,311	Saltpetre	52,235
Fertilizers	67,363	Sand and gravel	41,280
Fuller's earth	2,661	Slate and mfrs. of	53,707
Graphite, and mfrs. of	44,384	Sulphate of copper	87,847
Grindstones	34,382	Sulphur	215,433
Gypsum, plaster of Paris, &c	7,519	Sulphuric acid	7,066
Iron and steel—		Tins and manufactures of	2,418,455
Pigs, scrap, blooms, &c	2,001,875	Whiting	34,575
Rolled—bars, plates, &c., including chrome steel	7,499,242	Zinc and manufactures of	197,058
Ferro-silicon, ferro-manganese, &c	39,064	Total	$ 51,766,813
Manufactures of, machinery, hardware, &c	18,743,736		

Abrasive Materials.

ABRASIVE MATERIALS.

Grindstones.

Grindstones, woodpulp stones, scythe stones, &c., have for many years been made in the eastern provinces of Canada, from the millstone grit of the Carboniferous formation, which occupies a large portion of the surface of the eastern half of the province of New Brunswick, and the northern and western parts of Nova Scotia.

The production in 1900 which was 5,539 tons, valued at $53,450, shows quite a substantial increase over that of the previous year, viz., 1,028 tons, or nearly 23 per cent in quantity, and $10,185, or slightly over 23 per cent in value. It is in fact the largest output since 1888.

Statistics of production since 1886 are given in Table 1 below :—

Table 1.

Abrasive Materials.

Annual Production of Grindstones.

Calendar Year.	Nova Scotia.		New Brunswick.		Total.		Average Value per ton.
	Tons.	Value.	Tons.	Value.	Tons.	Value.	
1886	1,765	24,050	2,255	22,495	4,020	46,545	$11 58
1887	1,710	25,020	3,582	38,988	5,292	64,008	12 10
1888	1,971	20,400	3,793	30,729	5,764	51,129	8 87
1889	712	7,128	2,692	23,735	3,404	30,863	9 07
1890	850	8,536	4,034	33,804	4,884	42,340	8 67
1891	1,980	19,800	2,499	22,787	4,479	42,587	9 51
1892	2,462	27,610	2,821	23,577	5,283	51,187	9 69
1893	2,112	21,000	2,488	17,379	4,600	38,379	8 34
1894	2,128	16,000	1,629	16,717	3,757	32,717	8 71
1895	1,400	14,000	2,075	17,932	3,475	31,932	9 19
1896	1,450	14,500	2,263	18,810	3,713	33,310	8 97
1897	1,407	17,500	3,165	24,840	4,572	42,340	9 26
1898	1,422	12,350	3,513	32,425	4,935	44,775	9 07
1899	1,378	10,300	3,133	32,965	4,511	43,265	9 59
1900	1,411	12,600	4,128	40,850	5,539	53,450	9 65

ABRASIVE MATERIALS.

Grindstones.

The principal quarries are situated on the Bay of Chaleur at Clifton and Stonehaven; on Miramichi bay, in the vicinity of Newcastle; along the shores of Shepody bay and Cumberland basin in the Bay of Fundy, and at Woodbourne, Pictou county, N.S. The output is practically limited only by the demand, and a larger development of the industry is prevented solely by the cost of transportation to the Canadian markets, and the high protective tariff of the United States.

A large proportion of the production is exported, chiefly to the United States. Statistics of exports and imports are given in Tables 2 and 3.

Eighty-eight per cent of the imports came from the United States and 93 per cent of the imports were entered for consumption in the provinces of Ontario and Quebec.

TABLE 2.

ABRASIVE MATERIAL

EXPORTS OF GRINDSTONES.

Calendar Year.	Value.
1884	$28,186
1885	22,606
1886	24,185
1887	28,769
1888	28,176
1889	29,982
1890	18,564
1891	28,433
1892	23,567
1893	21,672
1894	12,579
1895	16,723
1896	19,139
1897	18,807
1898*	25,588
1899*	23,288
1900*	42,128

* Including stone for the manufacture of grindstones.

ABRASIVE MATERIALS.

Grindstones.

TABLE 3.

ABRASIVE MATERIALS.

IMPORTS OF GRINDSTONES.

Fiscal Year.	Duty.	Tons.	Value.
1880	....	1,044	$11,714
1881	....	1,359	16,895
1882	....	2,098	30,654
1883	....	2,108	31,456
1884	....	2,074	30,471
1885	....	1,148	16,065
1886	....	964	12,803
1887	....	1,309	14,815
1888	....	1,721	18,263
1889	....	2,116	25,564
1890	....	1,567	20,569
1891	....	1,381	16,991
1892	....	1,484	19,761
1893	....	1,682	20,987
1894	....	1,918	24,426
1895	....	1,770	22,834
1896	....	1,862	26,561
1897	....	1,521	25,547
1898	....	....	22,217
1899	....	....	27,476
1900 { Grindstones not mounted and not less than 36 inches in diameter.	15 p.c.	....	28,037
1900 { Grindstones N. E. S.	25 p.c.	....	6,345
			34,382

Following is a list of the operators from whom returns were received for 1900.

Nova Scotia.

The Atlantic Grindstone Co., Lower Cove, Cumberland county.
J. W. Sutherland, Quarry Island, Woodbourne, Pictou county.

New Brunswick.

Henry Tower, Lower Rockport, Westmoreland county.
H. C. Read, Sackville, Westmoreland county.
A. D. Richard, Dorchester, Westmoreland county.
*W. B. Deacon, Shediac, Westmoreland county.
C. E. Fish, Newcastle, Northumberland county.
J. B. Read, Stonehaven, Gloucester county.

* Made no grindstones in 1900, shipped a number of car loads of building stones.

Messrs. Lombard and Co., Clifton, Gloucester county and Boston, Mass. ABRASIVE MATERIALS.

R. W. Knowles, Clifton, Gloucester county.

Corundum.—Reference was made,at some length,in the report of the Section for 1897, to the occurrence of corundum in the northern part of Hastings county, and to explorations made by officers of the Geological Survey, resulting in a knowledge of the extent of the distribution of this mineral in this district. These explorations have demonstrated the existence of the corundum deposits in the following townships, Carlow and Bangor in Hastings county: Raglan, Brudenell, Radcliffe, Lyndoch, Sebastopol, in Renfrew county; North Burgess, in Lanark county, and Methuen, in Peterborough county. Corundum.

Reference was also made in the report of this Section for 1897, to the tests on concentration of corundum undertaken by Mr. Courtenay de Kalb, of the Kingston School of Mines (see seventh report of the Ontario Bureau of Mines). These tests have been furthur supplemented by practical tests of wheels made from the corundum. The Prescott Emery Wheel Co., of Prescott, Ont., the Hart Emery Wheel Co., Hamilton, Ont., and the Norton Emery Wheel Co., Worcester, Mass, U.S., to whom material was sent, manufactured a number of wheels, some of pure corundum, and others of mixed corundum and emery, the wheels varying in size from 1½ inches to 14 inches in diameter. These formed an important and comprehensive portion of the abrasive material section of the Canadian mineral exhibit at the Paris International Exhibition of 1900, and are also being shown at the Glasgow Exhibition of the present year (1901).

The Canada Corundum Company, with a head office in Toronto, and branch offices at Bridgeport, Conn., and Combermere, Ont., is now energetically carrying on the mining and subsequent treatment of this abrasive on lots 3 and 4 in concession XVIII. of Raglan. A mill operated both by steam and water power, has been built in a very suitable location, and fitted up with the latest machinery for the crushing and separating of the mineral. During the whole of the past summer (1900) the equipping and necessary experimenting has been going on steadily, and it is confidently believed that large and regular shipments of the very finest material will soon be made. The mining already done has shown conclusively, that the deposit is very rich and extensive, so that there is no likelihood of the supply giving out.

Although a considerable quantity of rock had been crushed, up to the 31st of December, only three tons of concentrated corundum were

ABRASIVE MATERIALS.

shipped before the close of the year. It was confidently expected, however, that shipments would soon reach from 5 to 10 tons per day.

That other companies are preparing to enter the field is evidenced by the incorporation on 13th March, 1901, of the Imperial Corundum Co., Ltd., authorized capital, $1,000,000, head office, Toronto.

Buhrstones.

TABLE 4.

ABRASIVE MATERIALS.

IMPORTS OF BUHRSTONES.

Fiscal Year.	Value.	Fiscal Year.	Value.
1880	$12,049	1891	$2,089
1881	6,337	1892	1,464
1882	15,143	1893	3,552
1883	13,242	1894	3,029
1884	5,365	1895	2,172
1885	4,517	1896	2,049
1886	4,062	1897	1,827
1887	3,545	1898	1,813
1888	4,753	1899	1,759
1889	5,465	*1900	1,546
1890	2,506		

* Buhrstones in blocks, rough or unmanufactured, not bound up or prepared for binding into mill-stones. Duty free.

Emery.

TABLE 5.

ABRASIVE MATERIALS.

IMPORTS OF EMERY.

Fiscal Year.	Emery. *a.*	Mfrs. of Emery. *b.*
1885	$ 5,066	$ 4,920
1886	11,877	5,832
1887	12,023	4,598
1888	15,674	4,001
1889	13,565	3,948
1890	16,922	5,313
1891	16,179	6,665
1892	17,782	6,492
1893	17,762	5,606
1894	14,433	2,223
1895	14,569	7,775
1896	16,287	11,913
1897	16,318	11,231
1898	17,661	15,478
1899	21,454	22,343
1900	19,312	25,615

a Emery, in bulk, crushed or ground. Duty free.
b Emery wheels and manufactures of emery. Duty 25 p.c.

Abrasive Materials.
Pumice Stone.

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	3,721
1897	2,903
1898	3,829
1899	5,973
*1900	5,604

* Pumice and pumice stone, ground or unground. · Duty free.

ASBESTUS.

Asbestus.

Production.

The asbestus production in Canada is confined almost entirely to the province of Quebec, in the districts of Black lake, Thetford and Danville in the Eastern Townships. The asbestus, (or more properly chrysotile) occurs in serpentine areas, occurring at intervals along a belt of country extending from the Vermont boundary to the Gaspé Peninsula. The economic occurrences of the mineral however, are restricted to the districts mentioned above. The mineral, occurs in small veins distributed throughout the rock, and mining is conducted in almost every case by open quarrying, some of the workings being from 100 to 200 feet in depth. The blasted rock is submitted to crushing, and the asbestus is separated, sorted and graded according to length of fibre, by the aid of special machinery.

Asbestus is also found in some serpentines of the Laurentian areas, as for example at Pointe au Chêne, in Argenteuil county, where a mill was formerly erected, but has since been removed, and also in Denholm township, and at other points in the counties of Wright and Labelle. The features of the industry in 1900, were a steady demand for the product, and a largely increased output and higher prices. A much larger output, had it been available, could have been sold. Labour too was not up to

ASBESTUS Production.

the demand during the year, in spite of a substantial increase in wages which took place in April, 1900.

The product 'asbestic' is said to be finding a more extended market as a wall plaster and fire proof material. It is reported to have been used in many of the large and modern structures recently erected in Ottawa and Montreal, and to have also been exported to the United States, Great Britain and the continent of Europe.

The total production of asbestus in 1900, amounted to 21,621 tons, valued at $729,886, or an average of $33.76 per ton. Compared with the previous year, this is an increase of 3,831 tons or 21·5 per cent in quantity and $261,251 or 55·7 per cent in value.

According to returns, the prices of first grade fibre average about $120 per ton, and of second grade from $70 to $80 per ton.

Statistics of production since 1886 are given in Tables 1 and 2 below and of exports and imports in Tables 3 and 4.

TABLE 1.

ASBESTUS.

PRODUCTION.—1896 TO 1900.

——	Tons.	Value.	Average Value per ton.
1896—Asbestus	10,892	$ 423,066	$ 38.84
Asbestic	1,358	6,790	5.00
	12,250	$ 429,856	$ 35.09
1897—Asbestus	13,202	$ 399,528	$ 0.26
Asbestic	17,240	45,840	2.66
	30,442	$ 445,368	$ 14.68
1898—Asbestus	16,124	$ 475,131	$ 29.46
Asbestic	7,661	16,066	2.10
	23,785	$ 491,197	$ 20.65
1899—Asbestus	17,790	$ 468,635	$ 26.34
Asbestic	7,746	17,214	2.22
	25,536	$ 485,849	$ 19.03
1900—Asbestus	21,621	$ 729,886	$ 33.76
Asbestic	7,520	18,545	2.46
	29,141	$ 748,431	$ 25 68

ASBESTUS.

Production.

TABLE 2.

ASBESTUS.

PRODUCTION, ETC.

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	
1881	540	35,100	65.00	
1882	810	52,650	65.00	
1883	955	68,750	71.98	Exports taken as production.
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

Exports

TABLE 3.

ASBESTUS.

EXPORTS.

Calendar Year.	Tons.	Value.	Average value per ton.
1892	5,380	$373,103	$69.35
1893	5,917	338,707	57.24
1894	7,987	477,837	59.82
1895	7,442	421,690	56.66
1896	11,842	567,967	47.96
1897	15,570	473,274	30.40
1898	15,346	494,012	32.19
1899	17,883	473,148	26.46
1900 1st class	4,076	$252,653	$62.12
1900 2nd "	3,636	182,459	50.18
1900 3rd "	9,281	237,993	25.64
Total, 1900	16,993	$673,105	39,61

ASBESTUS.

Imports.

TABLE 4.

ASBESTUS.

IMPORTS.

Fiscal Year.	Value.
1885	$ 674
1886	6,831
1887	7,836
1888	8,793
1889	9,943
1890	13,250
1891	13,298
1892	14,090
1893	19,181
1894	20,021
1895	26,094
1896	23,900
1897	19,032
1898	26,389
1899	32,607
*1900	43,455

*Asbestus, in any form other than crude, and all manufactures of. Duty 25 p.c.

During the year the majority of the larger companies were engaged in the erection of new mills, and generally increasing the facilities of their plants, while several new companies were formed and preparations made for the reopening of properties temporarily idle.

At Thetford the Johnsons Co., in addition to the old mill that they were running, have about completed a very large mill which should give them a considerably increased output. This firm has also been opening up an extensive property at Black lake where they are erecting a modern mill. Messrs. King Bros. and the Bells Asbestus Co., Ltd., are making big improvements, the first mentioned having commenced the erection of a large new mill which is to be fitted up with the latest and most approved machinery. The Beaver Asbestus Co., whose property has been closed down for four years, is preparing to resume operations on a large scale.

At Black lake the Canadian Asbestus Co., has leased the property of the Glasgow and Montreal Asbestus Co., for ten years and commenced work in June, 1900. New machinery has been put in and a large output is looked for in the future. Operations were continued by the Union Asbestus Mines, while the properties of the United Asbestus Co., are said to have been leased to the Manhattan Asbestus Co., of New York, under the management of J. J. Penhale. Dr. James Reed put in steam machinery to develop properties on lots 27, 28 and 29 of Range A., Coleraine, where he says the prospects are very bright for a large output of high grade fibre. ASBESTOS.

The output at Danville was considerably reduced, owing to a disastrous fire which occurred in March, 1900, and which destroyed the mill and a large part of the mining plant of the Asbestus and Asbestic Company, Ltd. As soon as possible a temporary mill was erected of about half the capacity of the old one, and operations were resumed in July.

Following is a list of firms engaged in mining asbestus :—

Bells Asbestus Co. Ltd.	Geo. R. Smith, Mgr.	Thetford Mines, Que.
King Bros.	B. Bennett, Mgr.	"
Johnsons Company		"
Beaver Asbestus Co., Ltd.	J. W. Woodside, Sec.	Sherbrooke, Que.
Anglo-Canadian Asbestus Co.	R. T. Hopper	Montreal, Que.
United Asbestus Co.	J. J. Penhale	Black Lake, Que.
Canadian Asbestus Co.	R. Stather, Sec.	"
Union Asbestus Mines		"
James Reed, M.D.		Reedsdale, Que.
Asbestus and Asbestic Co., Ltd.		Danville, Que.
Brompton Lake Asbestus Co.		Montreal, Que.
Ottawa Asbestus Mining Co.		Ottawa, Ont.

For additional informatiod concerning asbestus see past reports of the Section of Mines more particularly those for 1890, 1891 and 1896.

CHROMITE.

CHROMITE.

The chromite or chrome ore production of the 'Eastern Townships' of the province of Quebec has continued with much the same success as in former years. The output in 1900 reached a total of 2,335 tons, valued at about $27,000, or an average of $11.56 per ton, which when compared with the previous year shows an increase of 325 tons in quantity, and $5,158 in value.

Statistics of production are shown in Table 1.

Chromite.

Production.

Table 1.

Chromite.

Annual Production.

Calendar Year.	Tons, (2,000 lbs.)	Average Price per ton.	Value.
		$ cts.	$
1886	* 60	15 75	945
1887	38	15 00	570
1888 to 1893	no output		
1894	1,000	20 00	20,000
1895	3,177	13 00	41,300
1896	2,342	11 53	27,004
1897	2,637	12 31	32,474
1898	*2,021	12 00	24,252
1899	2,010	10 86	21,842
1900	2,335	11 56	27,000

* Railway shipments.

The greatest demand for chromium is for the manufacture of iron and steel alloys, it being used in both the United States and Germany for the manufacture of armour plate. High grade ore is used also in the manufacture of bi-chromates, while ore of lower quality is used as refractory lining material for furnaces. The Canadian product finds a market largely in Pennsylvania, although in 1900 several hundred tons are said to have been shipped to Buckingham, in the Province of Quebec, for use in the Electric Reduction Works there. The exports of chromite, taken from customs returns are given in Table 2.

Exports.

Table 2.

Chromite.

Exports.

Calendar Year.	Tons.	Value.
1895	2,908	$ 42,236
1896	2,466	31,411
1897	2,106	26,254
1898	1,683	20,783
1899	1,509	19,876
1900	368	8,259

The most important of the world's sources of supply of this mineral are Russia, Turkey, New Caledonia, Newfoundland and New South Wales. The production in the United States for the past few years, has amounted to only about 100 tons per annum, while the imports of that country have reached from 15,000 to 16,000 tons. There would therefore appear to be considerable opportunity for an enlargement of the Canadian production. CHROMITE.

The mineral is found, as before mentioned, in the 'Eastern Townships' of Quebec, the more important deposits at present operated, being situated in the township of Coleraine, Megantic county. The ore occurs in a serpentine belt which also includes the asbestus mines. The exploitation of the deposits is comparatively recent, and hitherto only the richest ores have been extracted. A beginning has, however, been made in the introduction of concentrating machinery, and the profitable working of the lower grade deposits may now be looked forward to with some degree of certainty.

A list of occurrences of chromite, most of which are believed to be workable deposits, is given hereunder, while a table of analyses of chrome ores is also appended.

County.	Township.	Range and Lot.
Brome	Bolton	IV.—13.
		VI.—26.
		VII.—9,13,26 W.
Megantic	Coleraine	Block "A."
		II.—25,26.
		III.—25,26.
		IV.—7,8,9,10,25.
		X.—19.
		XIII.—5,9.
		Block "B."
	Leeds	X.—1.
	Thetford	IV.—16.
Richmond	Melbourne	VI.—22.
Wolfe	Ham, South	II.—4,20,21.
	Garthby	I.—b, c, i.
		Island in Lake Breeches.
		II.—N. 4,5,6,7,8.
		V.—36,37.
	Wolfeston	II.—24.
		III.—23,24,25.
Gaspé		Shick Shock Mountains.

CHROMITE.

ANALYSES OF CHROME ORES.

Number.		Cr_2O_3.	FeO.	Al_2O_3.	SiO_2.	MgO.	CaO.	Total.
		%	%	%	%	%	%	%
Canadian.	1	45·90	35·68	3·20	....	15·03	....	99·81
	2	49·75	21·28	11·30	....	18·13	....	100·46
	3	52·82	....	....	....	....	....	....
	4	35·46	....	....	....	....	....	....
	5	39·15	27·12	7·00	7·00	16·11	3·41	99·79
	6	51·03	13·06	12·16	5·22	16·32	2·61	100·40
	7	53·07	15·27	8·01	6·44	16·08	1·20	100·07
	8	56·06	21·70	....	1·60	....	....	....
	9	65·16	27·36	7·48	....	....	....	100·00
	10	50·65	13·93	12·70	3·35	15·04	....	95·67
Foreign.	11	55·04	11·57	10·81	3·80	16·10	1·13	98·45
	12	51·80	24·72	13·90	2·05	7·81	0·41	100·69
	13	55·54	14·50	15·43	1·30	12·85	0·80	100·42
	14	42·40	12·28	20·23	5·69	16·52	1·40	98·52
	15	42·45	14·83	16·75	6·48	16·42	1·21	98·14

No. 1. Tp. Bolton, Que. G.S.C. Report, Geology of Canada, 1863, p. 504.
" 2. Lake Memphremagog. G.S.C. Report, Geology of Canada, 1863, p. 504.
" 3. Tp. Coleraine, Megantic Co., Que. Coleraine Mining Co. G. S. C. Report, 1894, p. 67 R.
" 4. 17. IV. Thetford, Megantic Co., Que. G.S.C. Report, 1887-88, pt. II., 56 T.
" 5, 6 and 7. Canadian Mining Manual, 1896, p. 342.
" 8. Coleraine Mining Co. } Chrome Iron in the Prov. of Quebec, Obalski, 1898.
" 9 "
" 10. Canada.
" 11 and 12. Turkish (Asia). } Mineral Industry, 1895, p. 101. Scientific Pub. Co., New York.
" 13. New Caledonia.
" 14 and 15. California.

The following is an analysis of chromite concentrates.*

Cr_2O_3	53·64	per cent
FeO	11·47	"
Al_2O_3	14·02	"
MgO	15·75	"
CaO	2·81	"
SiO_2	2·31	"
	100·00	

The principal producers of chromite in Canada in 1900, were as follows:—

Anglo-Canadian Asbestus Co. .... Montreal, Que.
Coleraine Mining Co. .... "

* Annual Report for 1899 Dept. Colonization and Mines of Quebec.

Coleraine Chrome Co.......... W. H. Lambly..... Inverness, Que. CHROMITE.
Messrs. Nadeau & Topping .... Black Lake, Que.
Canadian Chrome Iron Co., Ltd..... Hugh Leonard. D'Israeli, Que.
Messrs Beebe and Sons .... Boston, Mass.
James Reed, M.D .... Reedsdale, Que.
John McCaw .... Sherbrooke, Que.

COAL.

COAL.

With the exception of a small output of anthracite coal from the mines, situated in the Cascade coal-basin of the North-west Territories, the entire product in Canada consists of bituminous coal and lignite. The chief coal bearing areas at present worked are the Nova Scotia coal fields in rocks of Carboniferous age, the Cretaceous and Tertiary coals of Vancouver Island, British Columbia, and the more recently opened fields of the Crows Nest Pass, B.C., also found in the Cretaceous rocks. Lignitic coal of good quality is mined at Lethbridge, Alberta, and in the Souris River district, Assiniboia.

The production of coal in 1900 reached a total of 5,608,666 tons of 2,000 lbs. (5,007,737 tons of 2,240 lbs.) valued at $13,290,429, being an increase over the output of the previous year of 683,615 tons or nearly 14 per cent in quantity and $3,006,932, or 29 per cent in value. The greater increase in value has been due to the higher price of coal in Nova Scotia, where the supply has been unequal to the demand, and values have gone up accordingly.

Statistics of production by provinces for 1899 and 1900 are given in Table 1 following :

TABLE 1.

COAL.

PRODUCTION BY PROVINCES, 1899 AND 1900.

Production.

Province.	1899.		1900.	
	Tons.	Value.	Tons.	Value.
Nova Scotia................	3,148,822	$5,622,898	3,623,536	$8,088,250
British Columbia............	1,431,101	3,833,307	1 623 180	4,347,804
North-west Territories.......	334,600	811,500	351,950	839,375
New Brudswick...........	10,528	15,792	10 000	15,000
Total..............	4,925,051	$10,283,497	5,608,666	$13,290,429

For more detailed information concerning the coal fields of Canada, reference may be made to the following Reports G.S.C. (N.S.) Vol. XI., part S., and the descriptive atalogue of a collection of economic minerals of Canada, 1900.

COAL.

Production.

Nova Scotia continues to supply the greater part of the total Canadian product, over 64 per cent in 1900, and as the facilities for a largely increased output in this province are being rapidly pushed to completion, it is probable that this proportion will be continued for several years, even though a much larger production should also be attained in British Columbia.

The percentage of production to be credited to the several provinces at various periods since 1874, is as follows :—

Province.	1874.	1880.	1890.	1898.	1899.	1900.
	p. c.	p. c.	p. c.	p. c.	p. c.	p. c.
Nova Scotia	91	79	71	61·4	63·9	64·6
British Columbia	8	20	25	30·3	29·0	28·9
N. W. Territories and New Brunswick	.....	......	4	8·3	7·1	6·5

A comparison of the production of 1899 and 1900 by provinces is shown in Table 2.

TABLE 2.

COAL.

PRODUCTION. COMPARISON OF 1899 AND 1900.

Province.	Increase or Decrease.			
	Tons.	Per cent.	Value. $	Per cent.
Nova Scotia	*i* 474,714	*i* 15·07	*i* 2,465,352	*i* 43·84
British Columbia	*i* 192,079	*i* 13·42	*i* 514,497	*i* 13·42
North-west Territories	*i* 17,350	*i* 5·18	*i* 27,875	*i* 3·43
New Brunswick	*d* 528	*d* 5 01	*d* 792	*d* 5·01
Dominion	*i* 683,615	*i* 13·88	*i* 3,006,932	*i* 29·21

i Increase. *d* Increase.

The statistics of production since 1886, showing the increases each year, and the yearly average value per ton, are given in Table 3, while graphic Table A illustrates at a glance the variations in the production both of the Dominion as a whole and of the several provinces.

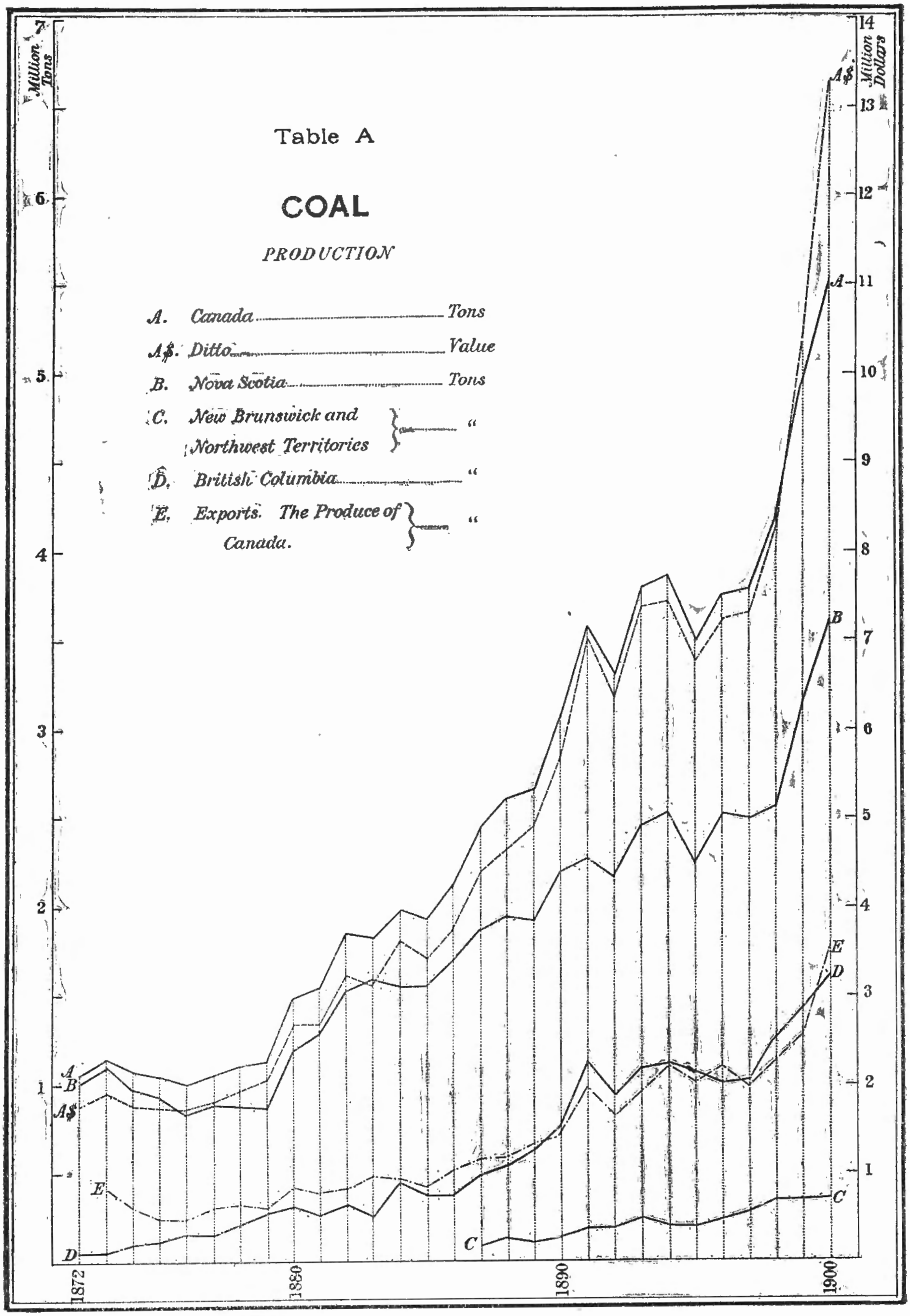


Table A
COAL
PRODUCTION
A. Canada .... Tons
A$. Ditto .... Value
B. Nova Scotia .... Tons
C. New Brunswick and Northwest Territories .... "
D. British Columbia .... "
E. Exports. The Produce of Canada. .... "
Million Tons
Million Dollars
1872
1880
1890
1900
1
2
3
4
5
6
7
8
9
10
11
12
13
14

COAL.

Production.

TABLE 3.

COAL.

ANNUAL PRODUCTION SHOWING THE INCREASE OR DECREASE EACH YEAR.

Calendar Year.	Tons.	Value.	Average Value per Ton.	Increase (*i*) or Decrease (*d*), in Tonnage.	Incr. (*i*) or Decr. (*d*) per cent.
1886.....	2,116,653	$3,739,840	$1 77	....	....
1887.....	2,429,330	4,388,206	1 81	*i* 312,677	*i* 14·8
1888.....	2,602,552	4,674,140	1 80	*i* 173,222	*i* 7·1
1889.....	2,658,303	4,894,287	1 84	*i* 55,751	*i* 2·1
1890.....	3,084,682	5,676,247	1 84	*i* 426,379	*i* 16·0
1891.....	3,577,749	7,019,425	1 96	*i* 493,067	*i* 16·0
1892.....	3,287,745	6,363,757	1 94	*d* 290,004	*d* 8·1
1893.....	3,783,499	7,359,080	1 95	*i* 495,754	*i* 15·1
1894.....	3,847,070	7,429,468	1 93	*i* 63,571	*i* 1·7
1895.....	3,478,344	6,739,153	1 94	*d* 368,726	*d* 9·6
1896.....	3,745,716	7,226,462	1 93	*i* 267,372	*i* 7·7
1897.....	3,786,107	7,303,597	1 93	*i* 40,391	*i* 1·1
1898.....	4,172,582	8,222,878	1 97	*i* 386,475	*i* 10·2
1899.....	4,925,051	10,283,497	2 09	*i* 752,469	*i* 18·0
1900.....	5,608,666	13,290,429	2 37	*i* 683,615	*i* 13·9

A large proportion of the production of Nova Scotia and British Columbia, more especially in the case of the latter province, finds a market in adjacent portions of the United States, while for the supply of Ontario and portions of Quebec, it is found more advantageous to import coal both bituminous and anthracite from the comparatively near fields of Pennsylvania.

The exports in 1900 amounted to 1,787,777 tons, or about 32 per cent of the year's production. The following tables exhibit the statistics of exports and imports, the figures being obtained as in past years from the books and reports of the Customs Department.

COAL.

Exports.

TABLE 4.

COAL.

EXPORTS.

Calendar Year.	Produce of Canada.	Not Produce.	Calendar Year.	Produce of Canada.	Not Produce.
	Tons.	Tons.		Tons.	Tons.
1873	420,683	5,403	1887	580,965	89,098
1874	310,988	12,859	1888	588,627	84,316
1875	250,348	14,026	1889	665,315	89,294
1876	248,638	4,995	1890	724,486	82,534
1877	301,317	4,829	1891	971,259	77,827
1878	327,959	5,468	1892	823,733	93,988
1879	306,648	8,468	1893	960,312	102,827
1880	432,188	14,217	1894	1,103,694	89,786
1881	395,382	14,245	1895	1,011,235	96,836
1882	412,682	37,576	1896	1,106,661	116,774
1883	486,811	44,388	1897	986,130	101,848
1884	474,405	62,665	1898	1,150,029	99,189
1885	427,937	71,003	1899	1,293,169	101,004
1886	520,703	78,443	1900	1,787,777	62,776

TABLE 5.

COAL.

EXPORTS.—NOVA SCOTIA AND BRITISH COLUMBIA.

Calendar Year.	Nova Scotia.		*British Columbia.	
	Tons.	Value.	Tons.	Value.
1874	252,124	$647,539	51,001	$ 278,180
1875	179,626	404,351	65,842	356,018
1876	126,520	263,543	116,910	627,754
1877	173,389	352,453	118,252	590,263
1878	154,114	293,795	165,734	698,870
1879	113,742	203,407	186,094	608,845
1880	199,552	344,148	219,878	775,008
1881	193,081	311,721	187,791	622,965
1882	216,954	390,121	179,552	628,437
1883	192,795	336,088	271,214	946,271
1884	222,709	430,330	245,478	901,440
1885	176,287	349,650	250,191	1,000,764
1886	240,459	441,693	274,466	960,649
1887	207,941	390,738	356,657	1,262,552
1888	165,863	330,115	405,071	1,605,650
1889	186,608	396,830	470,683	1,918,263
1890	202,387	426,070	508,882	1,977,191
1891	194,867	417,816	767,734	2,958,695
1892	181,547	407,980	599,716	2,317,734
1893	203,198	470,695	708,228	2,693,747
1894	310,277	633,398	770,439	2,855,216
1895	241,091	534,479	728,283	2,692,562
1896	380,149	787,270	679,799	2,507,752
1897	307,128	642,754	630,341	2,221,737
1898	309,158	629,363	813,843	2,948,428
1899	459,260	827,941	781,809	2,947,369

*See foot-note, table 16.

COAL

Imports.

TABLE 6.

COAL.

IMPORTS OF BITUMINOUS COAL.

Fiscal Year.	Tons.	Value.
1880	457,049	$1,220,761
1881	587,024	1,741,568
1882	636,374	1,992,081
1883	911,629	2,996,198
1884	1,118,615	3,613,470
1885	1,011,875	3,197,539
1886	930,949	2,591,554
1887	1,149,792	3,126,225
1888	1,231,234	3,451,661
1889	1,248,540	3,255,171
1890	1,409,282	3,528,959
1891	1,598,855	4,060,896
1892	1,615,220	4,099,221
1893	1,603,154	3,967,764
1894	1,359,509	3,315,094
1895	1,444,928	3,321,387
1896	1,538,489	3,299,025
1897	1,543,476	3,254,217
1898	1,684,024	3,179,595
1899	2,171,358	3,691,946
*1900	2,439,764	4,310,964

*Duty, 53c. per ton.

TABLE 7.

COAL.

IMPORTS OF ANTHRACITE COAL.

Fiscal Year.	Tons.	Value.	Fiscal Year.	Tons.	Value.
1880	516,729	$1,509,960	1891	1,399,067	5,224,452
1881	572,092	2,325,937	1892	1,479,106	5,640,346
1882	638,273	2,666,356	1893	1,500,550	6,355,285
1883	754,891	3,344,936	1894	1,530,522	6,354,040
1884	868,000	3,831,283	1895	1,404,342	5,350,627
1885	910,324	3,909,844	1896	1,574,355	5,667,096
1886	995,425	4,028,050	1897	1,457,295	5,695,168
1887	1,100,165	4,423,062	1898	1,460,701	5,874,685
1888	†2,138,627	5,291,875	1899	1,745,460	6,490,509
1889	1,291,705	5,199,481	*1900	1,654,401	6,602,912
1890	1,201,335	4,595,727			

*Coal, anthracite, and anthracite coal dust. Duty free.

†In Table 7, Imports of Anthracite Coal, a very considerable increase will be noticed in 1888 over 1887, an increase of over ninety-four per cent, the falling off again in 1889 being quite as remarkable. The average values per ton for the three years 1887, 1888 and 1889, were $4.02, $2.47 and $4.03 respectively. Although a duty of fifty cents per ton on anthracite coal was removed May 13, 1887, it is hardly thought this would account for the changes indicated, and unless some error may possibly have crept into the Trade and Navigation Report, no explanation is available

Coal
Imports

TABLE 8.

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	210,386	53,742
1897	225,562	59,609
1898	229,445	45,556
1899	276,547	44,717
*1900	330,174	98,349

*Duty, 20 p. c., not over 13c. per ton.

An approximation to the consumption of coal in Canada sufficiently accurate for purposes of comparison may be made as follows if we assume the figures of imports for the fiscal year to represent closely enough the importation during the calendar year.

	Tons.	Tons.
Production, Table 3	5,608,666	
Exports of coal, the produce of Canada, Table 4	1,787,777	
Home consumption of Canadian coal		3,820,889
Imports of bituminous, anthracite and coal dust, Tables 6, 7 and 8	4,424,339	
Exports of coal not the produce of Canada, Table 4	62,776	
Home consumption of imported coal		4,361,563
Total consumption of coal in Canada, home and imported		8,182,452

COAL.

Consumption in Canada.

Table 9 embodies similar calculations for each year since 1886. Therein is shown the consumption of Canadian and imported coal and the percentage of each as well as the total consumption per capita. The quantity of coal consumed in 1900 was greater than that used during the previous year by 458,209 tons or about 6 per cent.

An interesting feature to be deduced from the above figures is the relation between the total production as given in Table 3 and the total consumption. Thus is 1900 the production amounted to 68·5 per cent of the consumption, while in 1899 the proportion was 63·7 per cent; in 1898 it was 66·1 per cent, and in 1897 63·9 per cent. In 1890 it was 62·4 per cent and in 1886, 60·8 per cent.

TABLE 9.

COAL.

CONSUMPTION OF COAL IN CANADA.

Calendar Year.	Canadian.	Imported.	Total.	Percentage Canadian.	Percentage Imported.	Consumption per capita.
	Tons.	Tons.	Tons.			Tons.
1886	1,595,950	1,884,161	3,480,111	45·9	54·1	·758
1887	1,848,365	2,192,260	4,040,625	45·7	54·3	·871
1888	2,013,925	3,314,353	5,328,278	37·8	62·2	1·137
1889	1,992,988	2,490,931	4,483,919	44·4	55·6	·946
1890	2,360,196	2,581,187	4,941.383	47·8	52·2	1·031
1891	2,606,490	2,980,222	5,586,712	46·7	53·3	1·153
1892	2,464,012	3,082,429	5,546,441	44·4	55·6	1·133
1893	2,823,187	3,110,462	5,933,649	47·6	52·4	1·198
1894	2,743,376	2,917,818	5,661,194	48·5	51·5	1·130
1895	2,467,109	2,933,752	5,400,861	45·7	54·3	1·066
1896	2,639,055	3,206,456	5,845,511	45·1	54·9	1·140
1897	2,799,977	3,124,485	5,924,462	47·3	52·7	1·143
1898	3,022,553	3,274,981	6,297,534	48·0	52·0	1·200
1899	3,631,882	4,092,361	7,724,243	47·0	53·0	1·454
1900	3,820,889	4,361,563	8,182,452	46·7	53·3	1·521

Nova Scotia.

NOVA SCOTIA.

Detailed statistics of production of coal in this province are given in Tables 10, 11, 12 and 13. In Table 10, the output, sales and colliery consumption are shown both in tons of 2,240 lbs. and in tons of 2,000 lbs. The production has increased to 3,623,536 tons (2,000 lbs.) an advance over 1899 of over 15 per cent. From an average of $2 per long ton in 1899, the price has gone up to a general average of $2.50 in 1900. The supply has been unequal to the demand, both for home use and for export. As a result of the increase in price, the total value in 1900 is nearly 44 per cent greater than in 1899, and is over twice the value of the total production in 1898.

3

TABLE 10.
COAL.
NOVA SCOTIA :—OUTPUT, SALES, COLLIERY CONSUMPTION AND PRODUCTION.

Calendar Year.	Output, Tons, 2,240 lbs.	Sales, Tons, 2,240 lbs.	Colliery Consumption, Tons, 2,240 lbs.	Production* Tons, 2,240 lbs.	Output, Tons, 2,000 lbs.	Sales, Tons, 2,000 lbs.	Colliery Consumption, Tons, 2,000 lbs.	Production* Tons, 2,000 lbs.	Price per Ton, 2,240 lbs.	Value of production.
1872	880,950	785,914	110,341	896,255	986,664	880,224	123,582	1,003,806	$1 75	$1,568,446
1873	1,051,467	881,106	108,398	989,504	1,177,643	986,839	121,406	1,108,245	1 75	1,731,632
1874	872,720	749,127	119,582	868,709	977,446	839,022	133,932	972,954	1 75	1,520,240
1875	781,165	706,795	124,110	830,905	874,905	791,610	139,003	930,613	1 75	1,454,084
1876	709,646	634,207	113,788	747,995	794,804	710,312	127,443	837,755	1 75	1,308,991
1877	757,496	687,065	98,841	785,906	848,396	769,513	110,702	880,215	1 75	1,375,339
1878	770,603	693,511	88,627	782,138	863,075	776,732	99,262	875,994	1 75	1,368,741
1879	788,271	688,624	84,787	773,411	882,863	771,259	94,961	866,220	1 75	1,353,469
1880	1,032,710	954,659	96,831	1,051,490	1,156,635	1,069,218	108,451	1,177,669	1 75	1,840,108
1881	1,124,270	1,035,014	107,888	1,142,902	1,259,183	1,159,216	120,834	1,280,050	1 75	2,000,079
1882	1,365,811	1,250,179	111,381	1,361,560	1,529,708	1,400,200	124,747	1,524,947	1 75	2,382,730
1883	1,422,553	1,297,523	111,949	1,409,472	1,593,259	1,453,226	125,383	1,578,609	1 75	2,466,576
1884	1,389,295	1,261,650	116,769	1,378,419	1,556,011	1,413,048	130,781	1,543,829	1 75	2,412,233
1885	1,352,205	1,254,510	127,624	1,382,134	1,514,470	1,405,051	142,939	1,547,990	1 75	2,418,735
1886	1,502,611	1,373,666	142,421	1,516,087	1,682,924	1,538,506	159,512	1,698,018	1 75	2,653,152
1887	1,670,830	1,519,684	139,777	1,659,461	1,871,330	1,702,046	156,550	1,858,596	1 75	2,904,057
1888	1,776,128	1,576,692	157,443	1,734,135	1,989,263	1,765,895	176,336	1,942,231	1 75	3,034,735
1889	1,756,279	1,555,107	158,131	1,713,238	1,967,032	1,741,720	177,107	1,918,827	1 75	2,998,167
1890	1,984,001	1,786,111	161,240	1,947,351	2,222,081	2,000,444	180,589	2,181,033	1 75	3,407,864
1891	2,044,784	1,849,945	174,983	2,024,928	2,290,158	2,071,938	195,981	2,267,919	1 75	3,543,624
1892	1,942,780	1,752,934	175,092	1,928,026	2,175,913	1,963,286	196,103	2,159,389	1 75	3,374,046
1893	2,223,042	1,977,543	205,425	2,182,968	2,489,807	2,214,848	230,076	2,444,924	1 75	3,820,194
1894	2,250,631	2,060,920	196,206	2,257,126	2,520,707	2,308,231	219,751	2,527,982	1 75	3,949,970
1895	1,999,756	1,793,098	193,639	1,986,737	2,239,727	2,008,270	216,875	2,225,145	1 75	3,476,790
1896	2,292,675	2,046,828	192,975	2,239,803	2,567,796	2,292,447	216,132	2,508,579	1 75	3,919,655
1897	2,340,031	2,044,672	181,716	2,226,388	2,620,835	2,290,032	203,522	2,493,554	1 75	3,896,179
1898	2,262,656	2,121,126	167,428	2,288,554	2,534,175	2,375,661	187,519	2,563,180	1 75	4,004,970
1899	2,865,443	2,633,989	177,460	2,811,449	3,209,296	2,950,067	198,755	3,148,822	2 00	5,622,898
1900	3,298,791	2,998,737	236,563	3,235,300	3,694,646	3,358,585	264.951	3 623,536	2 50	8,088,250

* 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.

COAL.
Nova Scotia.

TABLE 11.

COAL.

NOVA SCOTIA :—COAL TRADE BY COUNTIES

Calendar Year.	Cumberland.		Pictou.		Cape Breton.		Other Counties.	
	Raised.	Sold.	Raised.	Sold.	Raised.	Sold.	Raised.	Sold.
	Tons, 2,000 lbs.	Tons, 2,000 lbs.	Tons, 2,000 lbs.	Tons, 2,000 lbs.	Tons, 2,000 lbs.	Tons. 2,000 lbs.	Tons, 2,000 lbs.	Tons, 2,000 lbs.
1st quarter......	141,112	126,266	147,991	128,467	656,139	576,726		
2nd "	138,134	128,116	150,758	138,926	642,417	633,145	4,208	3,102
3rd "	132,645	122,198	142,575	134,282	685,011	747,178	5,685	5,130
4th "	148,779	135,452	149,315	124,143	548,355	354,986	1,522	468
Total, 1900	560,670	512,032	590,639	525,818	2,531,922	2,312,035	11,415	8,700
" 1899	490,663	455,518	544,864	486,862	2,163,380	1,999,718	10,389	7,969

COAL.
Nova Scotia.

TABLE 12.

COAL.

NOVA SCOTIA :—OUTPUT BY COLLIERIES DURING THE CALENDAR YEAR, 1900.

Colliery.	Tons, 2,000 lbs.	Colliery.	Tons, 2,000 lbs.
Cumberland County.		*Victoria County.*	
Joggins	79,845	New Campbelton	8,731
Scotia	591		
Springhill	480,234		
Pictou County.		*Cape Breton County.*	
Acadia	320,371		
Intercolonial	270,267	Dominion Coal Co	2,239,708
Inverness County.		Nova Scotia Steel Co	272,256
		Gowrie and Blockhouse	8,790
Broad-Cove	63	Sydney	11,169
Mabou	146		
Pt. Hood	2,475	Total	3,694,646

The distribution of coal sold, exhibited in Table 13, shows a larger proportion of sales in the United States, 21 per cent of the total in 1900 as compared with nearly 11 per cent in 1899 and less than 5 per cent in 1898.

TABLE 13.

COAL.

NOVA SCOTIA :—DISTRIBUTION OF COAL SOLD.

Markets.	Calendar Years. 1899. Tons, 2,000 lbs.	1899. Per cent.	1900. Tons, 2,000 lbs.	1900. Per cent.
Nova Scotia, transported by land	390,494	13·2	576,807	17·2
" " sea	450,675	15·3	428,581	12·7
Total, Nova Scotia	841,169	28·5	1,005,388	29·9
New Brunswick	370,485	12·5	438,834	13·1
Prince Edward Island	76,622	2·6	69,046	2·1
Quebec	1,214,410	41·2	1,031,495	30·7
Newfoundland	120,163	4·1	107,605	3·2
West Indies	6,769	·2	....	....
United States	320,449	10·9	706,217	21·0
Total	2,950,067	100·0	3,358,585	100·0

COAL.

NEW BRUNSWICK.

New Brunswick.

The production of coal in this province, which is of small amount is shown in Table 14 below. In the absence of direct returns, the output in 1900 has been estimated at about 10,000 tons.

TABLE 14.

COAL.

NEW BRUNSWICK:—PRODUCTION.

Calendar Year.	Tons.	Value.	Value per ton.
1887	10,040	$ 23,607	$2 35
1888	5,730	11,050	1 93
1889	5,673	11,733	2 07
1890	7,110	13,850	1 95
1891	5,422	11,030	2 03
1892	6,768	9,375	1 39
1893	6,200	9,837	1 59
1894	6,469	10,264	1 59
1895	9,500	14,250	1 50
1896	7,500	11,250	1 50
1897	6,000	9,000	1 50
1898	6,160	9,240	1 50
1899	10,528	15,792	1 50
1900	10,000	15,000	1 50

NORTH-WEST TERRITORIES.

North-west Territories.

Coal mining was continued at Lethbridge, Anthracite, Canmore and in the vicinity of Edmonton, also at Estevan and Roche Percée along the Souris River. A total production of 351,950 tons, valued at $839,375 is reported, the greater part of which is lignitic coal.

COAL.

North-west Territories.

TABLE 15.

COAL.

NORTH-WEST TERRITORIES :—PRODUCTION.

Calendar Year.	Tons.	Value.	Value per ton.
1887	74,152	$ 157,577	$ 2 13
1888	115,124	183,354	1 59
1889	97,364	179,640	1 85
1890	128,953	198,498	1 54
1891	174,131	437,243	2 51
1892	184,370	469,930	2 55
1893	238,395	598,745	2 51
1894	199,991	488,980	2 45
1895	185,654	414,064	2 23
1896	225,868	606,891	2 69
1897	267,163	667,908	2 50
1898	340,088	825,220	2 43
1899	334,600	811,500	2 43
1900	351,950	839,375	2 38

A number of outcrops of coal have been noted in the Yukon district. A specimen from Cliff Creek, Yukon River, the property of the North American Transportation Company, Yukon, N.W.T., was exhibited at the Paris Exhibition of 1900. This deposit occurs in sandstones and shales apparently of Laramie age. The seam is stated to be about 15 feet thick and it is being worked. No record of production has been obtained.

The Commissioner of the Yukon, Mr. Wm. Ogilvie, writes as follows in the Annual Report of the Department of the Interior for 1900.

'Coal is being extensively developed at several points in the Territory and will take the place of wood for fuel. One of the companies in Dawson has made preparations to store several thousand tons for use here during the coming winter.

'The seams discovered and reported by myself in 1887, above Five Fingers, are now being exploited. The quality of the coal is lignite of a superior class, but not enough development has been done here to warrant any further remarks on it.'

BRITISH COLUMBIA.

British Columbia.

The production of coal in British Columbia in 1900, amounted to 1,623,180 tons, valued at $4,347,804, an increase of 13 per cent over that of the previous year.

Statistics of output, home consumption, quantity sold for export, &c., are shown in Table 16.

COAL.

British Columbia.

TABLE 16.

COAL.

BRITISH COLUMBIA :—PRODUCTION.

Calendar Year.	Output Tons, 2,240 lbs.	Home Consumption, Tons, 2,240 lbs.	Sold for Export, Tons, 2,240 lbs. ‡	PRODUCTION.* Tons, 2,240 lbs.	PRODUCTION.* Tons, 2,000 lbs.	Price per ton, 2,240 lbs.	Value.
						$	$
1836-52..	10,000	From 1836 to 1873 inclusive, the output is taken as production.			11,200	4 00	40,000
1852-59..	25,398				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				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
1897.....	892,296	290,310	619,860	910,170	1,019,390	3 00	2,730,510
1898.....	1,136,015	374,953	752,863	1,127,816	1,263,154	3 00	3,383,448
1899.....	1,306,324	526,058	751,711	1,277,769	1,431,101	3 00	3,833,307
1900....	1,590,178	535,084	914,184	1,449,268	1,623,180	3 00	4,347,804

*This production is obtained by adding 'Home Consumption' and 'Sold for Export.'

†52,935 of this amount was exported as sales without the division into the 'Home Consmption' and 'Sold for Export.'

‡The figures in the 'Sold for Export' column do not agree as they should with those given in Table 5, the only explanation being that the data in the two cases are from different sources, and it has not been possible to find out the cause of the difference.

¶Two months only.

COAL.

British Columbia.

The output at the Crows Nest Pass collieries was over 230,000 tons, of which, over half was used in making coke.

A large portion of the output of the Vancouver Island collieries, finds its way to the State of California.

The following table giving the source of California's coal supply in 1900, will illustrate the position which British Columbia coal occupies in that market.

Table showing source of California's coal for 1900.

	Ton of 2,000 lbs.
British Columbia	858,947
Australia	199,990
English and Welsh	60,591
Eastern (Cumberland and Anthracite)	19,397
Seattle, Washington	280,661
Tacoma, Washington	468,218
Mount Diablo, Cows Bay and Tesla	180,225
Japan and Rocky Mts	47,794
Total	2,115,823

COKE.

COKE.

In Nova Scotia there was but little change in the production of coke in 1900, the output being but a few tons less than in the previous year. In British Columbia, the building of new ovens and continued extension of operations at the Crows Nest Pass collieries, have resulted in a largely increased output.

The total production in 1900 was 157,134 tons, valued at $649,140, or an average of $4.13 per ton. Compared with 1899 this is an increase of 56,314 tons, or nearly 56 per cent in quantity and $299,118, or 85 per cent in value. The greater relative increase in the value is due in part to the higher price of coke in Nova Scotia, resulting from the increase in the price of coal in that province, but it is also assisted in a large measure by the greater quantity of British Columbia coke now included in the total, which brings a higher price than the Nova Scotia article.

COAL.
Coke.
Production.

Statistics of production are shown in Table 1.

TABLE 1.

COKE.

ANNUAL PRODUCTION.

Calendar Year.	Tons.	Value.	Value. per Ton.
1886	35,396	$101,940	$2 88
1887	40,428	135,951	3 36
1888	45,373	134,181	2 96
1889	54,539	155,043	2 84
1890	56,450	166,298	2 95
1891	57,084	175,592	3 08
1892	56,135	160,249	2 85
1893	61,078	161,790	2 65
1894	58,044	148,551	2 56
1895	53,356	143,047	2 68
1896	49,619	110,257	2 22
1897	60,686	176,457	2 91
1898	87,600	286,000	3 26
1899	100,820	350,022	3 47
1900	157,134	649,140	4 13

Previous to 1897 there was but little coke made in British Columbia. In 1900, however, the output in British Columbia was over 50 per cent greater than in Nova Scotia. Table 2 shows the production by provinces since 1897.

TABLE 2.

COKE.

PRODUCTION OF COKE BY PROVINCES.

Calendar Year.	Nova Scotia.		British Columbia.	
	Tons.	Value.	Tons.	Value.
		$		$
1897	41,532	90,950	19,154	85,507
1898	48,400	111,000	39,200	175,000
1899	62,459	178,767	38,361	171,255
1900	61,767	223,395	95,367	425,745

Considerable quantities of coke were formerly imported into British Columbia, but these have now almost ceased owing to the home production, and imports of any magnitude are practically confined to Ontario and Quebec.

COAL.
Coke.
Imports.

TABLE 3.

COKE.

IMPORTS OF OVEN COKE.

Fiscal Year.	Tons.	Value.
		$
1880....	3,837	19,353
1881....................	5,492	26,123
1882.....	8,157	36,670
1883.	8,943	38,588
1884.........	11,207	44,518
1885.......	11,564	41,391
1886....................	11,858	39,756
1887....................	15,110	56,222
1888......	25,487	102,334
1889.....	29,557	91,902
1890.....	36,564	133,344
1891......	38,533	177,605
1892..........	43,499	194,429
1893.....	41,821	156,277
1894....................	42,864	176,996
1895....................	43,235	149,434
1896....	61,612	203,826
1897..	83,330	267,540
1898....	135,060	347,040
1899....................	141,284	362,826
1900..........Duty free.	187,878	506,839

TABLE 4.

COKE.

IMPORTS OF OVEN COKE—FISCAL YEARS 1899 AND 1900.

Province.	1899.		1900.	
	Tons.	Value.	Tons.	Value.
		$		$
New Brunswick.......... ..	37	185	17	56
Quebec....................	9,459	33,249	11,860	46,750
Ontario	131,124	326,935	175,951	459,642
Manitoba..................	251	1,116	4	19
British Columbia..	413	1,341	34	213
Yukon.....................	....	....	12	159
Totals.....	141,284	362,826	187,878	506,839

COPPER.

COPPER.

Production.

Although copper occurrences are widely distributed throughout Canada and much prospecting has been done, extended mining operations have been confined to a comparatively few points in the province of British Columbia, to be considered in further detail under the heading of this province. In Ontario the chief source of supply for some years has been the copper-nickel deposits at Sudbury, and the copper of Quebec is obtained in connection with the mining of the pyrite deposits in the county of Sherbrooke.

The production in 1900 reached a total of 18,937,138 lbs., valued at $3,065,922 or an average of 16·19 cents per lb., the average price of refined copper in New York. This output is over twice that obtained in 1896, and over three times the production in 1890, while the increase over 1899 was more than 25 per cent in quantity and over 15 per cent in value. The average price per pound was slightly less than in 1899, though still higher than during any other of the past 15 years.

Previous to 1899, Ontario was the most important copper producing province. During the past two years, however, British Columbia has assumed the lead. The proportions contributed by the various provinces in 1900 were as follows British Columbia : nearly 53 per cent, Ontario over 35 per cent, and Quebec about 12 per cent. In 1899 the proportions were British Columbia : 51 per cent, Ontario 38 per cent, and Quebec 11 per cent, and in 1898, British Columbia 41 per cent, Ontario 47 per cent and Quebec 12 per cent.

COPPER.
Production.

TABLE 1.

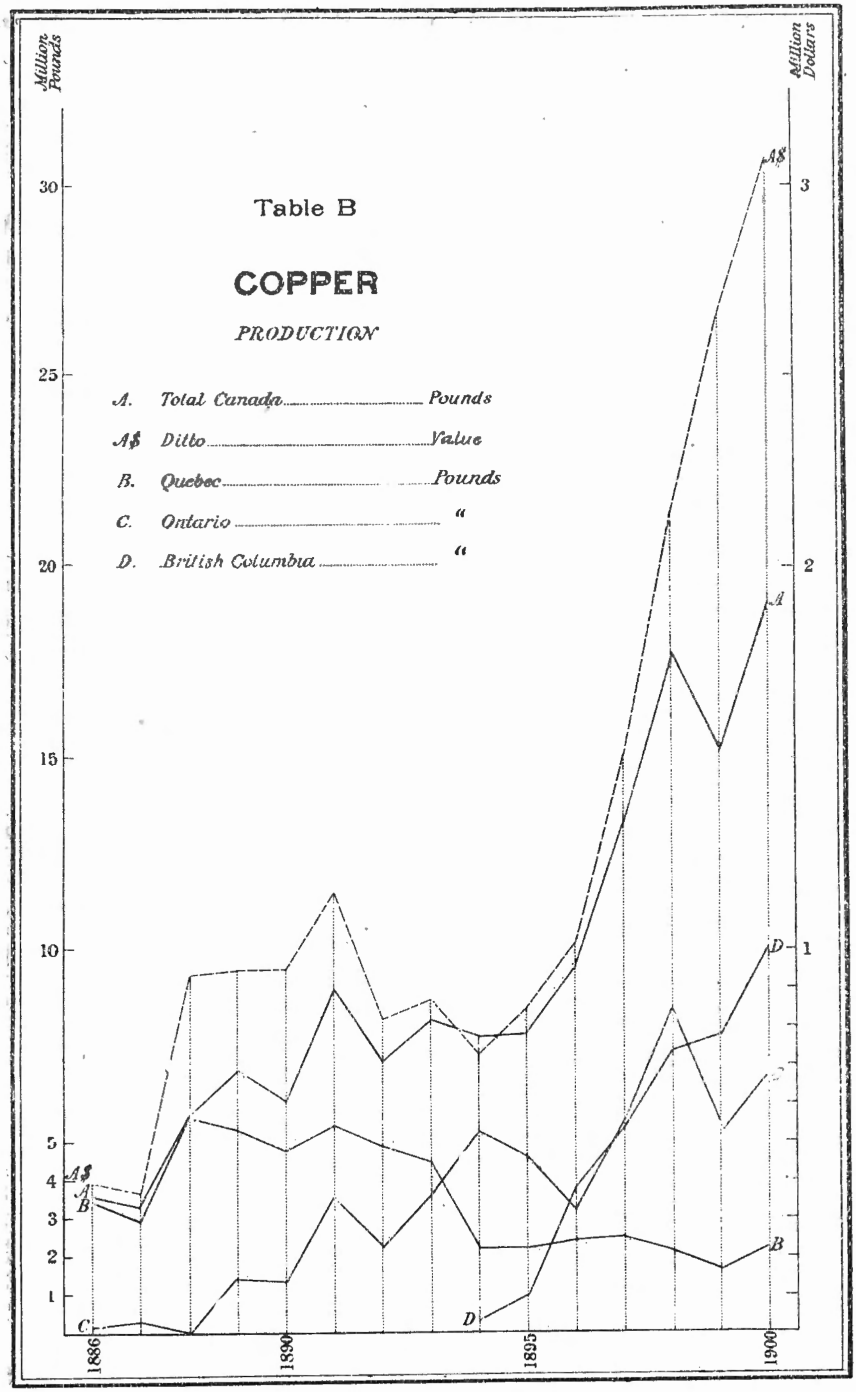
COPPER.

ANNUAL PRODUCTION.*

Calendar 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.......	7,708,789	401,067	4·94	736,960	134,849	15·46	9·56
1895.......	7,771,639	62,850	·81	836,228	99,268	13·47	10·76
1896.......	9,393,012	1,621,373	20·86	1,021,960	185,732	22·21	10·88
1897.......	13,300,802	3,907,790	41·60	1,501,660	479,700	46·94	11·29
1898.......	17,747,136	4,446,334	33·43	2,134,980	633,320	42·17	12·03
1899.......	15,078,475	2,668,661	15·04	2,655,319	520,339	24·37	17·61
1900.......	18,937,138	3,858,663	25·59	3,065,922	410,603	15·46	16·19

* 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.


Million Pounds
Million Dollars
Table B
COPPER
PRODUCTION
A. Total Canada Pounds
A$ Ditto Value
B. Quebec Pounds
C. Ontario "
D. British Columbia "
30
25
20
15
10
5
4
3
2
1
3
2
1
A$
A
B
C
D
1886
1890
1895
1900

The exports and imports of copper as obtained from the Customs returns, are shown in Tables 2, 3 and 4. COPPER.

The imports of copper have increased very largely during the past three years, and amounted in 1900 to a value of over $1,270,000.

TABLE 2.

COPPER.

EXPORTS OF COPPER IN ORE, MATTE, ETC. Exports.

Calendar Year.	Lbs.	Value.
		$
1885	....	262,600
1886	....	249,259
1887	....	137,966
1888	....	257,260
1889	....	168,457
1890	....	398,497
1891	....	348,104
1892	....	277,632
1893	4,792,201	269,160
1894	1,625,389	91,917
1895	3,742,352	236,965
1896	5,462,052	281,070
1897	14,022,610	850,336
1898	11,572,381	840,243
1899	11,371,766	1,199,908
1900	23,631,523	1,741,885

TABLE 3.

COPPER.

IMPORTS OF PIGS, OLD, SCRAP, ETC. Imports.

Fiscal Year.	Lbs.	Value.	Fiscal Year.	Lbs.	Value.
		$			$
1880	31,900	2,130	1890	112,200	11,521
1881	9,800	1,157	1891	107,800	10,452
1882	20,200	1,984	1892	343,600	14,894
1883	124,500	20,273	1893	168,300	16,331
1884	40,200	3,180	1894	101,200	7,397
1885	28,600	2,016	1895	72,062	6,770
1886	82,000	6,969	1896	86,905	9,226
1887	40,100	2,507	1897	49,000	5,449
1888	32,300	2,322	1898	1,050,000	80,000
1889	32,300	3,288	1899	1,655,000	246,740
1900 { Copper, old and scrap or in blocks ..... Duty free				191,900	18,736
1900 { Copper in pigs or ingots .... "				952,100	162,254
Total, 1900				1,144,000	180,990

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
1896	285,220
1897	264,587
1898	786,529
1899	551,586

		Duty.	Pounds.	$
1900	Copper, in bolts, bars and rods, in coils, or otherwise in lengths not less than 6 feet, unmanufactured	Free.	3,158,700	$555,278
	Copper, in strips, sheets or plates, not planished or coated, &c	"	1,481,000	226,256
	Copper tubing in lengths not less than 6 feet, and not polished, bent or otherwise manufactured	"	246,850	54,728
	Copper rollers, for use in calico printing, imported by calico printers for use in their own factories	"	....	24,457
	Copper and manufactures of :—			
	Nails, tacks, rivets and burrs or washers	30 p. c.	... .	7,538
	Wire, plain, tinned or plated	15 "	769,519	152,745
	Wire cloth, &c	25 "	....	675
	All other manufactures of, N.O.P.	30 "	.. ..	68,603
	Total	....	....	1,090,280

Quebec.

QUEBEC.

The output of this province which amounted to 2,220,000 lbs. was derived as usual from the pyrites deposits in the county of Sherbrooke. This ore is mined primarily for its sulphur contents.

Ontario.

ONTARIO.

In Ontario the production of copper reached a total of 6,728,000 lbs., an increase of 1,060,000 lbs. over 1899, though still less than the output in 1898.

The production in this province as given by the Ontario Bureau of Mines, is as follows in Table 5, with the exception of the final value, which has been added to facilitate comparison with the other tables in the report. COPPER. Ontario.

TABLE 5.

COPPER.

ONTARIO :—PRODUCTION.

Calendar Year.	Pounds.	Spot Value.		Final Value.	
		Total.	Per lb.	Total.	Per lb.
		$	cts.	$	cts.
1892	3,872,000	232,135	6·00	447,216	11·55
1893	2,862,000	115,200	4·03	307,865	10·75
1894	5,496,000	195,750	3·56	525,418	9·56
1895	4,731,000	160,913	3·40	509,056	10·76
1896	3,736,000	130,660	3·50	406,477	10·88
1897	5,500,000	200,067	3·63	620,950	11·29
1898	8,373,560	268,080	3·20	1,007,339	12·03
1899	5,668,000	176,237	3·11	998,135	17·61
1900	6,728,000	319,681	4·75	1,089,263	16·19

Although the output for the year was derived from the established mines in the region, there has been a great deal of progress in the opening, developing and testing of new properties. The Canadian Copper Co. opened up a number of new mines. It is now equipped with six furnaces having a capacity of eight hundred tons of ore per day. At Massey Station some prospecting was done on a property owned by R. M. Thompson, president of the Orford Copper Co., and a small shipment of copper ore was made to New Jersey. The Orford Copper Co. has also erected a smelting works at Copper Cliff for the further treatment of the matte of the Canadian Copper Co. and other copper ores.

The Great Lakes Copper Co. did considerable development on the Mount Nickel Mine, situated on lot 5, concession II, township of Blezzard. A fine body of good ore is said to have been opened up. A large amount of work was accomplished by the Mond Nickel Co., at Victoria mines, the Lake Superior Power Co., at the Gertrude Mine, and the Nickel Copper Co., of Ontario.

At Bruce Mines, the old Bruce, Wellington and Copper Bay properties, which had during the previous year been exploited by the Lake

COPPER.

British Columbia.

Huron Copper Syndicate, were transferred to the Bruce Copper Mines, Ltd. Exhaustive tests for the concentration of the ore at this place had been made and in due season, machinery, supplies and construction material were ordered, and since about the middle of September 1900, work has been in progress. Roughly, this consists of enlarging and properly timbering the shafts, the construction of head works, installation of compressed air plant, machine shop, warehouses, boarding houses for miners, stables and a standard gauge tramway, extending from the headworks to the mill, a distance of about a mile. At the mill the work has comprised the erection of a concentrating mill for the handling of four hundred tons of ore per day and a water-works for the supply of the mill, having a capacity of two million gallons per day. This property is under the management of Wm. Braden, M.E., to whom we are indebted for the above information.*

About nine miles north of Bruce Mines, the Rock Lake Mining Co. has been developing a copper property and has installed a concentrator of 200 tons daily capacity.

BRITISH COLUMBIA.

The statistics of copper production in British Columbia, for the past seven years are given in Table 6 below. The output has increased from less than 200 tons in 1894, to nearly 5,000 tons in 1900.

TABLE 6.

COPPER.

BRITISH COLUMBIA—PRODUCTION.

Calendar Year.	Copper contained in ores, matte, &c.	Increase.		Final Value.
	Lbs.	Lbs.	%	
1894	324,680	....	.....	$ 31,039
1895	952,840	628,160	193	102,526
1896	3,818,556	2,865,716	301	415,459
1897	5,325,180	1,506,624	39	601,213
1898	7,271,678	1,946,498	36	874,783
1899	7,722,591	450,913	6	1,359,948
1900	9,977,080	2,254,489	29	1,615,289

In 1898 and 1899 the Rossland mines of the Trail Creek Mining Division were the source of the greater part of the copper production

*Since the above was written work has been suspended at the mines owing to the destruction of part of the plant by fire.

in British Columbia. In 1900, however, although the quantity of ore treated in this division was much greater, the copper contents were so much diminished, that the output of the Rossland mines was exceeded by that of the Boundary Creek mines, as well as by that of the mines of the coast districts.

COPPER. British Columbia.

Up to 1899, productive operations in the Boundary district had been altogether confined to the mining of free-milling gold ore at Camp McKinney. In 1900, however, the several copper properties in the district which had been undergoing extensive development during the past few years commenced shipment. The total output from the district from all classes of metal mines, according to the official figures, reached over 100,000 tons, with a copper content of 5,672,177 lbs., and carrying gold to the value of $374,628. The greater part of this gold product, however, was derived from the Cariboo-McKinney, which is a free-milling gold mine, where there were treated during the year 15,238 tons of ore, yielding 11,469 oz., of gold bullion, and 557 tons of concentrates.

The district has now two smelters in operation, and a third nearing completion. The Granby smelter was the first to be completed and was 'blown in' during the fall of 1900. It is situated on the north fork of the Kettle river, about half a mile above the town of Grand Forks. The smelter building proper is 104 feet long by 70 feet wide, and contains two stacks, although room has been left for extending the building so as to allow for the placing of six furnaces in all. The ore appears to be practically self-fluxing. A 50 per cent copper matte was produced at the first smelting, and the furnaces were smelting an average of 300 tons of ore each, in 24 hours.

The British Columbia Copper Company's smelting works, are located on an elevated flat between Greenwood and Anaconda, and only two and a half miles in a straight line from the Mother Lode Mine, owned by the same company. The smelter has been planned with a view to permit of its enlargement in the future to treat up to 1800 tons of ore daily, and the addition of Bessemer works, when the production of a sufficient amount of matte justifies their erection. Although the works were completed in the latter part of the year, smelting operations were not begun until February, 1901.

The Standard Pyritic Smelting Company's smelter was being erected on Boundary Creek, about three miles south of Greenwood.

In the coast districts the shipments of ore slightly exceeded 14,000 tons with a copper content of 2,193,962 lbs., besides over $60,000

COPPER.

British Columbia.

worth of gold and $30,000 of silver. The shipments were made largely from the several mines of the Van Anda Copper and Gold Co., Ltd., and from the Lenora Mine, owned by the Lenora-Mount Sicker Mining Company. The Van Anda Copper and Gold Company, Ltd., continuously worked its several properties during the year, but the principal work was done on the Copper Queen and Cornell claims, which have been steady producers. The company has erected a 75 ton smelter at the works, which with the old smelter of 50 tons, gives a total capacity of 125 tons per day. The quantity of ore smelted during the year, comprised 7,054 tons from the Company's mines and 2,472 tons purchased.

From the Lenora Mine some 7,000 tons of ore were shipped having an average assay value of $20 per ton. The ore shipped was conveyed by wagons to the foot of Mount Sicker, thence by wooden tramway to the E. and N. Railway and from there to Ladysmith by rail. From Ladysmith it was shipped by steamer to the Van Anda, Everett and Tacoma smelters.

GRAPHITE.

GRAPHITE.

The production of graphite in Canada in 1900 was comprised almost entirely of crude material and reached a total of 1,922 tons, valued at $31,040. This is an increase, compared with the previous year, of 792 tons, or nearly 70 per cent in quantity and $6,861 or 28 per cent in value. In former years an output more or less great of manufactured graphite has usually been included in the statement of production, and it is to the absence of this in 1900, that the smaller increase per cent in value as compared with the quantity, is to be attributed. The value of crude in 1900 at point of shipment, ranged from $12 to $18 per ton.

Statistics of production are shown in Table 1. GRAPHITE.

TABLE 1.

GRAPHITE.

ANNUAL PRODUCTION. Production.

Calendar Year.	Tons.	Value.
1886	500	$4,000
1887	300	2,400
1888	150	1,200
1889	242	3,160
1890	175	5,200
1891	260	1,560
1892	167	3,763
1893	nil.	nil.
1894*	3	223
1895	220	6,150
1896	139	9,455
1897	436	16,240
1898	....	13,698
1899	1,130	24,179
1900	1,922	31,040

* Exports.

The exports and imports of graphite are shown in Tables 2 and 3.

TABLE 2.

GRAPHITE.

EXPORTS. Exports.

Calendar Year.	Value.	Calendar Year.	Value.
1886	$ 3,586	1894	$ 223
1887	3,017	1895	4,833
1888	1,080	1896	9,480
1889	538	1897	4,325
1890	1,529	1898	13,098
1891	72	1899	22,490
1892	3,952	1900	46,197
1893	38		

	Cwt.	Value
1900 Crude	30.996	$40,132
1900 Manufactures of		6,065
		$46,197

GRAPHITE.

Imports.

TABLE 3.

GRAPHITE.

IMPORTS OF RAW AND MANUFACTURED GRAPHITE.

Fiscal Year.		Plumbago.	Manufactures of plumbago.	
			Black-lead.	Other Manufactures.
1880		$1,677	$18,055	$2,738
1881		2,479	26,544	1,202
1882		1,028	25,132	2,181
1883		3,147	21,151	2,141
1884		2,891	24,002	2,152
1885		3,729	24,487	2,805
1886		5,522	23,211	1,408
1887		4,020	25,766	2,830
1888		3,802	7,824	22,604
1889		3,546	11,852	21,789
1890		3,441	10,276	26,605
1891		7,217	8,292	26,201
1892		2,988	13,560	23,085
1893		3,293	16,595	23,051
1894		2,177	17,614	16,686
1895		2,586	13,922	21,988
1896		2,865	18,434	19,497
1897		1,406	17,863	20,674
1898		1,862	19,638	32,653
1899		4,979	21,334	36,490
	Duty.			
1900 Plumbago, not ground, &c.	10 p.c.	$4,437		
1900 Black-lead	25 "	....	$ 22,078	
1900 Plumbago, ground and manufactures of, N.E.S.	25 "	....	....	$17,869
1900 Crucibles, clay or plumbago	....	....	....	20,571
Total, 1900	....	$4,437	$22,078	$38,440

The sources of the output of graphite in 1900 were as follows :—

New Brunswick.

NEW BRUNSWICK.

Marble Cove Mine, near Fairville Station, N.B., owned and operated by The Canada Paint Co. 572 William street, Montreal.

Quebec.

QUEBEC.

No reports of active operations were received from any of the Buckingham Mines. At Grenville, the Keystone Graphite Co., of Wilksbarrie, Pa., under the management of Mr. J. P. Williams, continued operations on lot 10, concession V., of Grenville township, Argenteuil county, and shipped a number of car loads of raw ore to Jersey City, N.J., for treatment.

ONTARIO. GRAPHITE.

Ontario.

Work in this province was continued by the Ontario Graphite Co., at the Black Donald Mine, lots 17, 18 and 19, Range IV., township of Brougham, Renfrew county. The company reports as to its operations as follows: "We have succeeded in getting our mine into good working order. We are down about 80 feet, and are in 21 feet of solid ore, that is the width of the vein. We first sank 50 feet, then drifted 200 feet under the lake, and at the end of the drift the vein was eight feet wide at its narrowest place. We then sank 30 feet more in the old shaft and we are now stoping back to the old drift."

GYPSUM.

GYPSUM.

Production.

Although gypsum occurrences are known in nearly all the provinces of the Dominion, active mining of this mineral is still confined to the deposits in Nova Scotia and New Brunswick and, to a smaller extent, Ontario. The output, including all grades, of product, attained a total in 1900 of 252,101 tons, valued at $259,009, which was not only greater than that of the previous year, but is the largest production on record since statistics have been available. Although plaster of Paris, calcined plaster, &c., are included in the above total, the greater part consisted of crude gypsum, of which the product was 240,970 tons, valued at $200,323 or 83 cents per short ton at the quarries. The principal market for this output is in the adjoining States. The following tabulated statement shows the production for the past four years, arranged according to class of product.

Production 1897.	Tons.	Value.	Value per Ton.
		$	$ cts.
Crude gypsum	228,416	187,918	0 82
Calcined and land plaster	1,956	4,753	2 43
Plaster of Paris and terra alba	9,319	51,860	5 62
Total	239,691	244,531	1 02

GYPSUM.
Production.

Production 1898.	Tons.	Value.	Value per Ton.
		$	$ cts.
Crude gypsum...........................	208,061	174,445	0 84
Calcined and land plaster................	1,583	4,574	2 89
Plaster of Paris and terra alba...........	9,612	53,496	5 57
Total	219,256	232,515	1 06

Production 1899.	Tons.	Value.	Value per Ton.
		$	$ cts.
Crude gypsum...........................	233,819	198,831	0 85
Calcined and land plaster................	717	2,246	3 13
Plaster of Paris and terra alba...	10,030	56,252	5 61
Total	244,566	257,329	1 05

Production 1900.	Tons.	Value.	Value per Ton.
		$	$ cts.
Grude gypsum..........................	240,970	200,323	0 83
Calcincd and land plaster.................	1,523	4,806	3 15
Plaster of Paris and terra alba.....	9,608	53,880	5 60
Total....	252,101	259,009	1 02

n since 1886 are shown in Tables 1 and 2. GYPSUM. Production.

TABLE 1.

GYPSUM.

ANNUAL PRODUCTION.

Calendar Year.	Tons.	Value.	Average price per ton.
1886	162,000	$178,742	$ 1 10
1887	154,008	157,277	1 02
1888	175,887	179,393	1 01
1889	213,273	205,108	0 96
1890	226,509	194,033	0 86
1891	203,605	206,251	1 01
1892	241,048	241,127	1 00
1893	192,568	196,150	1 02
1894	223,631	202,031	0 90
1895	226,178	202,608	0 89
1896	207,032	178,061	0 86
1897	239,691	244,531	1 02
1898	219,256	232,515	1 06
1899	244,566	257,329	1 05
1900 Nova Scotia	138,712	108,828	0 78
1900 New Brunswick	112,294	145,850	1 29
1900 Ontario	1,095	4,331	3 95
Total, 1900	252,101	$259,009	$1 02

TABLE 2.

GYPSUM.

ANNUAL PRODUCTION BY PROVINCES.

CALENDAR YEAR.	NOVA SCOTIA.		NEW BRUNSWICK.		ONTARIO.		TOTAL.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.
		$		$		$		$
1886	......	......	......	......	...	......	162,000	178,742
1887	116,346	116,346	29,102	29,216	8,560	11,715	154,008	157,277
1888	124,818	120,429	44,369	48,764	6,700	10,200	175,887	179,393
1889	165,025	142,850	40,866	49,130	7,382	13,128	213,273	205,108
1890	181,285	154,972	39,024	30,986	6,200	8,075	226,509	194,033
1891	161,934	153,955	36,011	33,996	5,660	18,300	203,605	206,251
1892	197,019	170,021	39,709	65,707	4,320	5,399	241,048	241,127
1893	152,754	144,111	36,916	41,846	2,898	10,193	192,568	196,150
1894	168,300	147,644	52,962	48,200	2,369	6,187	223,631	202,031
1895	156,809	133,929	66,949	63,839	2,420	4,840	226,178	202,608
1896	136,590	111,251	67,137	59,024	3,305	7,786	207,032	178,061
1897	155,572	121,754	82,658	118,116	1,461	4,661	239,691	244,531
1898	132,086	106,610	86,083	121,704	1,087	4,201	219,256	232,515
1899	126,754	102,055	116,792	151,296	1,020	3,978	244,566	257,329
1900	138,712	108,828	112,294	145,850	1,095	4,331	252,101	259,009

GYPSUM.
Exports.

The exports and imports of gypsum are shown in Tables 3, 4 and 5.

TABLE 3.

GYPSUM.

EXPORTS OF CRUDE GYPSUM.

Calendar Year.	Nova Scotia.		New Brunswick.		Ontario.		Total.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.	ons.	Value.
1874	67,830	$ 68,164	....	....	......	....	67,830	$ 68,164
1875	86,065	86,193	5,420	$ 5,420	......	....	91,485	91,613
1876	87,720	87,590	4,925	6,616	120	$ 180	92,765	94,386
1877	106,950	93,867	5,030	5,030	......	....	111,980	98,897
1878	88,631	76,695	16,335	16,435	489	675	105,455	93,805
1879	95,623	71,353	8,791	8,791	579	720	104,993	80,864
1880	125,685	111,833	10,375	10,987	875	1,240	136,935	124,060
1881	110,303	100,284	10,310	15,025	657	1,040	121,270	116,349
1882	133,426	121,070	15,597	24,581	1,249	1,946	150,272	147,597
1883	145,448	132,834	20,242	35,557	462	837	166,152	169,228
1884	107,653	100,446	21,800	32,751	688	1,254	130,141	134,451
1885	81,887	77,898	15,140	27,730	525	787	97,552	106,415
1886	118,985	114,116	23,498	40,559	350	538	142,833	155,213
1887	112,557	106,910	19,942	39,295	225	337	132,724	146,542
1888	124,818	120,429	20	50	670	910	125,508	121,389
1889	146,204	142,850	31,495	50,862	483	692	178,182	194,404
1890	145,452	139,707	30,034	52,291	205	256	175,691	192,254
1891	143,770	140,438	27,536	41,350	5	7	171,311	181,795
1892	162,372	157,463	27,488	43,623	......	....	189,860	201,086
1893	132,131	122,556	30,061	36,706	......	....	162,192	159,262
1894	119,569	111,586	40,843	46,538	......	....	160,412	158,124
1895	133,369	125,651	56,117	67,593	......	....	189,486	193,244
1896	116,331	109,054	64,946	77,535	......	....	181,277	186,589
1897	122,984	116,665	66,222	80,485	......	....	189,206	197,150
1898	99,215	93,474	70,399	81,433	......	....	169,614	174,907
1899	104,795	99,984	96,831	108,094	*½	12	201,626	208,090
1900	....	....	....	....	....	....	188,262	201,912

*Exported from British Columbia.

TABLE 4.

GYPSUM.

EXPORTS OF GROUND GYPSUM.

Calendar Year.	Nova Scotia.	New Brunswick.	Ontario.	Total.
	$	$	$	$
1890........	....	....	....	105
1891........	....	....	....	588
1892........	....	....	....	20,255
1893........	....	....	....	22,132
1894........	2,124	17,930	....	20,054
1895........	3,364	18,827	42	22,233
1896........	1,270	19,246	751	21,267
1897........	1,655	5,024	84	6,763
1898........	1,548	4,900	....	6,448
1899........	205	7,898	20	8,123
1900........	....	....	....	19,834

GYPSUM.
Imports.

TABLE 5.

GYPSUM.

IMPORTS OF GYPSUM, ETC.

Fiscal Year.	Crude Gypsum.		Ground Gypsum.		Plaster of Paris.	
	Tons.	Value.	Pounds.	Value.	Pounds.	Value.
1880	1,854	$3,203	1,606,578	$ 5,948	667,676	$ 2,376
1881	1,731	3,442	1,544,714	4,676	574,006	2,864
1882	2,132	3,761	759,460	2,576	751,147	4,184
1883	1,384	3,001	1,017,905	2,579	1,448,650	7,867
1884	....	3,416	687,432	1,936	782,920	5,226
1885	1,353	2,354	461,400	1,177	689,521	4,809
1886	1,870	2,429	224,119	675	820,273	5,463
1887	1,557	2,492	13,266	73	594,146	4,342
1888	1,236	2,193	106,068	558	942,338	6,662
1889	1,360	2,472	74,390	372	1,173,996	8,513
1890	1,050	1,928	434,400	2,136	693,435	6,004
1891	376	640	36,500	215	1,035,605	8,412
1892	626	1,182	310,250	2,149	1,166,200	5,595
1893	496	1,014	140,830	442	552,130	3,143
1894	....	1,660	23,270	198	422,700	2,386
1895	603	960	20,700	88	259,200	1,619
1896	1,045	848	64,500	198	297,000	2,000
1897	....	772	45,000	123	969,900	4,489
1898	1,147	1,742	35,700	293	329,600	2,025
1899	325	692	33,900	338	496,300	3,120
1900	77	958	*6,300	69	849,100	6,492

*Equivalent to 21 barrels.

Crude gypsum, duty free. Ground gypsum, duty 15%. Plaster of Paris, duty 12½c. per 100 lbs.

The gypsum deposits of Manitoba have hitherto not been put to any economic use, although the following report of the Dominion Lands agent at Winnipeg would seem to indicate that some development of this mineral may be expected in the near future.

'The gypsum deposits situated in the district lying north of Lake St. Martin, in townships 32 and 33, ranges 8 and 9 west, are being rapidly staked out. The Manitoba Union Mining Company, composed of Canadian and American capitalists, have staked out a large area of land valuable for this commodity, and propose developing the claims at an early date. It is their present intention to place a reduction mill at Portage Bay, on Lake Manitoba, and to construct a tramway from that place to the mines. The quality of the gypsum is pronounced excellent, and it is stated that it will produce plaster of Paris of the finest quality.'*

*Report of the Department of the Interior, 1900.

GYPSUM.

These gypsum deposits at Lake St. Martin were noted by Mr. J. B. Tyrrell, of the Geol. Survey in 1887, and he speaks of them as follows in the Summary Report of the Geol. Survey for that year, (Geol. Surv. of Canada Vol. III., (N.S.) Part I., p. 74A).

'It was found to be a thick deposit of white, or in places crystalline and transparent gypsum, and to extend apparently, in lenticular masses, and bands over very large areas. As this deposit is readily accessible, it will be of great economic value in the near future, being destined to furnish Manitoba and the surrounding territories with land plaster and plaster of Paris, both of which must now be brought from Michigan, Iowa, Ontario or more distant places. It can be quarried without difficulty and can be readily removed by water; or if the proposed Hudson's Bay railway should be built on the east side of Lake Manitoba, it will pass through this area, and the quarries would then be within one hundred and fifty miles by rail from Winnipeg.'

IRON.

IRON.

The progress of the more important industries connected with the mining of iron ore, and the metallurgical extraction of the metal is illustrated by the following tables:—

In Table No. 1, giving the production by provinces, the figures show a large growth during 1900 in the total production of ore from Canadian mines, equivalent to over 62 per cent. This is entirely due to Ontario, all the other provinces showing a falling off. During the fifteen years recorded in the tables, the output has fluctuated considerably, 1893 being credited with the largest amount, the grand total being yet over 3,000 tons larger than that for 1900. At that time Nova Scotia was the chief contributor by a very large margin, followed by Quebec, the mines of Ontario being idle. It will be noted that the production of iron ores in Nova-Scotia and Quebec has been fairly constant, whilst in Ontario the mines have been idle at times for some years, and that British Columbia has been always a small contributor.

In Nova Scotia, the iron smelting industry has been in a transition state, and the production both of ore and pig has fallen off. With the completion in the near future, however, of very extensive plants at Sydney, of the Nova Scotia Steel and Coal Co. and the Dominion Iron and Steel Co., the province will again assume front rank. This will doubtless enlarge the production of ores in the province itself, although both companies will draw the larger part of their supply from their very extensive ore-beds on Bell Island, in the adjacent colony of Newfoundland. A great many discoveries of iron ores are on record at various points in this province, and no doubt some of these will be proved to be of large extent, when development work shall have been done up on them. The quality of these ores, as far as the available analyses, show is well illustrated by reference to the tables issued in the report of this Section for 1897 (part S. Vol.X., Annual Report, Geological Survey of Canada). IRON.

In Quebec, the output represents the consumption by the furnaces at Drummondville and Radnor, of bog ores, almost altogether mined in the district, although of late years small quantities of magnetite from eastern Ontario have been consumed. For the fourteen years for which figures are available the production has been fairly steady.

In Ontario the amounts given for the earlier years represent magnetite ores mined in the districts served by the Kingston and Pembroke and Central Ontario Railways, which found their market in the United States, but the subsequent imposition of a heavy duty on ore entering that country caused a cessation of these operations for some years. A revival of mining in the province has, however, followed on the inauguration of smelting operations at several points in the province, the figures of output being also much enhanced through the opening up of recently discovered and extensive deposits in the Michipicoten district, Lake Superior. The large proportion of American ores which the smelters find it best to use, of course limits the consumption of the home product, a difficulty which will be doubtless overcome as other known and extensive deposits on the Canadian side become accessible.

The quantity of ore mined in British Columbia, always small, has fallen off also since 1899 and represents material used locally and also in the United States for fluxing purposes in smelters treating other metallic ores.

Iron.

Production.

TABLE 1.

IRON.

PRODUCTION OF ORE BY PROVINCES.

Calendar Year.	Nova Scotia.	Quebec.	Ontario.	British Columbia.	Total.
	Tons.	Tons.	Tons.	Tons.	Tons.
1886........	44,388	....	16,032	3,941	64,361
1887........	43,532	13,401	16,598	2,796	76,330
1888........	42,611	10,710	16,894	8,372	78,587
1889........	54,161	14,533	....	15,487	84,181
1890........	49,206	22,305	....	....	76,511
1891........	53,649	14,380	....	950	68,979
1892........	78,258	22,690	....	2,300	103,248
1893........	102,201	22,076	....	1,325	125,602
1894........	89,379	19,492	....	1,120	109,991
1895........	83,792	17,783	....	1,222	102,797
1896........	58,810	17,630	15,270	196	91,906
1897........	23,400	22,436	2,770	2,099	50,705
1898........	19,079	17,873	21,111	280	58,343
1899........	28,000	19,420	25,126	2,071	74.617
1900........	18,940	19,000	82,950	1,110	122,000

TABLE 2.

IRON.

Nova Scotia.

NOVA SCOTIA :—ANNUAL PRODUCTION OF ORE.

(Previous to 1886).

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

A small amount of the ore produced finds a market abroad, as will be evidenced by the figures given in Tables 3 and 4 below, which are for the calendar and fiscal years respectively.

IRON.

Exports.

TABLE 3.

IRON.

EXPORT OF IRON ORE.

Calendar year.	Tons.	Value.
		$
1893	2,419	7,590
1894	....	21,294
1895	1,571	3,909
1896	1,033	1,911
1897	403	811
1898	182	278
1899	4,145	9,538
1900	5,527	13,511

TABLE 4.

IRON.

EXPORTS OF IRON ORE.

Fiscal Year.	Tons.	Value.	Fiscal Year.	Tons.	Value.
		$			$
1879	3,562	7,530	1890	13,811	31,376
1880	30,524	76,474	1891	14,648	32,582
1881	44,677	114,850	1892	7,707	36,935
1882	43,835	135,463	1893	7,811	26,114
1883	44,914	138,775	1894	1,859	9,026
1884	25,308	66,549	1895	2,315	5,743
1885	54,367	132,074	1896	14	35
1886	7,542	23,039	1897	1,320	2,492
1887	23,345	71,934	1898	260	402
1888	13,544	39,945	1899	1,849	4,968
1889	24,752	60,289	1900	4,327	7,689

Comparing the figures of exports with those of production, it is found that during the period of years from 1886 to 1892, the exported ore averaged about 19 per cent of the production, whilst from 1893 to 1900, the proportion had fallen off to about 3 per cent. Until recently practically all the ore mined in Ontario or British Columbia found a market in the United States, and the rest was used locally in the province in which it was produced. Now there is a local market in Ontario, and British Columbia is the only province exporting entirely.

Table 5 below gives all the data available regarding the iron smelting industry of Canada, the features being graphically illustrated in Table C.

IRON.

Production of Pig Iron.

TABLE 5.

IRON.

PIG IRON PRODUCTION: CONSUMPTION OF ORE, FUEL, &c.

Calendar Year.	Iron Ore Consumed.		Fuel Consumed.						Flux Consumed.		Pig Iron Made.		
			Charcoal.		Coke.		Coal.						
	Tons.	Value.	Bushels.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.	Value per ton.
		$		$		$		$		$		$	$
1887	60,434	130,808	940,400	48,593	30,248	89,123	3,333	5,877	17,171	17,500	24,827	366,192	14 75
1888	54,956	102,343	804,286	41,800	28,031	82,986	2,197	4,709	16,857	16,533	21,799	313,235	14 37
1889	65,670	126,064	755,800	41,568	33,289	94,791	3,044	6,525	22,122	21,909	25,921	499,872	19 28
1890	57,304	117,880	589,860	29,493	32,832	97,659	1,241	2,638	18,478	18,361	21,772	331,688	15 23
1891	60,933	130,955	441,812	22,091	30,626	98,402	2,170	2,868	11,377	11,546	23,891	368,901	15 44
1892	96,948	250,966	1,121,365	78,291	50,882	152,311	1,740	1,797	22,967	21,687	42,443	637,421	15 02
1893	124,053	296,979	1,302,720	90,976	58,711	163,849	6,621	13,539	27,797	27,519	55,947	790,283	14 13
1894	108,871	223,861	1,173,970	53,958	52,373	142,303	7,653	14,571	35,101	34,347	49,967	646,447	12 94
1895	93,208	218,336	789,561	31,582	48,540	139,475	3,089	5,396	31,585	29,922	52,454	696,440	13 28
1896	(a) 96,560	200,887	756,600	32,256	(a) 48,660	106,939	1,407	2,288	37,462	36,140	67,268	924,129	13 74
	(b) 46,300	100,205			(b) 33,990	109,253							
1897	(a) 53,658	131,705	1,031,800	43,230	(a) 35,800	71,600	......	......	31,273	30,258	58,007	738,701	12 73
	(b) 55,722	138,504			(b) 27,810	94,553							
1898	(a) 57,881	151,760	836,400	41,820	(a) 31,952	63,904	......	......	33,913	31,153	77,015	912,395	11 85
	(b) 77,107	213,165			(b) 50,407	158,783							
1899	(a) 66,384	216,322	1,928,025	87,858	(a) 44,844	134,532	......	......	51,826	44,286	102,940	1,377,306	13 38
	(b) 120,650	402,860			(b) 64,648	193,944							
1900	(a) 71,341	184,191	1,799,737	82,408	(a) 45,021	180,084	......	......	52,966	39,332	96,575	1,501,698	15 55
	(b) 113,042	351,382			(b) 59,345	255,892							

(a) Canadian. (b) Foreign.

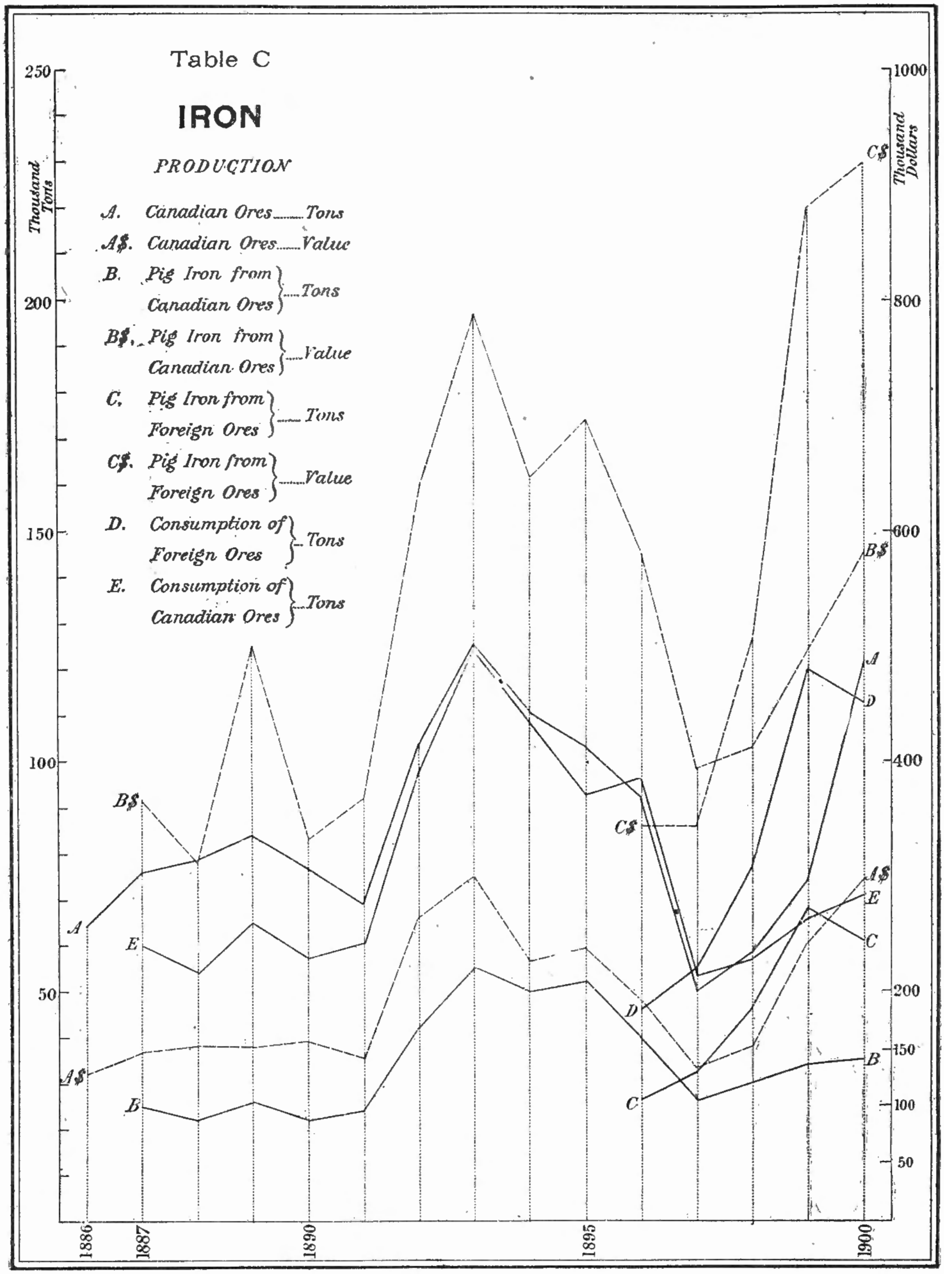


Table C
IRON
PRODUCTION
A. Canadian Ores......Tons
A$. Canadian Ores......Value
B. Pig Iron from Canadian Ores......Tons
B$. Pig Iron from Canadian Ores......Value
C. Pig Iron from Foreign Ores......Tons
C$. Pig Iron from Foreign Ores......Value
D. Consumption of Foreign Ores......Tons
E. Consumption of Canadian Ores......Tons
Thousand Tons
Thousand Dollars
250
200
150
100
50
1000
800
600
400
200
150
100
50
1886
1887
1890
1895
1900

IRON.

Production of Pig Iron

It will be noted that previous to 1895, all the pig iron made in Canada was from home ores. Since then, ore imported from the United States and from Newfoundland has been largely used, constituting about one third of that consumed in 1896, and nearly two thirds for the past two years.

Of the total product for 1900, charcoal iron constituted 18 per cent by weight and 21 per cent of the value. During the year there were six furnaces in blast, operated by six companies, the Dominion Iron and Steel smelting plant not being ready for operation. The iron smelting plants operating in Canada are as follows :—

The Dominion Iron and Steel Co., Sydney, N.S.

The Nova Scotia Steel Co., New Glasgow, N.S.

John McDougall & Co., Drumondville, Que.

The Canada Iron Furnace Co., Radnor, Que.

The Canada Iron Furnace Co., Midland, Ont.

The Deseronto Iron Co., Deseronto, Ont.

The Hamilton Steel and Iron Co., Hamilton, Ont.

Besides these, there are some older plants in Nova Scotia which are idle, and at Sault Ste. Marie and at other places in Ontario, the erection of furnaces is in contemplation. The total capacity of the furnaces in operation during 1900 would be about 500 tons per day, or over 180,000 tons per annum, as compared with an actual production of about one half that amount. This was due to the fact that some of them were run for short periods only during the year.

In the Summary of the Mineral Production of Canada for 1900, previously issued, and in the tabulated statement at the beginning of this report, the production of pig iron in Canada from Canadian ores has been given, while in Table 5 above, the total production from both Canadian and imported ores is shown. The separation into the two classes, viz., pig iron from Canadian ore and pig iron from imported ore has been made on the basis of the proportion of Canadian and imported ores entering into the production of the pig iron at the several furnaces. The production for the past five years separated in this way has been as follows :—

Calendar Year.	Pig iron from Canadian ore.	Pig iron from imported ore
	Tons.	Tons.
1896	40,720	26,548
1897	26,200	31,807
1898	30,553	46,462
1899	34,244	68,699
1900	35,387	61,188

These figures are, however, necessarily only approximate, since we are assuming the average iron contents of the various classes of ore used to be the same. IRON.

Bounties: — Bounties.

Bounties on iron and steel made in Canada were provided for by the Dominion Government in 1897 (chapter 6 of 60-61 Victoria Statutes of Canada) as follows :—

On steel ingots manufactured from ingredients of which not less than 50 per cent of the weight thereof consists of pig iron made in Canada. $3.00 per ton
On puddled iron bars manufactured from pig iron made in Canada.......................... 3.00 "
On pig iron manufactured from ore,
On the proportion produced from Canadian ore. 3.00 "
On the proportion produced from foreign ore.. 2.00 "

The Act further provided that the above mentioned bounties should cease on the 23rd April, 1902. In 1899, an Act was passed, extending the time for payment of bounties to 30th June, 1907, and changing the rates in a manner providing for a gradual extinguishment of the bounties. Under the new regulations the bounties will be as follows, the classes of product being the same as those adopted in the Act of 1897 :

Period.	On steel ingots, puddled iron bars, and pig iron from Canadian ore.	On pig iron from foreign ore.
	Per ton.	Per ton.
Up to April 23, 1902	$ 3·00	$ 2·00
From April 23, 1902 to June 30, 1903	2·70	1·80
" July 1st, 1903 to June 30, 1904	2·25	1·50
" " 1904 to June 30, 1905	1·65	1·10
" " 1905 to June 30, 1906	1·05	0·70
" " 1906 to June 30, 1907	0·60	0·40

It is also provided that no bounty shall be paid on steel ingots made from puddled iron bars manufactured in Canada.

Iron. Bounties.

The payments by the Dominion Government on account of iron and steel bounties during the fiscal year ending June 30, 1900, were as follows, the figures having been compiled from the Auditor General's Report for 1900 :

BOUNTIES ON PIG IRON.

Company.	On Pig Iron from Canadian Ore.		On Pig Iron rom Foreign Ore.		Total Bounties.
	Tons.	Bounties.	Tons.	Bounties.	
		$ cts.		$ cts.	$ cts.
Canada Iron Furnace Co...	6,052 78	18.158 34	38 29	76 58	18,234 92
Deseronto Iron Co.........	462 00	1,386 00	12,820 00	25,640 00	27,026 00
Hamilton Blast Furnace Co.	11,929 19	35,787 57	35,611 06	71,222 12	107,009 69
John McDougall & Co.....	1,828 37	5,485 07	....	....	5,485 07
Nova Scotia Steel Co......	11,886 22	35,658 67	18,751 77	37,503 55	73,162 22
Mineral Products Co......	2,459 41	7,378 24	....	....	7,378 24
	34,617 97	103,853 89	67,221 12	134,442 25	238,296 14

BOUNTY ON PUDDLED IRON BARS.

Company.	Tons.	Bounties.
		$ cts.
Ontario Rolling Mills Co......................... .. .	400 16	1,200 50
Hamilton Blast Furnace Co..........................	2,973 54	8,920 60
	3,373 70	10,121 10

IRON.

Bounties.

BOUNTY ON STEEL INGOTS.

Company.	Tons.	Bounty.
		$ cts.
Nova Scotia Steel Co..........	21,453 43	64,360 29

Table 6 following, illustrates the extent of the foreign trade of the country in regard to iron and steel products and machinery etc., made therefrom.

TABLE 6.

IRON.

Exports.

EXPORTS OF IRON AND STEEL GOODS. THE PRODUCT OF CANADA.

Calendar Year 1900.	Quantity.	Value.
		$
Stoves.................................. .... No.	594	6,015
Sewing Machines................................. "	809	17,020
Machinery, N. E. S.............................. $	....	425,581
Hardware, N. E. S............................... "	....	212,102
Steel and Manufactures of........................ "	....	389,486
Castings, N. E. S............................... "	....	173,889
Scrap Iron and Steel.............................Cwt	250,967	257,868
Pig Iron...................................Tons	3,513	88,052
Total.....................................	....	1,570,013

The Canadian consumption of iron and steel products of foreign origin is illustrated in the following Tables Nos. 7, 8, 9, 10*a*, 10*b*, 11. The first three deal with the cruder forms of the metal, the next two with manufactured articles wholly or largely composed of iron and steel, whilst the last table summarises all the preceding ones. They all cover the fiscal year ending June 30, 1900 :

IRON.

Imports.

TABLE 7.

IRON.

IMPORTS OF IRON, PIG, SCRAP, &c.

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	(a 23,159	371,956	....	....	928	14,042	....	....
1881	(a 43,630	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	13,607	157,996
1897	(d) 25,766	291,788	2,936	35,373	238	1,362	7,903	93,541
1898	(d) 37,186	382,103	2,250	23,533	1,559	13,251	(e)48,903	534,577
1899	(d) 44,261	452,911	(f) 1,955	19,123	(f) 2,378	22,594	(e)28,352	301,268
1900	(d) 49,767	811,490	(f) 1,816	38,736	(f)13,747	150,681	(e)38,753	638,505

(a) Comprises pig-iron of all kinds.

(b) From May 13 only.

(c) These figures appear in Customs reports under heading 'Iron in pigs, iron kentledge and cast scrap-iron.'

(d) Includes iron kentledge. Duty $2.50 per ton.

(e) Scrap iron and scrap steel, old, and fit only to be remanufactured, being part of, or recovered from, any vessel wrecked in waters subject to the jurisdiction of Canada. Duty free.

Iron or steel scrap, wrought, being waste or refuse, including punchings, cuttings and clippings of iron or steel plates or sheets, having been in actual use, crop ends of tin plate bars, blooms and rails, the same not having been in actual use. Duty $1 per ton.

(f) Duty $2.50 per ton.

Iron.
Imports.

Table 8.

Iron.

Imports of Ferro-manganese, &c.

Fiscal Year.	Tons.	Value.
*1887	123	$ 1,435
*1888	1,883	29,812
*1889	5,868	72,108
*1890	696	18,895
*1891	2,707	40,711
*1892	1,311	23,930
*1893	529	15,858
*1894	284	9,885
†1895	164	5,408
†1896	652	12,811
†1897	426	9,233
†1898	1,418	22,516
†1899	1,160	22,539
†1900 (Duty, 5 p.c.)	1,149	39,064

*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 9.

Iron.

Imports: Iron in Slabs, Blooms, Loops and Puddled Bars, &c.

Fiscal Year.	Cwt.	Value.	Fiscal Year.	Cwt.	Value.
1880	195,572	$244,601	1891	41,567	$38,931
1881	111,666	111,374	1892	64,397	56,186
1882	203,888	222,056	1893	65,269	58,533
1883	258,639	269,818	1894	50,891	45,018
1884	252,310	264,045	1895	78,639	67,321
1885	312,329	287,734	1896	128,535	110,757
1886	273,316	248,461	1897	56,560	48,954
1887	522,853	421,598	1898	162,891	122,426
1888	110,279	93,377	1899	124,311	103,198
1889	80,383	67,181	1900*	255,145	362,463
1890	15,041	45,923			

*Iron or steel ingots, cogged ingots, blooms, slabs, billets, puddled bars, and loops or other forms, N.O.P., less finished than iron or steel bars, but more advanced than pig-iron, except castings. Duty $2 per ton.

Examining Table No. 7, it will be noted that notwithstanding the general increase in the home production for the past four years, there has been also a steady growth in the imports of the ordinary grades of pig iron. Charcoal pig shows a decided and steady falling off since 1893, whilst the imports of cast scrap have increased considerably of

IRON.

Imports.

late. The importation of wrought scrap and scrap steel seems to have remained fairly constant. The effect of the higher prices for these products ruling during the greater part of the period covered, will be very evident on comparison of the figures for 1900 with those for 1899.

There is nothing new to note in Table 8, except that the value of the manganese and silicon pigs advanced. In Table 9, however, the figures show a very considerable enlargement of the imports of slabs, blooms, puddled bars, &c., accompanied by higher values.

The imports of the numberless kinds of manufactures of iron and steel in whole or consisting mostly of those metals, are given in the following Tables 10*a* and 10*b*, the items being selected from the reports of the Trade and Navigation Department.

TABLE 10*a*.

IRON.

IMPORTS OF IRON AND STEEL GOODS.

Fiscal Year, 1900.		Duty.	Quantity.	Value.
				$
Bar iron or steel rolled, whether in coils, bundles, rods or bars, comprising rounds, ovals, squares and flats and rolled shapes, N.O.P.	Cwt.	$7 per ton.	267,413	525,639
Castings, iron or steel, in the rough, N.E.S.	$	25 %	....	296,870
Canada plates, Russia iron, flat galvanized iron or steel sheets, terne plates and rolled sheets of iron or steel coated with zinc, spelter or other metal, of all widths or thicknesses, N.O.P.	Cwt.	5 "	418,562	963,331
Iron or steel bridges or parts thereof, iron or steel structural work, columns, shapes or sections drilled, punched, or in any further stage of manufacture than as rolled or cast, N.E.S	"	35 "	95,811	330,167
Malleable iron castings and iron or steel castings, N.E.S.	"	25 "	4,524	18,018
Mould boards, or shares or plough plates land sides and other plates for agricultural implements, cut to shape from rolled plates of steel but not moulded, punched, or otherwise manufactured	"	5 "	31,032	126,233
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 "	5,384	132,689
Carried forward		....	....	2,392,947

TABLE 10a—*Continued.*

IRON.

IMPORTS OF IRON AND STEEL GOODS.

Fiscal Year, 1900.		Duty.	Quantity.	Value.
				$
Brought forward				2,392,947
Railway fish-plates and tie plates	Tons.	$8 per ton.	8,478	226,280
Rolled iron or steel angles, tees, beams, channels, joists, girders, zees, stars or rolled shapes, or trough, bridge, building, or structural rolled sections, or shapes not punched, drilled or further manufactured than rolled, N.E.S., and flat eye bar blanks not punched or drilled	Cwt.	10	673,511	877,404
Rolled iron or steel hoop, band, scroll or strip, 8 inches or less in width, No. 18 gauge and thicker, N.E.S.	"	$7 per ton.	21,832	45,480
Rolled iron or steel hoop, band, scroll or strip, thinner than No. 18 gauge, N.E.S.	"	5 %	68,242	105,169
Rolled iron or steel angles, tees, beams, channels, girders and other rolled shapes or sections, weighing less than 35 lbs. per lineal yard, not punched, drilled or further manufactured than rolled, N.O.P.	"	$7 per ton.	110,259	183,214
Rolled iron or steel plates or sheets, sheared or unsheared, and skelp iron or steel, sheared or rolled in grooves, N.E.S.	"	$7 "	83,194	160,873
Rolled iron or steel plates, not less than 30 inches in width and not less than ¼ inch in thickness, N.O.P.	Cwt.	10	251,332	386,556
Rolled iron or steel sheets No. 17 gauge and thinner, N.O.P.	"	5 "	172,964	377,116
Rolls of chilled iron or steel	"	30 "	1,710	6,703
Skelp iron or steel, sheared or rolled in grooves, imported by manufacturers of wrought iron or steel pipe for use only in the manufacture of wrought iron or steel pipe in their own factories	"	5 "	247,469	428,871
Swedish rolled iron and Swedish rolled steel nail rods under half an inch in diameter for the manufacture of horse-shoe nails	"	15 "	18,736	43,199
Switches, frogs, crossings and intersections for railways	"	30 "	12,594	41,833
Steel—chrome steel	"	15 "	7,220	17,374
Steel plate, universal mill or rolled edge bridge plates imported by manufacturers of bridges	"	10 "	67,610	127,524
Steel in bars, bands, hoops, scroll or strips, sheets or plates, of any size, thickness or width when of greater value than 2½c. per lb., N.O.P.	"	5 "	381,183	856,509
Hoop iron not exceeding ⅜ of an inch in width and being No. 25 gauge and thinner, used for the manufacture of tubular rivets	"	Free.	22,785	52,571
Iron or steel beams, sheets, plates, angles, knees and cable chains for wooden, iron, steel, or composite ships or vessels	"	"	65,020	123,214
Locomotive and car wheel tires of steel, in the rough	"	"	28,790	81,312
Carried forward				6,534,149

IRON.

Imports.

TABLE 10a—*Concluded.*

IRON.

IMPORTS OF IRON AND STEEL GOODS.

Fiscal Year, 1900.		Duty.	Quantity.	Value.
				$
Brought forward		....	....	6,534,149
Steel for saws and straw cutters cut to shape, but not further manufactured	Cwt.	Free.	23,403	259,676
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	"	"	10,810	46,665
Steel of No. 20 gauge and thinner, but not thinner than No. 30 gauge, for the manufacture of corset steels, clock springs and shoe shanks imported by the manufacturers of such articles for the exclusive use in the manufacture thereof in their own factories	"	"	1,747	7,177
Steel valued at 2½ cents per lb. and upward, imported by the manufacturers of skates, for use exclusively in the manufacture thereof in their own factories	"	"	1,253	5,810
Steel, under ½-inch in diameter, or under ½ inch square, imported by the manufacturers of cutlery, or of knobs, or of locks, for use exclusively in the manufacture of such articles in their own factories	"	"	1,373	5,370
Steel, No. 12 gauge and thinner, but not thinner than No. 30 gauge, for the manufacture of buckle clasps, bed fasts, furniture casters and ice creepers, imported by the manufacturers of such articles, for use exclusively in the manufacture thereof in their own factories	"	"	1,149	4,609
Steel of No. 24 and 17 gauge, in sheets sixty-three inches long, and from 18 inches to 32 inches wide, imported by the manufacturers of tubular bow sockets for use in the manufacture of such articles in their own factories	"	"	1,437	4,311
Steel for the manufacture of bicycle chains, imported by the manufacturers of bicycle chain for use in the manufacture thereof in their own factories	"	"	10,008	4,459
Steel for the manufacture of files, augers, auger bits, hammers, axes, hatchets, scythes, reaping hooks, hoes, hand rakes, hay or straw knives, windmills and agricultural or harvesting forks imported by the manufacturers of such or any of such articles for use exclusively in the manufacture thereof in their own factories	"	"	75,592	149,788
Steel springs for the manufacture of surgical trusses imported by the manufacturers for use exclusively in the manufacture thereof in their own factories	"	"	491	1,561
Barbed fencing wire of iron and steel	"	"	177,579	475,667
Total		....	....	7,499,242

TABLE 10 *b*.

IRON.

IMPORTS OF IRON AND STEEL GOODS.

IRON.
Imports.

Fiscal Year, 1900.		Duty.	Quantity.	Value.
				$
Agricultural implements, N.E.S., viz:				
Binding attachments	No.	20 %	....	32,160
Cultivators	"	20 "	1,735	18,199
Drills, grain seed	"	20 "	1,426	40,195
Farm, road or field rollers	"	25 "	9	149
Forks, pronged	"	25 "	29,512	9,691
Harrows	"	20 "	3,409	63,819
Harvesters, self binding and without binders	"	20 "	8,978	804,304
Hay tedders	"	25 "	78	8,175
Hoes	"	25 "	18,328	3,217
Horse rakes	"	20 "	6,097	120,136
Knives, hay or straw	"	25 "	239	367
Lawn mowers	"	35 "	1,741	5,187
Manure spreaders	"	20 "	118	4,187
Mowing machines	"	20 "	10,305	355,645
Ploughs	"	20 "	7,569	215,988
Post hole diggers	"	25 "	133	204
Potato diggers	"	25 "	29	755
Rakes, N.E.S	"	25 "	9,695	2,118
Reapers	"	20 "	410	21,762
Scythes and snaths, sickles or reaping hooks	Doz.	25 "	3,208	16,663
Spades and shovels and spade and shovel blanks, and iron or steel cut to shape for the same	"	35 "	8,487	30,885
Weeders	No.	20 "	107	2,102
All other agricultural implements, N.E.S.	$	25 "	....	57,689
Anvils and vises	"	30 "	....	19,442
Cart or wagon skeins or boxes	Lbs.	30 "	106,788	5,687
Springs, axles, axle bars, N. E. S., and axle blanks and parts thereof of iron or steel, for railway or tramway or other vehicles	Cwt.	35 "	30,823	77,338
Butts and hinges, N.E.S.	$	30 "	....	19,361
Cast iron pipe of every description	Cwt.	$8 per ton	25,910	61,859
Chains, coil chains, chain links and chain shackles of iron or steel 5-16 of an inch in diameter and over	"	5 %	34,478	107,672
Chain, malleable sprocket or link belting, for binders	$	20 "	....	24,341
Chains, N.E.S	"	30 "	....	47,551
Tacks, shoe	Lbs.	35 "	59,954	4,970
Cut tacks, brad sprigs, or shoe nails, double pointed, and other tacks of iron and steel, N.O.P	"	35 "	165,659	14,784
Engines, locomotives for railways, N.E.S.	No.	35 "	72	446,097
Fire engines	"	35 "	6	7,830
Fire extinguishing machines	"	35 "	....	32,198
Steam engines and boilers	"	25 "	556	292,239
Fittings, iron or steel, for iron and steel pipe	Lbs.	30 "	3,653,072	234,782
Carried forward		....	....	3,209,748

IRON.

Imports.

TABLE 10b—*Continued.*

IRON.

IMPORTS OF IRON AND STEEL GOODS.

Fiscal Year, 1900.		Duty.	Quantity.	Value.
				$
Brought forward		....	....	3,209.748
Forgings of iron or steel, of whatever shape or size, or in whatever stage of manufacture, N.E.S., and steel shafting, turned, compressed or polished, and hammered iron or steel bars or shapes, N.O.P	Lbs.	30 %	1,366,781	65,074
Hardware, viz:				
Builders', cabinet-makers', upholsterers', harness-makers', saddlers' and carriage hardware, including currycombs and horse boots, N.E.S	$	30 "	....	591,683
Horse, mule and ox shoes	"	30 "	....	10,459
Locks of all kinds	"	30 "	....	128,552
Machines and machinery, &c.:				
Fanning mills	No.	25 "	206	2,197
Grain crushers	"	25 "	8	343
Windmills	"	25 "	347	16,971
Ore crushers and rock crushers, stamp mills, cornish and belted rolls, rock drills, air compressors, cranes, derricks and percussion coal cutters	$	25 "	....	35,745
Portable machines:				
Fodder or feed cutters	No.	25 "	11	139
Horse powers	"	25 "	29	2,106
Portable engines	"	25 "	185	157,553
Portable saw mills and planing mills	"	25 "	7	1,555
Threshers and separators	"	25 "	302	117,892
All other portable machines	"	25 "	603	41,971
Parts of portable machines	$	25 "	....	43,106
Sewing machines and parts of	No.	30 "	9,211	210,508
Slot machines	"	25 "	387	14,202
Machines, type-writing	"	25 "	1,890	109,867
All other machinery composed wholly or in part of iron or steel, N.O.P	$	25 "	....	3,433,688
Nails and spikes, composition and sheathing nails	Lbs.	15 "	17,453	3,398
Nails and spikes, wrought and pressed, trunk, clout, coopers, cigar box, Hungarian horseshoe and other nails, N.E.S.	"	30 "	198,062	11,023
Nails and spikes, cut, and railway spikes	"	½c. per lb.	2,039,552	52,354
Nails, wire of all kinds, N.O.P	"	⅗c. "	512,287	19,900
Pumps, N.E.S	$	25 "	....	171,210
Safes, doors for safes and vaults	"	30 "	....	14,336
Screws, iron and steel, commonly called "woodscrews," N.E.S	Lbs.	35 "	153,286	19,328
Scales, balances, weighing beams and strength testing machines	$	30 "	....	88,325
Skates of all kinds and parts thereof	Pairs	35 "	72,440	24,323
Stoves of all kinds and parts thereof, N.E.S.	$	25 "	....	129,676
Stove plates, and sad or smoothing, hatters' and tailors' irons, plated wholly or in part or not	"	25 "	....	9,608
Carried forward		....	....	8,736,840

TABLE 10b—*Continued.*

IRON.

IMPORTS OF IRON AND STEEL GOODS.

Fiscal Year, 1900.		Duty.	Quantity.	Value.
				$
Brought forward				8,736,840
Tubing:				
Boiler tubes of wrought iron or steel, including flues and corrugated tubes for marine boilers	Lbs.	5 %	6,883,499	392,876
Tubes of rolled steel, seamless, not joined or welded, not more than 1½ inches in diameter	"	10 "	269,581	23,871
Tubes, seamless steel, for bicycles	"	10 "	516,238	46,386
Tubing, wrought iron or steel, plain or galvanized, threaded and coupled or not, over two inches in diameter, N.E.S	"	15 "	5,210,128	260,564
Tubing, wrought iron or steel, plain or galvanized, threaded and coupled or not, 2 inches or less in diameter, N.E.S.	"	35 "	6,428,507	293,746
Other iron or steel tubes or pipes, N.O.P.	"	30 "	633,949	43,685
Ware, galvanized sheet iron or of galvanized sheet steel, manufactures of, N.O.P.	$	25 "	....	39,964
Ware, agate, granite or enamelled iron or steel hollow ware	"	35 "	....	25,548
Ware, enamelled iron or steel ware, N.E.S., iron or steel hollow ware, plain black, tinned or coated, and nickel and aluminium kitchen or household hollow ware, N.E.S	"	30 "	....	103,432
Wire cloth or wove wire and netting of iron or steel	Lbs.	30 "	407,142	29,121
Wire screens, doors and windows	$	30 "	....	8,287
Wire fencing, woven, buckthorn strip and wire fencing of iron or steel, N.E.S.	Lbs.	15 "	2,159,348	82,868
Wire, single or several, covered with cotton, linen, silk, rubber or other material, &c., N.E.S.	"	30 "	3,718,316	469,153
Wire of all kinds, N.O.P.	"	20 "	5,012,178	191,914
Wire rope, stranded or twisted wire, clothes lines, picture or other twisted wire and wire cables, N.E.S.	"	25 "	839,040	78,242
Iron or steel nuts, washers, rivets and bolts with or without threads and nut bolt and hinge blanks, and T. and strap hinges of all kinds, N.E.S	"	¾ c.p. lb. and 25 %	2,055,111	95,949
Pen-knives, jack-knives and pocket knives of all kinds	$	30 %	....	122,854
Table cutlery, all kinds, N.O.P.	"	30 "	....	137,661
All other cutlery, N.E.S.	"	30 "	....	158,292
Guns, rifles, including air guns and air rifles, (not being toys) muskets, cannons, pistols, revolvers, or other firearms	"	30 "	....	140,911
Bayonets, swords, fencing foils and masks	"	30 "	....	2,780
Needles of any material or kind, N.O.P.	"	30 "	....	51,752
Carried forward				11,536,996

IRON.

Imports.

TABLE 10b—*Continued.*

IRON.

IMPORTS OF IRON AND STEEL GOODS.

Fiscal Year, 1900.		Duty.	Quantity.	Value.
				$
Brought forward		....	....	11,536,996
Tools and implements :				
Adzes, cleavers, hatchets, wedges, sledges, hammers, crow bars, cant dogs and track tools, picks, mattocks and eyes or poles for the same	$	30 %	....	54,461
Axes	Doz.	25 "	7,267	39,829
Saws	$	30 "	....	95,664
Files and rasps, N.E.S.	"	30 "	....	101,945
Tools, hand or machine, of all kinds, N.O.P	"	30 "	....	533,642
Knife blades, or blanks, and forks of iron or steel, in the rough not handled, filed, ground or otherwise manufactured	"	10 "	....	2,348
Manufactured articles or wares not specially enumerated or provided for, composed wholly or in part of iron or steel, and whether partly or wholly manufactured.	"	30 "	....	1,490,534
Anchors	Cwt.	Free	3,437	11,891
Iron or steel, rolled round wire rods, in the coil not over ⅜-inch in diameter, imported by wire manufacturers for use in making wire in the coil in their factories	"	"	839,870	1,196,593
Iron or steel masts, or parts of	"	"	5	12
Rolled iron tubes not welded, or joined, 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, and brass trimmings for bedsteads imported for the manufacture of iron or brass bedsteads	"	"	24,126	84,621
Steel bowls for cream separators and cream separators	$	"	....	216,953
Steel rails weighing not less than 45 lbs. per lineal yard for use only in the tracks of railways which are employed in the common carrying of goods and passengers, and are operated by steam motive power only	Cwt.	"	2,612,344	2,793,903
Steel strip and flat steel wire imported by manufacturers of buckthorn and plain strip fencing, for use in their own factories in the manufacture thereof	"	"	2,191	6,342
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, imported by manufacturers of wire mattresses, to be used in their own factories in the manufacture of such articles	"	"	4,987	12,817
Carried forward		....	....	18,178,551

IRON.

Imports.

TABLE 10*b*—*Concluded.*

IRON.

IMPORTS OF IRON AND STEEL GOODS.

Fiscal Year, 1900.		Duty.	Quantity.	Value.
				$
Brought forward		....	....	18,178,551
Flat steel wire of No. 16 gauge or thinner imported by the manufacturers of crinoline, corset wire and dress stays, for use in the manufacture of such articles in their own factories	Cwt.	Free.	2,798	17,547
Flat spring steel, steel billets and steel axle bars, imported by manufacturers of carriage springs and carriage axles for use exclusively in the manufacture of springs and axles for carriages or vehicles other than railway or tramway, in their own factories	"	"	70,239	108,644
Spiral spring steel for spiral springs for railways, imported by the manufacturers of railway springs for use exclusively in the manufacture of railway spiral springs in their own factories	"	"	32,194	57,914
Wire, crucible cast steel	Lbs.	"	738,509	51,239
Galvanized iron or steel wire Nos. 9, 12 and 13 gauge	Cwt.	"	146,653	329,841
Total		....	....	18,743,736

Table 11 following, gives the total imports of all classes of iron and steel goods summarised from the previous tables amounting in all to a value of over twenty eight and a quarter millions of dollars, as compared with less than nineteen and a half million of dollars in 1899. Heavy increases in the values of all the several lines are shown, although as stated previously, the quantities fall off slightly in one or two instances.

TABLE 11.

IRON.

IMPORTS OF PIG IRON, IRON AND STEEL GOODS, &C., FISCAL YEAR, 1899-1900.

Recapitulation of Tables, 7, 8, 9, 10*a* and 10*b*.

——	Tons.	Value.
Pig iron and iron kentledge	49,767	$ 811,490
Pig iron, charcoal	1,816	38,736
Scrap iron, cast	13,747	150,681
Scrap steel, wrought	38,753	638,505
Ferro-manganese, &c	1,149	39,064
Iron in slabs, blooms, puddled bars, &c	12,757	362,463
Iron and steel goods partially manufactured	....	7,499,242
Iron and steel goods highly manufactured*	....	18,743,736
Total	....	$28,283,917

* Machinery, &c., classed under iron and steel goods in Customs report.

LEAD.

LEAD.

Production.

The output of lead in 1900 was greater by 188 per cent than that of 1899, and reached a total of 63,169,821 lbs., valued at $2,760,521, or 4·37 cents per pound, this being the average price of the metal in New York. With the exception of a very small quantity mined in Quebec, the production is entirely from the province of British Columbia.

Statistics of production since 1887 are given in Table 1.

TABLE 1.

LEAD.

ANNUAL PRODUCTION.

Calendar Year.	Pounds.	Price per Pound.	Value.
		c.	
1887	204,800	4·50	$ 9,216
1888	674,500	4·42	29,813
1889	165,100	3·93	6,488
1890	105,000	4·48	4,704
1891	88,665	4·35	3,857
1892	808,420	4·09	33,064
1893	2,135,023	3·73	79,636
1894	5,703,222	3·29	187,636
1895	16,461,794	3·23	531,716
1896	24,199,977	2·98	721,159
1897	39,018,219	3·58	1,396,853
1898	31,915,319	3·78	1,206,399
1899	21,862,436	4·47	977,250
1900	63,169,821	4·37	2,760,521

Although the figures of output for 1900 are large in comparison with previous years, yet the lead mining industry has been of a somewhat variable and uncertain character. From an output of a little over 1,000 tons in 1893, the production rose to nearly 20,000 tons in 1897, but fell off again during the two succeeding years, to a little over 10,000 tons in 1899, and rising in 1900 to over 31,585 tons.

At present the ore, &c., is all shipped to smelters and refineries in the United States and elsewhere to be refined. In many cases this is a serious disadvantage, if not an absolute deterrent to the miner, entailing as it does, heavy charges for freight and the treatment charges.

The Dominion government has therefore upon the representation of those interested in lead mining, and with a view to the encouragement of local industry, offered a bonus for the establishment of lead refineries as per the following regulations :— LEAD. Bounty.

1 EDWARD VII.

CHAP. 8.

An Act to provide for the payment of bounties on lead refined in Canada.

(Assented to 23rd May, 1901.)

In order to encourage the refining of lead in Canada, His Majesty, by and with the advice and consent of the Senate and House of Commons of Canada, enacts as follows :—

1. The Government in Council may authorize the payment of the undermentioned bounties on lead refined in Canada from materials produced in Canadian smelters from Canadian lead ore :— Bounties on lead refined in Canada.

(*a.*) On every ton of lead so refined during the fiscal year beginning the first day of July, 1902, five dollars ;

(*b.*) On every ton of lead so refined during the fiscal year beginning the first day of July, 1903, four dollars.

(*c.*) On every ton of lead so refined during the fiscal year beginning the first day of July, 1904, three dollars ;

(*d.*) On every ton of lead so refined during the fiscal year beginning the first day of July, 1905, two dollars ;

(*e.*) On every ton of lead so refined during the fiscal year beginning the first day of July, 1906, one dollar ;

2. The said bounties shall be payable half-yearly on the first day of January and the first day of July in each year. Payable half-yearly.

3. The total sum payable for such bounties shall not exceed one hundred thousand dollars in any year. If the sum payable at the rate per ton mentioned in section 1 of this Act on lead refined during the half of any fiscal year, exceeds fifty thousand dollars, then the bounty payable per ton shall be reduced as regards that half-year to such rate per ton as will make the amount of bounties payable in respect of such half-year not more than fifty thousand dollars. Amount payable each year.

LEAD.

Bounty.

4. If the sum paid for such bounties in any half-year is less than fifty thousand dollars, the unpaid balance (that is to say the difference between the sum so paid and fifty thousand dollars) shall be carried to the credit of the bounty fund for the next succeeding half-year and may be paid out in such succeeding half year, in addition to the fifty thousand dollars hereinbefore provided. As to unpaid balances.

5. The Governor in Council may make such rules and regulations, including regulations as to rates and charges for refining, as as are deemed expedient in the public interest for carrying out the purposes of this Act, and all payments of bounty shall be subject to the due observance of such rules and regulations. Regulations.

6. All bounties payable under this Act shall cease and determine on the thirtieth day of June, 1907. Duration of Act.

7. The expression 'ton' in this Act means two thousand pounds avoirdupois. 'Ton' defined.

The value of the exports of lead in ore, &c., is shown in Table 2, while the imports are given in Tables 3 and 4, and of litharge in Table 5. Imports of dry white and red lead, &c., are shown in Table 6. In the latter table since 1890 the imports of zinc white have been included with the lead oxides.

The total value of the imports in 1900, including lead, manufactured and unmanufactured, litharge, lead oxides and zinc white, amounted to $1,019,729.

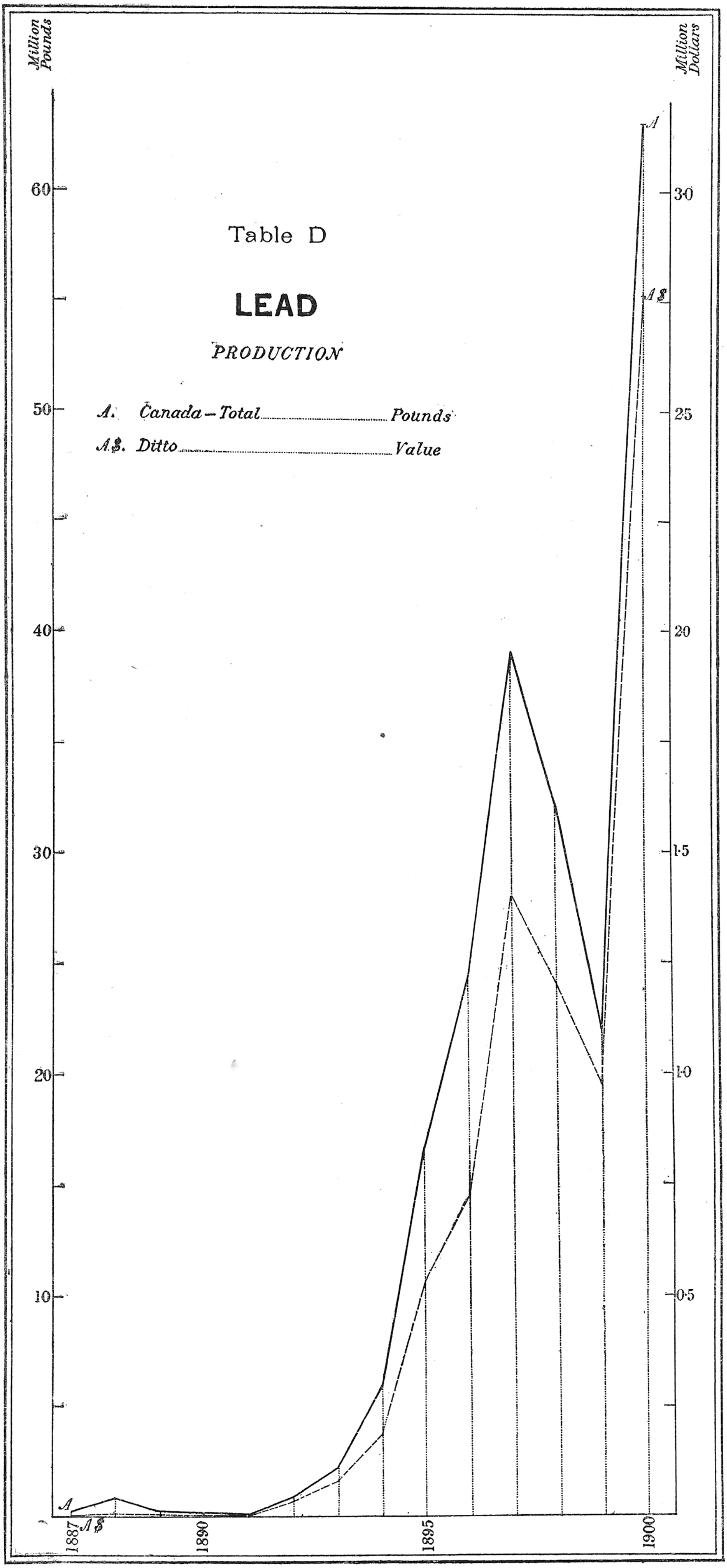
Exports.

TABLE 2.

LEAD.

EXPORTS.

Calendar Year.	Value.	Calendar Year.	Value.
1873	$ 1,993	1887	724
1874	127	1888	18
1875	7,510	1889	....
1876	66	1890	....
1877	720	1891	5,000
1878	....	1892	2,509
1879	230	1893	3,099
1880	....	1894	144,509
1881	....	1895	435,071
1882	32	1896	462,095
1883	5	1897	925,144
1884	36	1898	885,485
1885	....	1899	466,950
1886	....	1900	1,917,690


Million Pounds
Million Dollars
Table D
LEAD
PRODUCTION
A. Canada—Total Pounds
A$. Ditto Value
60
50
40
30
20
10
3·0
2·5
2·0
1·5
1·0
0·5
A
A$
1887
1890
1895
1900

Facing p. 80 s.

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
1897	65,279	158,381	10,516	29,175	75,795	187,556
	Old, Scrap, Pig and Block.*		Bars and Sheets.†		Total.	
1898	88,420	$260,779	22,214	$39,041	110,634	$299,820
1899	114,659	283,432	44,796	39,833	159,455	323,265
1900	62,361	207,819	15,493	53,506	77,854	251,325

* Duty 15 p. c.
† Duty 25 p. c.

LEAD.

Imports.

TABLE 4.

LEAD.

IMPORTS OF LEAD MANUFACTURES.

Fiscal Year.	Value.	Fiscal Year.	Value.
1880	$15,400	1890	$25,600
1881	22,629	1891	23,893
1882	17,282	1892	22,636
1883	25,556	1893	33,783
1884	31,361	1894	29,361
1885	36,340	1895	38,015
1886	33,078	1896	50,722
1887	19,140	1897	60,735
1888	18,816	1898	63,179
1889	16,315	1899	91,497

		Duty.	
1900	Lead Tea	Free.	$43,615
	" Pipe	35 p. c.	8,560
	" Shot and bullets	35 "	4,289
	" Manufactures, N.E.S	30 "	48,272
	Total		$104,736

TABLE 5.

LEAD.

IMPORTS OF LITHARGE.

Fiscal Year.	Cwt.	Value.
1880	3,041	$14,334
1881	6,126	22,129
1882	4,900	16,651
1883	1,532	6,173
1884	5,235	18,132
1885	4,990	16,156
1886	4,928	16,003
1887	6,397	21,865
1888	7,010	23,808
1889	8,089	31,082
1890	9,453	31,401
1891	7,979	27,613
1892	10,384	34,343
1893	7,685	24,401
1894	38,547	28,685
1895	11,955	32,953
1896	10,710	32,817
1897	12,028	34,538
1898	11,446	32,904
1899	9,530	32,518
1900 Duty free.	9,139	29,176

LEAD.
Imports.

TABLE 6.

LEAD.

IMPORTS OF DRY WHITE AND RED LEAD AND ORANGE MINERAL.

Fiscal Year.	Pounds.	Value.
		$
1885	5,404,753	198,913
1886	6,703,077	213,258
1887	6,998,820	233,725
1888	6,361,334	216,654
1889	7,066,465	267,236

IMPORTS OF DRY WHITE AND RED LEAD, ORANGE MINERAL AND ZINC WHITE.

Fiscal Year.	Pounds.	Value.
		$
1890	10,859,672	381,959
1891	8,560,615	337,407
1892	10,288,766	351,686
1893	10,865,183	364,680
1894	10,958,170	353,053
1895	8,780,052	282,353
1896	11,711,496	367,569
1897	10,310,463	347,539
1898	12,682,808	448,659
1899	14,507,945	514,842
1900 Duty 5 p.c.	14,679,920	634,492

BRITISH COLUMBIA.

British Columbia.

The production of lead in British Columbia since 1887 is shown in Table 7 below.

TABLE 7.

LEAD.

BRITISH COLUMBIA: 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	Nil.	....	....
1891	"	....	....
1892	808,420	4·09	33,064
1893	2,131,092	3·73	79,490
1894	5,703,222	3·29	187,636
1895	16,461,794	3.23	531,716
1896	24,199,977	2·98	721,159
1897	38,841,135	3·58	1,390,513
1898	31,693,559	3·78	1,198,017
1989	21,862,436	4·47	977,250
1900	63,158,621	4·37	2,760,031

LEAD.

British Columbia.

The various mining districts have contributed to the output for 1900 as follows ;

	Pounds.
East Kootenay :	
Fort Steele	38,494,077
Other districts	81,354
West Kootenay :	
Ainsworth	3,366,962
Nelson	1,485,899
Slocan	19,365,743
Trail Creek	1,045
Other districts	363,439
Yale	102
	63,158,621

It will thus be seen that the greater part of the output, nearly 61 per cent, was derived from the Fort Steele division, which for the first time assumes a prominent place as a mineral producer. The Slocan, which was formerly the chief lead producing district, now occupies second place, with a little over 30 per cent of the total.

In the Fort Steele division the ore shipped was 86,868 tons. The lead contents therefore averaged 22 per cent or 443 pounds per ton of ore. The ore also carried 960,411 ounces of silver, or an average of 11·05 ounces per ton. The output was derived almost entirely from the St. Eugene, North Star, and Sullivan mines, and shipments were made *via* the Crows Nest Pass branch of the Canadian Pacific Railway, to the completion of which, is practically due the ability to place such large quantities of ore on the market. The St. Eugene mine turned out more lead in 1900 than any other single producer in the province and nearly as much as the combined output of the Slocan district. The tonnage of ore treated amounted to between 65,000 and 70,000 tons, which concentrated about 4½ to 1, and produced a concentrate running from 65 to 70 per cent lead,

Shipments from the North Star mine, amounted to about 16,000 tons, and averaged from 50 to 55 per cent lead, and from 20 ounces to 25 ounces of silver per ton.

About 5,000 tons only were shipped from the Sullivan group, the ore having been taken out largely in the course of development.

In the Slocan division the quantity of ore shipped in 1900 was 25,520 tons, and the average contents nearly 38 per cent of lead and 83 ounces silver to the ton.

MANGANESE.

MANGANESE.

Production.

There was but little shipment of manganese ore in 1900, the total being placed at 30 tons, valued at $1,800.

This was derived in part from the Tenny Cape mine in Nova Scotia, operated by the Tenny Cape Manganese Mining Company, Ltd., and in part from the Jordan mine in New Brunswick, owned by Fred. W. Stockton, and leased by the Mineral Products Company of New York.

The statistics of production since 1886 are given in Table 1 which shews also the average value per ton.

TABLE 1.

MANGANESE.

ANNUAL PRODUCTION.

Calendar Year.	Tons.	Value.	Value per ton.
1886	1,789	$41,499	$23 20
1887	1,245	43,658	35 07
1888	1,801	47,944	26 62
1889	1,455	32,737	22 50
1890	1,328	32,550	24 51
1891	255	6,694	26 25
1892	115	10,250	89 13
1893	213	14,578	68 44
1894	74	4,180	56 49
1895	125	8,464	67 71
1896*	123½	3,975	32 19
1897*	15¼	1,166	76 46
1898	50	1,600	32 00
1899	1,581	20,004	12 65
1900	30	1,800	60 00

* Exports.

From the table it will be seen that from 1886 to 1890 the value of the production ranged from $30,000 to $40,000. Since 1891, however, the output has been comparatively small, while the grade of ore mined has been exceedingly variable, as evidenced by the varying values per ton.

The increased output in 1899 was due to the operations of the Mineral Products Company, which in that year commenced the manufacture of ferro-manganese at Pictou, N.S., utilizing the bog manganese ores of

MANGANESE. Dawson Settlement, Albert county, N.B. Owing to an accident to the furnace, however, smelting operations were suspended and have not since been resumed. The same company in 1900, was working the Jordan Mountain mine, King's county, N.B., and is said to have placed from 3,000 to 5,000 tons of ore on the dump.

The New Ross deposits in Lunenburg county, N.S., owned by Miner T. Foster, of Halifax, were not operated in 1900. During the past two years the Tenny Cape mine, in Hants county, has been prospected and developed to a considerable extent, and the company operating, now claim to have a large quantity of high grade ore in sight.

The exports of manganese ore are given in Table 2, and the imports of oxide of manganese in Table 3.

TABLE 2.

MANGANESE.

Exports. EXPORTS OF MANGANESE ORE.

Calendar Year.	Nova Scotia.		New Brunswick.		Total.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
1873	....	....	1,031	$20,192	1,031	$20,192
1874	6	$ 12	776	16,961	782	16,973
1875	....	200	194	5,314	203	5,514
1876	21	723	391	7,316	412	8,039
1877	106	3,699	785	12,210	891	15,909
1878	106	4,889	520	5,971	626	10,860
1879	154	7,420	1,732	20,016	1,886	27,436
1880	79	3,090	2,100	31,707	2,179	34,797
1881	200	18,022	1,504	22,532	1,704	40,554
1882	123	11,520	771	14,227	894	25,747
1883	313	8,635	1,013	16,708	1,326	25,343
1884	134	1,054	469	9,035	603	20,089
1885	77	5,054	1,607	29,595	1,684	34,649
1886	(a) 441	854	1,377	27,484	(a)1,818	58,338
1887	578	14,240	837	20,562	1,415	34,802
1888	87	5,759	1,094	16,073	1,181	21,832
1889	59	3,024	1,377	26,326	1,436	29,350
1890	177	2,583	1,729	34,248	1,906	36,831
1891	22	563	233	6,131	255	6,694
1892	84	6,180	59	2,025	143	8,205
1893	123	12,409	10	112	133	12,521
1894	11	720	45	2,400	56	3,120
1895	108	6,348	$\frac{3}{10}$	3	$108\frac{3}{10}$	6,351
1896	$123\frac{1}{2}$	3,975	....	....	$123\frac{1}{2}$	3,975
1897	$15\frac{1}{4}$	1,166	....	....	$15\frac{1}{4}$	1,166
1898	11	325	....	....	11	325
1899	67	2,328	3	82	70	2,410
1900	....	....	....	....	34	1,720

(a) 250 tons from Cornwallis should more correctly be classed under the heading of mineral pigments.

MANGANESE.

Imports.

TABLE 3.

MANGANESE.

IMPORTS: OXIDE OF MANGANESE.

Fiscal Year.	Tons.	Value.
1884	3,989	$ 258
1885	36,778	1,794
1886	44,967	1,753
1887	59,655	2,933
1888	65,014	3,022
1889	52,241	2,182
1890	67,452	3,192
1891	92,087	3,743
1892	76,097	3,530
1893	94,116	3,696
1894	101,863	4,522
1895	64,151	2,781
1896	108,590	4,075
1897	70,663	2,741
1898	130,456	5,047
1899	141,356	5,539
1900 ....Duty free	126,725	4,155

MERCURY.

MERCURY.

There has been no output of mercury reported since 1897. The small output for the years 1895, 1896 and 1897, was obtained from the cinnabar mines in the vicinity of Kamloops Lake, B.C.

TABLE 1.

MERCURY.

PRODUCTION.

Production.

Calendar Year.	Flasks, (76½ lbs.)	Price per flask.	Value.
1895	71	$ 33 00	$ 2,343
1896	58	33 44	1,940
1897	9	36 00	324

MERCURY.

Imports.

TABLE 2.

MERCURY.

IMPORTS.

Fiscal Year.	Pounds.	Value.
1882	2,443	$ 965
1883	7,410	2,991
1884	5,848	2,441
1885	14,490	4,781
1886	13,316	7,142
1887	18,409	10,618
1888	27,951	14,943
1889	22,931	11,844
1890	15,912	7,677
1891	29,775	20,223
1892	30,936	15,038
1893	50,711	22,998
1894	36,914	14,483
1895	63,732	25,703
1896	77,869	32,343
1897	76,058	33,534
1898	59,759	36,425
1899	103,017	51,695
1900........Duty free	85,342	51,987

The following notes on the cinnabar claims in the Kamloops Lake mining division, are taken from the Report of the Minister of Mines for B.C., for 1900, page 891.

'The Columbian is situated on Hardie Mountain. The tunnel has been extended for about 60 feet to represent the assessment work on the group of claims owned by the Hardie Mountain Cinnabar Mining Company. On the Idria, a shaft and several open cuts were put in this year, exposing a large body of cinnabar ore averaging ½ per cent to 1 per cent quicksilver. On the Martel and Barnato, the assesment work has been carried out this year with good results.

'*Belleview.*—A tunnel has been driven on this claim for a distance of 32 feet, exposing a large body of rock carrying cinnabar of a low grade.

'*Briar Claim,*—On this claim a tunnel over 60 feet long has been run in on a vein of dolomite, the width of which has not been ascertained. The tunnel is in ore for the whole distance, cinnabar and antimonite occurring in solid massive bands throughout the vein rock. On the dump are several tons of picked ore which probably contains 20 per cent to 30 per cent of quicksilver. A 12 feet open-cut and 4 feet tunnel were also put in further up the gulch, showing high-grade ore, which is believed to be an extension of the vein in the first mentioned tunnel. MERCURY.

'It is to be trusted that the coming season will see more interest taken in quicksilver mining. At present the world's output is not keeping pace with the demand for this metal and, with the exception of the New Almaden and Idria mines, nearly all the California cinnabar properties are closed down.

'There are without doubt, large bodies of cinnabar ore in British Columbia, of low grade it is true, but this should be no drawback when ½ per cent ore is treated at a profit in Russia, and 1 per cent ore in the case of some California properties. The cinnabar deposits seem all to be grouped along one zone running north and south from Kamloops Lake; they can be traced throughout a section about 45 miles long and having a width of 1 mile. Certainly the approaching exhaustion of the present supply of quicksilver necessitates new producers, and it is a question of some interest whether these may possibly be in British Columbia.

'The Toon Kwa is another cinnabar claim, situated 12 miles south of Kamloops Lake and 3,900 feet above sea-level. Last year's assessment work consisted mainly in surface development over the dolomite zone, which occurs here and which is similar to the country rock of all the cinnabar locations in British Columbia. The width of the zone tested by the work done so far is only about 8 feet, and carries 1½ per cent of quicksilver. The cinnabar occurs mostly in well-defined streaks, but is also to some extent finely disseminated; streaks of massive cinnabar half an inch in width have also been met with. Here, as at Copper creek it is noticeable that these rich streaks of ore are invariably found associated with stibnite.'

MICA.

MICA.

Production.

The production of mica has been calculated according to the practice followed during the past few years, viz., of adding to the known exports an estimate of the value of the home consumption.

On this basis, the production for 1900 was valued at $166,000, an increase over the production of 1899 of but $3,000.

Statistics of production and exports are given in Tables 1 and

Mica.

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
1897	76,000
1898	118,375
1899	163,000
1900	166,000

Exports.

TABLE 2.

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
1897	69,101
1898	110,507
1899	153,002
1900	146,750

The mica marketed is chiefly the product of mines in the provinces of Ontario and Quebec, in the district about Ottawa and is practically all of the phlogopite and biotite varieties.

During the early part of the year the demand for mica was strong, and prices fairly good. In the latter part of the season, however, buyers were offering much lower prices, and a number of properties were closed down. Prices at Ottawa, averaged for the year about as follows: MICA.

Sizes	1 inch	x 3 inches,	price	8 cts.	to 12 cts.	per pound.
"	2 "	x 3	"	22	" 30	"
"	2 "	x 4	"	35	" 45	"
"	3 "	x 5	"	60	" 75	"
"	4 "	x 6	"	$1.00	to $1.50	"
"	5 "	x 8	"	and over, $1.50 and upward.		

Efforts have been made by the Geological Survey to assist in introducing Canadian mica upon the British market, and the following notes on the subject are taken from the Summary Report of the Director for the year 1900.

"The market has been so far chiefly in the United States or in Canada, where higher prices have been realized than could be obtained in competition with Indian mica in Great Britain. As the Indian mica has throughout been equally available to customers in the United States, there appeared to be reason to assume that the preference for the Canadian 'amber mica' really indicated a superiority in quality for electrical purposes, dependent on the high degree of insulation afforded by the mica, with its flexibility and softness, the latter quality enabling sheets of requisite thickness to wear down equally with the adjacent copper.

"Advantage was therefore taken of the kind offer of Professor Wyndham R. Duncan, F.R.S., Director of the Scientific and Technical Department of the Imperial Institute, London, to submit some specimens of Canadian 'amber mica' to the special examination of experts. From Professor Duncan's report on these tests, lately received, the following extracts may be given. They appear fully to bear out the opinion formed as to the exceptionally high value of this mica for electrical purposes.

"'The four samples consisted of very fine specimens of Canadian 'knife-trimmed' amber mica, labelled as follows:—

1. Wallingford Mine.
2. Lake Girard Mine.
3. Vavasour Mine.
4. Blackburn Mine.

"'They are stated to represent a fair average commercial quality and size.

MICA

"'General physical and chemical examination showed that the samples were uniform in character, pliable and softer than much of the mica which appears in the English market. In order to ascertain its commercial value, and especially its fitness for electrical purposes, the samples were submitted to one of the largest electrical manufacturers in London, and also to one of the largest mica brokers in the city.

"'The electrical manufacturers report that the mica is suitable for a variety of electrical purposes, but they refrain from quoting a price for it, and recommend that this could be done better through mica merchants. The mica merchants have taken considerable pains in examining the samples and have made a very full report. They state that the approximate values in the London market are as follows :—

[The values range from 1s. to 5s. 6d. per pound for the actual samples sent, but as the values depended more on the size of the plates actually sent (which were far from uniform) than on the intrinsic peculiarities of the specimens, it might be misleading to publish these figures in conjunction with the names of the several mines.]

"'It is evident, however, that greater importance is attached to the size of the plates in the London market than in that of the United States. The brokers add that the Wallingford sample being of especially fine quality would be eagerly sought after in the British market. The product of the Vavasour mine would also command a large sale here. The Blackburn sample to which a large price is attached, chiefly on account of the size of the plates, shows rather serious cracks and is not quite flat, otherwise it would have been of even greater value. It is also pointed out that the Lake Girard mica ought to command greater success in the British market than has been hitherto the case. Its indifferent success is attributed by the brokers chiefly to an attempt to direct business through a London office, instead of proceeding through the usual channels.

"'On the general question of the uses and comparative value of the Canadian amber mica, the brokers remark that this variety of mica is of no other value than for electrical purposes, its special value being principally due to its softness and easy lamination. They are of opinion that Canadian amber mica is of greater value for electrical work than most of the Indian mica that comes to this country. They remark, however, that there are two or three varieties of Indian mica, such as White Bengal, Cochin, from the west coast of Madras and Ceylon amber mica, which compare very favourably with the Canadian product, whilst the selling prices of these Indian varieties are often from one-third to one-half those asked for the Canadian mica. They confirm the opinions expressed in Dr. Dawson's letters of February 16 and April 4 of this year, that Canadian miners obtain a better price in the United States than in the London market, chiefly from the circumstance that American electricians prefer the Canadian product which is close at hand and can be depended upon for uniformity of quality and regularity of supply. MICA.

"'Although circumstances point to the United States as being the natural outlet of Canadian mica, nevertheless it would be worth while to take steps to make it better known in the British market since there are several factors operating against the Indian product, especially in the matters of tariff and regularity of supply.

"'If the proprietors of the mines represented by the samples now under consideration are of opinion that the values quoted are sufficiently encouraging to make it worth while to send trial shipments to this country, I shall be glad to put them in communication with the brokers who have expressed their willingness to give them any assistance in their power.'"

MINERAL PIGMENTS.

MINERAL PIGMENTS.

Under this heading is included the production of ochres and baryta. Production.

Ochres.—The production of ochres in 1900 amount to 1,966 tons, valued at $15,398, a decrease from the output of the previous year of 1,953 tons in quantity and $4,602 in value. The product mined is derived almost entirely from the ochre deposits near Three Rivers, Champlain county, Quebec. The firms engaged in the production were the Canada Paint Co., of Montreal, the Champlain Oxide Co., of Three Rivers, and Thos. H. Argall, of Three Rivers.

The output is of comparatively small amount. The highest for any one year having been less than 4,000 tons. The imports of ochres, &c. for the past ten years have ranged from 700 to 1,200 tons per annum.

Statistics of production, imports and exports, are given in Tables 1, 2 and 3.

MINERAL PIGMENTS.

Production of ochres.

TABLE 1.

MINERAL PIGMENTS.

ANNUAL PRODUCTION OF OCHRES.

Calendar Year.	Tons.	Value.
1886	350	$ 2,350
1887	485	3,733
1888	397	7,900
1889	794	15,280
1890	275	5,125
1891	900	17,750
1892	390	5,800
1893	1,070	17,710
1894	611	8,690
1895	1,339	14,600
1896	2,362	16,045
1897	3,905	23,560
1898	2,226	17,450
1899	3,919	20,000
1900	1,966	15,398

Imports.

TABLE 2.

MINERAL PIGMENTS.

IMPORTS OF OCHRES.

Fiscal Year.	Duty.	Pounds.	Value.
1880		571,454	$ 6,544
1881		677,115	8,972
1882		731,526	8,202
1883		898,376	10,375
1884		533,416	6,398
1885		1,119,177	12,782
1886		1,100,243	12,267
1887		1,460,128	17,067
1888		1,725,460	17,664
1889		1,342,783	12,994
1890		1,394,811	14,066
1891		1,528,696	20,550
1892		1,708,645	22,908
1893		1,968,645	23,134
1894		1,358,326	18,951
1895		793,258	12,048
1896		1,159,494	16,954
1897		1,504,044	18,504
1898		2,126,592	26,307
1899		2,444,698	31,092
1900 Ochres and ochrey earths and raw siennas	20 p. c.	1,065,982	$ 10,050
1900 Oxides, dry fillers, fire-proofs, umbers and burnt siennas, N.E.S.	25 "	1,408,555	21,967
Total, 1900	....	2,474,537	$32,017

MINERAL PIGMENTS.

Exports.

TABLE 3.

MINERAL PIGMENTS.

EXPORTS OF MINERAL PIGMENTS IRON OXIDES, &C,

Calendar Year.	Tons.	Value.
1897..	512	$7,706
1898...................	283	4,227
1899..................	308	5,408
1900..................	651	7,154

Baryta.—The mining of baryta in Canada has been very irregular, as a glance at the following table will show.

Production of Baryta.

TABLE 4.

MINERAL PIGMENTS.

ANNUAL PRODUCTION OF BARYTA.

Calendar Year.	Tons.	Value.
1885.....	300	$ 1,500
1886.....................	3,864	19,270
1887.....................	400	2,400
1888...	1,100	3,850
1889.....................	....	....
1890.....................	1,842	7,543
1891.....................	....	....
1892..	315	1,260
1893.....	....	....
1894.....	1,081	2,830
1895.....................	....	....
1896.....................	145	715
1897...............	571	3,060
1898.....................	1,125	5,533
1899.....................	720	4,402
1900.....................	1,337	7,605

Of the production in the earlier years mentioned in the table the greater proportion was obtained from an extensive vein on McKellars island, Lake Superior. This, however, has not recently been worked. During the past four or five years shipments have been made from Lake Ainslie, Inverness county, and from Brookfield, Colchester county, Nova Scotia, by Messrs Henderson and Potts, of Halifax, while the Canada Paint Co. takes out several hundred tons annually from its mine near Cantley, Hull township, Quebec.

Statistics of imports are given in Tables 5 and 6.

MINERAL PIGMENTS.

Imports of Baryta.

TABLE 5.

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 6.

MINERAL PIGMENTS.

Miscellaneous imports.

MISCELLANEOUS IMPORTS, FISCAL YEAR, 1900.

—	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.	40,254	5,199
Paints and colours, and rough stuff and fillers, anti-corrosive and anti-fouling paints, commonly used for ship hulls, N.E.S. "	25 "	96,316	3,893
Paris green, dry.... "	10 "	304,133	41,096
Paints and colours ground in spirits, and all spirit varnishes and lacquers......... Galls.	$1.12½ par gallon..	501	1,384
Putty..... Lbs.	20 p. c.	406,663	5,862
Total	....	....	57,434

MINERAL WATER.

MINERAL WATER.

Production.

Mineral springs are known to occur at many places throughout Canada, and at a number of them the water is being utilized, either put up in bottles for sale throughout the country or used for drinking or bathing purposes at the places where it is found. At several points, hotels have been erected at which the guests have the privilege of using the mineral water at the place. In view of this, it is difficult to obtain statistics giving any intelligent idea of the extent or value of the industry.

Statistics of production and imports are given in Tables 1 and 2.

TABLE 1.
MINERAL WATERS.
ANNUAL PRODUCTION.

Calendar Year.	Gallons.	Value.	Calender Year.	Gallons.	Value.
1888............	124,850	$ 11,456	1895............	739,382	$ 126,048
1889............	424,600	37,360	1896............	706,372	111,736
1890.	561,165	66,031	1897............	749,691	141,477
1891............	427,485	54,268	1898........ .. .	555,000	100,000
1892............	640,380	75,348	1899...	....	100,000
1893............	725,096	108,347	1900.	....	75,000
1894............	767,460	110,040			

Imports.

TABLE 2.
MINERAL WATERS.
IMPORTS.

Fiscal Year.	Value.	Fiscal Year.	Value.
1880....................	$15,721	1890	40,802
1881........	17,913	1891....................	41,797
1882....................	27,909	1892.....	55,763
1883.	28,130	1893	57,953
1884....................	27,879	1894................	49,546
1885............	32,674	1895....................	48,613
1886....................	22,142	1896	55,864
1887....................	33,314	1897	47,006
1888.	38,046	1898....................	52,989
1889....................	30,343	1899	54,891
1900 { Mineral waters, natural, not in bottle .... Duty free..			$ 1,126
1900 { Mineral and ærated waters........... .... " 20 p.c			65,205
Total.........			$66,331

Natural Gas.

NATURAL GAS.

Production.

The total value of natural gas sold in Canada in 1900 was $417,094. This output is practically all derived from wells in southern Ontario, in what are known as the Essex and Welland fields.

At Medicine Hat, N.W.T., there are two small wells from which the gas is used for the burning of lime. The pressure is reported to be about 115 lbs. per square inch.

In the Essex field, Ontario, the United Gas and Oil Co., of Ontario, Ltd., has been formed, absorbing the two corporations formerly known as the Natural Gas and Oil Co., of Ontario, Ltd., and the Standard Oil and Gas Co., of Essex, Ltd. The production in this field for the year 1900 was about three billion (3,000,000,000) cubic feet.

The Provincial Natural Gas and Fuel Co., of Ontario, Ltd., controls the greater part of the Welland fields and sells its output chiefly in Buffalo.

During the year a well was bored in the vicinity of Hepworth to a depth of about 1,400 feet, and gas was said to have been struck showing a pressure of 425 pounds to the square inch.

Table 1.

Natural Gas.

Annual Production.

Calendar Year.	Value.
1892	$ 150,000
1893	376,233
1894	313,754
1895	423,032
1896	276,301
1897	325,873
1898	322,123
1899	387,271
1900	417,094

NICKEL.

NICKEL.

Production.

The production of nickel in Canada from the nickel-copper ores of Sudbury, Ont., amounted in 1900 to 7,080,227 lbs., or 3,540 tons, which at the average price for the year of refined nickel in New York, 47 cents per lb., was worth $3,327,707. Compared with 1899, this is an increase of 1,336,227 lbs., or 23 per cent in quantity, and $1,259,867 or nearly 61 per cent in value.

In 1899 the average price per lb. was 36 cents, advancing to an average of 47 cents in 1900, or an increase of 11 cents per lb., or 30 per cent. For the first five months of 1900, the price ranged from 40 to 45 cents, advancing in June to from 50 to 60 cents, and continuing at that for the balance of the year.

The production given above represents the nickel contained in matte &c., exported to the United States, there being no refining as yet carried on in Canada. The methods of treatment of the ore in this district, have been described in past reports, see reports of this Section for 1890 and 1891.

The amount of ore treated in 1900 amounted to 211,960 tons, from which there was produced 23,336 tons of matte, with nickel contents as stated above. The percentage of nickel in the matte would thus be about 15 per cent, the copper contents being in 1900 between 14 and 15 per cent. The average nickel contents of the ore treated during the year was 1·67 per cent.

The statistics of nickel production since 1889 are given in Table 1, and the values of the exports and imports in Tables 2 and 3 below.

NICKEL.

Production.

TABLE 1.

NICKEL.

ANNUAL PRODUCTION.

Calendar Year.	Pounds of Nickel in Matte.	Final Average Market price per lb. at New York.	Value.
1889	*830,477	60c.	$ 498,286
1890	1,435,742	65c.	933,232
1891	4,626,627	60c.	2,775,976
1892	2,413,717	58c.	1,399,956
1893	3,982,982	52c.	2,071,151
1894	4,907,430	38⅛c.	1,870,958
1895	3,888,525	35c.	1,360,984
1896	3,397,113	35c.	1,188,990
1897	3,997,647	35c.	1,399,176
1898	5,517,690	33c.	1,820,838
1899	5,744,000	36c.	2,067,840
1900	7,080,227	47c.	3,327,707

* Calculated from shipments made by rail.

Exports

TABLE 2.

NICKEL.

EXPORTS.*

Calendar Year.	Value.
1890	$ 89,568
1891	667,280
1892	293,149
1893	629,692
1894	559,356
1895	521,783
1896	658,213
1897	723,130
1898	1,019,363
1899	939,915
1900	1,031,030

*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 happened 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, &c.

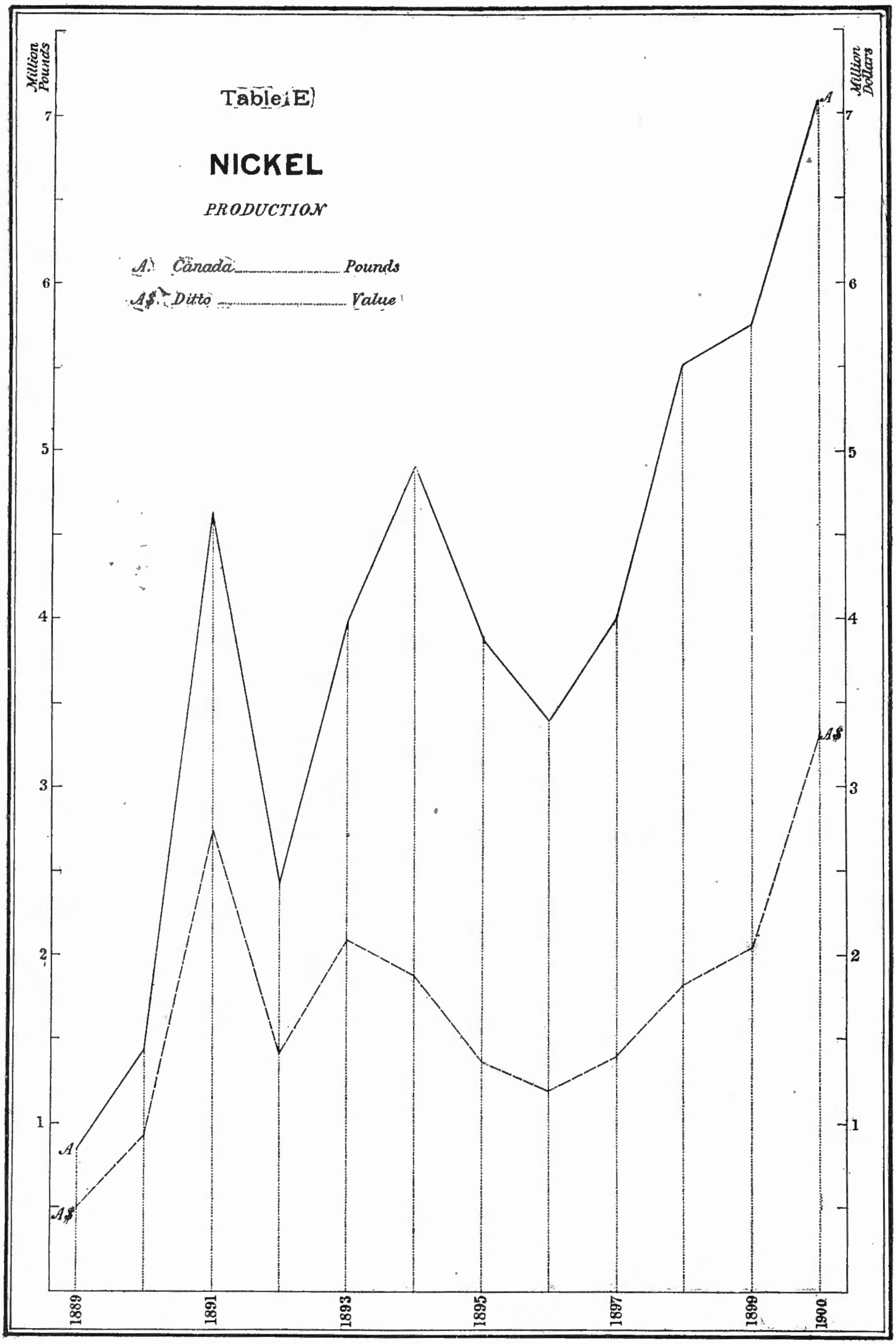


Table (E)
NICKEL
PRODUCTION
A Canada .... Pounds
A$ Ditto .... Value
Million Pounds
Million Dollars
1
2
3
4
5
6
7
1889
1891
1893
1895
1897
1899
1900

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		4,787
1897		4,737
1898		5,882
1899		9,449
	Duty.	
1900 { Nickel anodes	10 p. c.	6,944
1900 { Nickel*	Free.	44
		$ 6,988

*Classified under the general heading of minerals in the Trade and Navigation Report.

The companies operating in Sudbury district are :—

The Canadian Copper Company.
The Mond Nickel Company.
The Lake Superior Power Company.
The Nickel Copper Company of Ontario.

Of these the first two operate smelting plants producing nickel-copper, matte, and the last mentioned is erecting similar works (1901). The operations of the Lake Superior Power Company, have so far been limited to development work on their properties.

PETROLEUM.

PETROLEUM.

Production.

The production of crude petroleum as deduced from the inspection returns of the Inland Revenue Department was given in the Summary of the Mineral Production of Canada. The total quantity of Canadian refined oils inspected was 13,428,422 gallons. Assuming the ratio of crude to refined to be 100 to 54, this is equivalent to 24,867,449 gallons of crude oil, or 710,498 barrels of 35 galls. The average price paid for the oil for the year was $1.62 per barrel, being an increase over the average paid during the previous year of 13½ cents. The total value of the year's production at this rate was $1,151,007. There is also some crude oil used by manufacturers and others, that does not appear in this calculation, which includes only the oil used for refining, but the amount is probably comparatively small. Prices for crude oil which in 1899 had advanced from $1.40 to nearly $1.70 per barrel, continued to increase during the early months of 1900, and reached $1.75 per barrel in March and April. In June, however, the market lost its strength, and prices fell away to about $1.50, ranging between $1.50 and $1.60 for the balance of the year.

The production of Canadian oil refineries for 1899 and 1900 according to returns published by the Ontario Bureau of Mines was as follows :

TABLE 1.

PETROLEUM.

PRODUCTION OF CANADIAN OIL REFINERIES.

Product.	1899.		1900.	
	Quantity.	Value.	Quantity.	Value.
		$		$
Illuminating oil.........galls.	11,697,910	1,059,485	11,783,755	1,076,242
Benzine and Naphtha.... "	1,394,530	148,963	1,463,599	174,346
Lubricating oil.......... "	2,087,475	189,294	1,980,428	232,805
Gas and fuel oils and tar "	5,410,915	213,544	3,669,102	200,934
Paraffine wax and candles lbs.	2,792,766	136,066	4,599,683	184,718
		1,747,352		1,869,045

PETROLEUM.

In Table 2 there is shown the statistics since 1881 of refined oil inspected together with the crude equivalent calculated in gallons and also in barrels of 35 imperial gallons, as well as the average price per barrel of crude, &c. In Table 3 the amounts both of Canadian and of imported oils are exhibited side by side, and the percentage of each shown. It will be seen that there has been a gradual increase in the proportion of imported oils used advancing to nearly 40 per cent in 1899, though falling off slightly in 1900.

TABLE 2.

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......	11,027,982	29,018,637	100:38	829,104	1 00¾	835,322
1895......	10,674,232	25,414,838	100:42	726,138	1 49⅔	1,086,738
1896......	10,684,284	25,438,771	100:42	726,822	1 59	1,155,647
1897......	10,434,878	24,844,995	100:42	709,857	1 42½	1,011,546
1898......	11,148,348	26,543,685	100:42	758,391	1 40	1,061,747
1899......	11,927,981	28,399,955	100:42	808,570	1 48⅔	1,202,020
1900......	13,428,422	24,867,449	100:54	710,498	1 62	1,151,007

PETROLEUM.

Inspection of oils.

TABLE 3.
PETROLEUM.
TOTAL AMOUNT OF OIL INSPECTED, CANADIAN AND IMPORTED.

Fiscal Year.	Canadian.	Imported.	Total.	Canadian.	Imported,
	Galls.	Galls.	Galls.	%	%
1881..........	6,406,783	476,784	6,883,567	93.1	6·9
1882..........	5,910,747	1,351,412	7,262,159	81.4	18·6
1883..........	6,970,550	1,190,828	8,161,378	85.4	14·6
1884.........	7,656,001	1,142,575	8,798,586	87.0	13·0
1885..........	7,661,617	1,278,115	8,939,732	85.7	14·3
1886........ .	8,149,472	1,327,616	9,477,088	86.0	14·0
1887..........	8,243,962	1,665,604	9,909,566	83.2	16·8
1888..........	9,545,895	1,821,342	11,367,237	84.0	16·0
1889..........	9,462,834	1,767,812	11,230,646	84.3	15·7
1890.....	10,121,210	2,020,742	12,141,952	83.4	16·6
1891..........	10,270,107	2,022,002	12,292,109	83.6	16·4
1892..........	10,238,426	2,429,445	12,667,871	80.8	19·2
1893	10,683,806	2,641,690	13,325,496	80.2	19·8
1894..........	10,824,270	5,633,222	16,457,492	65.8	34·2
1895..........	10,936,992	5,650,994	16,587,986	65.9	34·1
1896..........	10,533,951	5,807,991	16,341,942	64.5	35·5
1897..........	10,506,526	6,248,743	16,755,269	62.7	37·3
1898...	10,796,847	6,880,734	17,677,581	61.1	38·9
1899..........	11,005,804	7,232,348	18,238,152	60.3	39·7
1900..........	13,014,713	*8,216,207	21,230,920	61.3	38·7

* Item *(a)* Table 5.

Tables 4, 5, 6, 7 and 8 show the exports and imports of petroleum and its products as obtained from the Trade and Navigation Reports.

Exports.

TABLE 4.
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
1897	....	....	342	49	342	49
1898	96	4	12,735	3,001	12,831	3,005
1899	....	....	3,425	859	3,425	859
1900	40.	2	8,559	2,394	8,599	2,396

PETROLEUM.

Imports.

TABLE 5.

PETROLEUM.

IMPORTS OF PETROLEUM AND PRODUCTS OF.

Fiscal Year.	Gallons.	Value.	Fiscal Year.	Gallons.	Value.
		$			$
1880	687,641	131,359	1890	5,075,650	515,852
1881	1,437,475	262,168	1891	5,071,386	498,330
1882	3,007,702	398,031	1892	5,649,145	475,732
1883	3,086,316	358,546	1893	6,002,141	446,389
1884	3,160,282	380,082	1894	6,597,108	439,988
1885	3,767,441	415,195	1895	7,577,674	525,372
1886	3,819,146	421,836	1896	8,005,891	735,913
1887	4,290,003	467,003	1897	8,415,302	697,169
1888	4,523,056	408,025	1898	9,074,311	724,519
1889	4,650,274	484,462	1899	10,394,208	763,303

		Duty.	Gallons.	$
1900	Oils: Mineral—			
	(a) Coal and kerosene, distilled, purified or refined, naphtha and petroleum, N.E.S.	5c. p. gall.	8,216,207	704,758
	(b) Products of petroleum	5c. "	61,443	7,588
	(c) Crude petroleum, fuel and gas oil (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	2½c. "	334,704	23,244
	(d) Illuminating oils composed wholly or in part of the products of pretroleum, coal, shale or lignite, costing more than 30 cents per gallon	25 p. c.	10,740	3,976
	(e) Lubricating oils composed wholly or in part of petroleum, costing less than 25 cents per gallon	5c. p. gall.	1,010,553	125,267
	Total		9,633,647	864,833

TABLE 6.*

PETROLEUM.

IMPORTS OF CRUDE AND MANUFACTURED OILS, OTHER THAN ILLUMINATING.

Fiscal Year.	Gallons.	Fiscal Year.	Gallons,
1881	960,691	1891	3,049,384
1882	1,656,290	1892	3,047,199
1883	1,895,488	1893	1,481,749
1884	2,017,707	1894	1,860,829
1885	2,489,326	1895	1,106,907
1886	2,491,530	1896	1,079,940
1887	2,624,399	1897	800,411
1888	2,701,714	1898	1,046,493
1889	2,882,462	1899	727,014
1890	3,054,908	1900	1,071,996

* This table is composed of items (*b*) and (*e*) of Table 5.

Petroleum.
Imports.

TABLE 7.

PETROLEUM.

IMPORTS OF PARAFFINE WAX.

Fiscal Year.	Pounds.	Value.
1883	43,716	$ 5,166
1884	39,010	6,079
1885	59,967	8,123
1886	62,035	7,953
1887	61,132	6,796
1888	53,862	4,930
1889	63,229	5,250
1890	239,229	15,844
1891	753,854	50,275
1892	733,873	48,776
1893	452,916	38,935
1894	208,099	15,704
1895	163,817	11,579
1896	150,287	10,042
1897	138,703	7,945
1898	103,570	5,987
1899	92,242	4,025
1900 (Duty, 30 p. c.)	47,400	3,529

TABLE 8.

PETROLEUM.

IMPORTS OF PARAFFINE WAX CANDLES.

Fiscal Year.	Pounds.	Value.
1880	10,445	$2,269
1881	7,494	1,683
1882	5,818	1,428
1883	7,149	1,734
1884	8,755	2,229
1885	9,247	2,449
1886	12,242	2,587
1887	21,364	3,611
1888	22,054	2,829
1889	8,038	1,337
1890	7,233	1,186
1891	10,598	2,116
1892	9,259	1,952
1893	8,351	1,735
1894	10,818	1,685
1895	19,448	2,541
1896	25,787	4,072
1897	25,114	2,929
1898	60,802	4,427
1899	62,331	5,856
1900 (Duty, 30 p. c.)	27,663	3,671

PETROLEUM.
Prices.

The average monthly prices for crude oil at Petrolia from 1894 to 1900 are given in Table 9 following:

TABLE 9.

PETROLEUM.

AVERAGE MONTHLY PRICES FOR CRUDE OIL AT PETROLIA.

Months.	Calendar Years.						
	1894.	1895.	1896.	1897.	1898.	1899.	1900.
	$	$	$	$	$	$	$
January	1.01¼	1.16	1.72	1.50	1.40	1.40	1.71
February..........	1.01	1.19⅞	1.72	1.50	1.40	1.40	1.74
March.........	1.01	1.27	1.72	1.50	1.40	1.40	1.75
April	.99½	1.55¾	1.72	1.40	1.40	1.43	1.75
May..............	.92	1.67¼	1.70	1.40	1.40	1.45	1.65
June..............	.92¾	1.52	1.50	1.40	1.40	1.45	1.53
July..............	.94	1.54¼	1.50	1.40	1.40	1.45	1.56
August.	.96	1.54	1.50	1.40	1.40	1.46½	1.57
September.........	.98	1.55½	1.50	1.40	1.40	1.52½	1.57
October...........	1.06	1.59⅞	1.50	1.40	1.40	1.57	1.55
November.........	1.12¼	1.64½	1.50	1.40	1.40	1.63½	1.51
December	1.13½	1.72⅜	1.50	1.40	1.40	1.66½	1.55
The Year.......	1.00¾	1.49⅔	1.59	1.42½	1.40	1.48⅔	1.62

PHOSPHATE.

PHOSPHATE (*Apatite*).

Production.

The production of phosphate in 1900 amounted to 1,415 tons, valued at $7,105, and was obtained chiefly as a by-product in the mining of mica in the vicinity of Buckingham and Templeton, province of Quebec.

Apatite running 80 per cent phosphate of lime was sold at about $7 per ton at the mine, while 50 per cent to 60 per cent mineral brought only $3.

PHOSPHATE.
Production.

TABLE 1.

PHOSPHATE.

ANNUAL PRODUCTION.

Calendar Year.	Tons.	Average Value per ton.	Value.
1886	20,495	$14 85	$304,338
1887	23,690	13 50	319,815
1888	22,485	10 77	242,285
1889	30,988	10 21	316,662
1890	31,753	11 37	361,045
1891	23,588	10 24	241,603
1892	11,932	13 20	157,424
1893	8,198	8 65	70,942
1894	6,861	6 00	41,166
1895	1,822	5 25	9,565
1896	570	6 00	3,420
1897	908	4 39	3,984
1898	733	5 00	3,665
1899	3,000	6 00	18,000
1900	1,415	5 02	7,105

Exports.

TABLE 2.

PHOSPHATE.

EXPORTS.

Calendar Year.	Ontario.		Quebec.		Totals.	
	Tons.	*Value.	Tons.	*Value.	Tons.	*Value.
1878	824	$12,278	9,919	$195,831	10,743	$208,109
1879	1,842	20,565	6,604	101,470	8,446	122,035
1880	1,387	14,422	11,673	175,664	13,060	190,086
1881	2,471	36,117	9,497	182,339	11,968	218,456
1882	568	6,338	16,585	302,019	17,153	308,357
1883	50	500	19,666	427,168	19,716	427,668
1884	763	8,890	20,946	415,350	21,709	424,240
1885	434	5,962	28,535	490,331	28,969	496,293
1886	644	5,816	19,796	337,191	20,460	343,007
1887	705	8,277	22,447	424,940	23,152	433,217
1888	2,643	30,247	16,133	268,362	18,776	298,609
1889	3,547	38,833	26,440	355,935	29,987	394,768
1890	1,866	21,329	26,591	478,040	28,457	499,369
1891	1,551	16,646	15,720	368,015	17,271	384,661
1892	1,501	12,544	9,981	141,221	11,482	153,765
1893	1,990	11,550	5,748	56,402	7,738	67,952
1894	1,980	10,560	3,470	29,610	5,450	40,170
1895	.....	.....	250	2,500	250	2,500
1896	1	5	299	2,990	300	2,995
1897	70	450	165	400	235	850
1898	21	240	702	8,000	723	8,240
1899	215	1,850	93	1,725	308	3,575
1900	.....	.....	.....	.....	Nil	Nil

* These values do not compare with those in Table 1 above, the spot value being adopted for the production whilst the exports are valued upon quite a different basis.

Precious Metals.

PRECIOUS METALS.

The precious metals, gold and silver are considered together, following the custom of past years.

Gold.

Gold.

From an output of less than a million dollars in 1893, the production of gold in Canada has increased to a total of $27,908,153 in 1900. The increase over 1899 amounted to $6,646,569 or 31 per cent, while the increase of 1899 over 1898 was 54 per cent, that of 1898 over 1897 128 per cent, and that of 1897 over 1896 118 per cent.

Of the production in 1900, $23,558,724 or 84 per cent of the whole was derived from placer diggings and $4,349,429 or 16 per cent from vein or lode mining as compared with 82 per cent from placer working and 18 per cent from lode mining in 1899. Of the placer output 22,275,000 is to be credited to the Yukon district. The balance with the exception of a small output from the Saskatchewan river, was derived from British Columbia. No production was recorded from Quebec placers during 1900.

The various provinces contributed to the total in 1900 in about the following proportions: Yukon district about 80 per cent, British Columbia nearly 17 per cent, Nova Scotia 2 per cent and Ontario 1 per cent. In 1899 the proportions were: Yukon district 75 per cent, British Columbia nearly 20 per cent, Nova Scotia about 3 per cent and Ontario about 2 per cent.

Table 1.

Precious Metals.

Production.

Gold—Annual Production in Canada.

Calendar Year.	*Ounces. Fine.	Value.	Calendar Year.	*Ounces. Fine.	Value.
1887	57,465	$ 1,187,804	1894	54,605	$ 1,128,688
1888	53,150	1,098,610	1895	100,806	2,083,674
1889	62,658	1,295,159	1896	133,274	2,754,774
1890	55,625	1,149,776	1897	291,582	6,027,016
1891	45,022	930,614	1898	666,445	13,775,420
1892	43,909	907,601	1899	1,028,620	21,261,584
1893	47,247	976,603	1900	1,350,176	27,908,153

* Calculated from the values at the rate of $20.67 per ounce.

PRECIOUS METALS.
Gold.
Production.

TABLE 2.

PRECIOUS METALS.

GOLD :—PRODUCTION BY PROVINCES AND DISTRICTS, CALENDAR YEAR 1900.

Provinces.	*Ounces. Fine.	Value.
Nova Scotia	(*b*) 28,958	$ 598,553
Ontario	(*b*) 14,392	297,495
North west Territories—		
Yukon District	(*a*)1,077,649	22,275,000
Saskatchewan River	(*a*) 242	5,000
British Columbia	(*c*) 228,935	4,732,105
Total	1,350,176	$27,908,153

*Calculated from the value at the rate of $20.67 per ounce.
(*a*) Placer gold.
(*b*) Gold from vein mining.
(*c*) As follows: Gold from placer mining..........$ 1,278,724
" vein " 3,453,381
$ 4,732,105

NOVA SCOTIA.

Nova Scotia.

The statistics of gold production in Nova Scotia are given in Tables 3,4,5 and 6. Table 3 shows the annual gold output; Table 4 the tons of quartz crushed and the average yield per ton: in Table 5 the total product of each district from 1862 to the end of 1900 is exhibited as well as the average yield per ton; and Table 6 shows the amount of ore crushed and the yield per district for 1900.

The production in 1900 amounted to $598,553 a slight decrease from that of 1899 though greater than any other previous year. The average yield per ton of quartz crushed, however, showed an increase in 1900, being $6.85 as compared with $5.50 in 1899. The details of production in some 18 different districts are shown in Table 6, the most interesting feature of which is the high average return of over $193 per ton from 588 tons of ore in the Renfrew district. This is probably more particularly due according to Mr. Faribault to the mining of some extremely rich quartz from the Jubilee vein recently found to the east of the fault on the Colonial property. A crushing of 110 tons is reported to have given 2,700 ounces of gold valued at some $53,000.*

*Summary Report of the Geol. Survey Dept. 1900, p. 167.

PRECIOUS METALS.

Gold.

Nova Scotia.

TABLE 3.

PRECIOUS METALS.

GOLD :—NOVA SCOTIA—ANNUAL PRODUCTION.

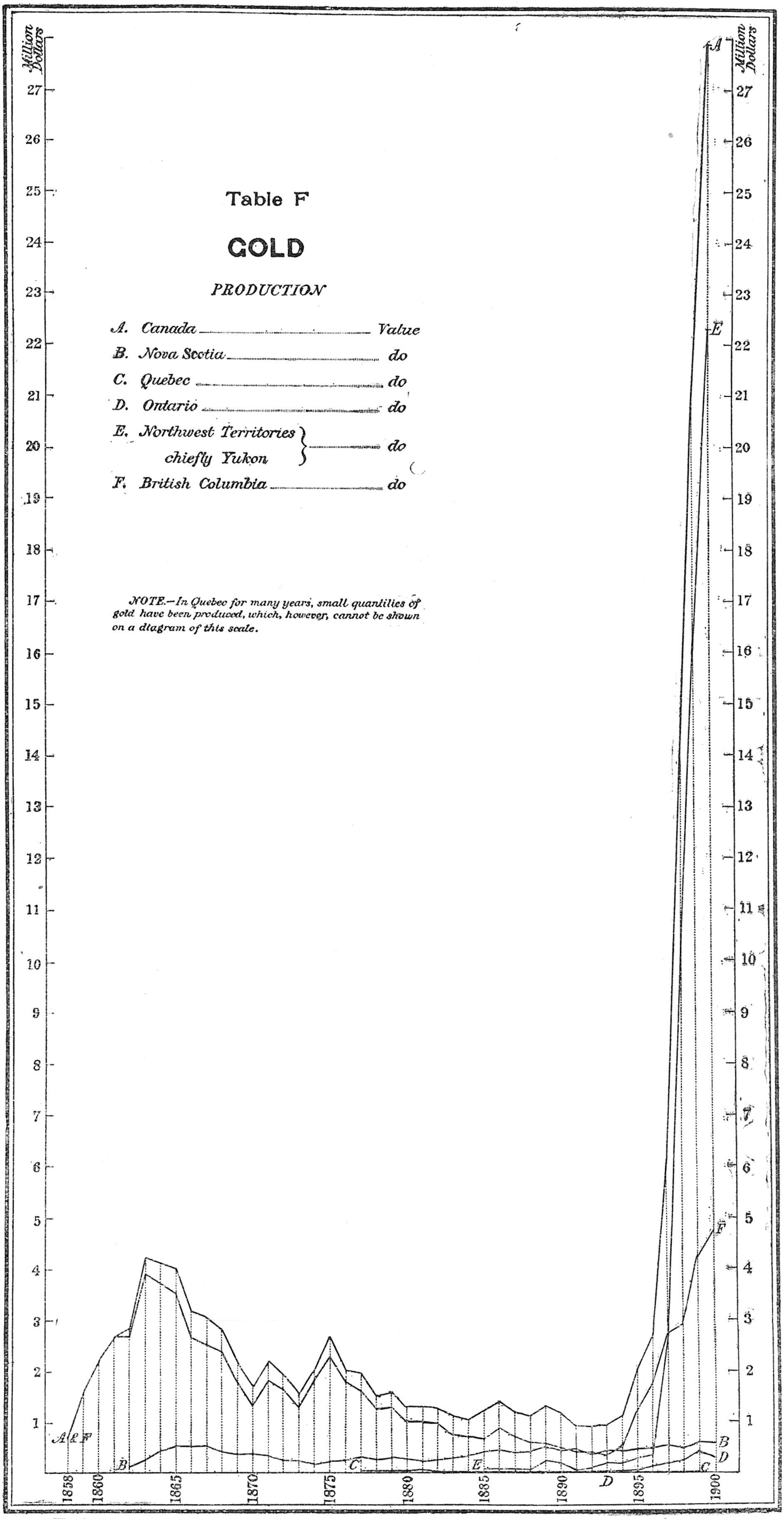
Calendar Year.	Value.	Calendar Year.	Value.
1862	$141,871	1882	$275,090
1863	272,448	1883	301,207
1864	390,349	1884	313,554
1865	496,357	1885	432,971
1866	491,491	1886	455,564
1867	532,563	1887	413,631
1868	400,555	1888	436,939
1869	348,427	1889	510,029
1870	387,392	1890	474,990
1871	374,972	1891	451,503
1872	255,349	1892	389,965
1873	231,122	1893	381,095
1874	178,244	1894	389,338
1875	218,629	1895	453,119
1876	233,585	1896	493,568
1877	329,205	1897	562,165
1878	245,253	1898	538,590
1879	268,328	1899	617,604
1880	257,823	1900	598,553
1881	209,755		

TABLE 4.

PRECIOUS METALS.

GOLD :—NOVA SCOTIA, ORE TREATED AND YIELD OF GOLD PER TON.

Calendar Year.	Tons Treated.	Yield of Gold per Ton.	Calendar Year.	Tons Treated.	Yield of Gold per Ton.
1862	6,473	$21·91	1882	21,081	$13·04
1863	17,000	16·02	1883	25,954	11·60
1864	21,431	18·21	1884	25,186	12·44
1865	24,421	20·32	1885	28,890	14·98
1866	32,157	15·28	1886	29,010	15·70
1867	31,384	16·96	1887	32,280	12·81
1868	32,259	12·41	1888	36,178	12·08
1869	35,144	19·91	1889	39,160	13·02
1870	30,824	12·56	1890	42,749	11·11
1871	30,787	12·17	1891	36,351	12·42
1872	17,089	14·94	1892	32,552	11 98
1873	17,708	13·05	1893	42,354	8·99
1874	13,844	12·87	1894	55,357	7·04
1875	14,810	14·76	1895	60,600	7·47
1876	15,490	15·08	1896	69,169	7·13
1877	17,369	18·95	1897	73,192	7·68
1878	17,989	13·63	1898	82,774	6·50
1879	15,936	16·83	1899	112,226	5·50
1880	13,997	18·42	1900	87,390	6·85
1881	16,556	12·66			



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PRECIOUS METALS.
Gold.
Nova Scotia.

TABLE 5.

PRECIOUS METALS.

GOLD:—NOVA SCOTIA.—PRODUCTION OF THE DIFFERENT DISTRICTS FROM 1862 TO 1900, INCLUSIVE.

Districts.	Tons of Ore Crushed.	Total Yield.				Average Yield per Ton of 2,000 lbs.
		Ozs.	Dwt.	Grs.	Value at $19.50 per oz.	
					$	$ c.
Brookfield	52,959	25,221	9	22	491,819	9.28
Caribou	129,999	43,931	11	20	856,666	6.59
Central Rawdon	13,340	10,121	11	21	197,371	14.80
Fifteen-mile Stream	40,280	18,132	13	5	353,587	8.78
Killag	1,291	1,967	8	12	38,365	29.72
Lake Catcha	15,163	12,947	5	22	252,472	16.65
Malaga	24,268	16,940	13	21	330,344	13.61
Montague	25,498	39,655	15	15	773,287	30.32
Oldham	48,897	52,929	11	..	1,032,127	21.11
Renfrew	49,295	40,174	7	12	783,400	15.89
Salmon-River	103,602	33,898	6	21	661,018	6.38
Sherbrooke	246,740	145,491	9	10	2,837,084	11.50
Stormont	215,745	73,158	6	21	1,426,588	6.61
Tangier	37,721	22,297	..	2	434,791	11.52
Uniacke	56,456	39,048	15	8	761,451	13.49
Waverly	126,467	63,067	19	3	1,229,825	9.72
Wine Harbour	51,380	34,152	16	18	665,981	12.96
Whiteburn	7,378	10,218	18	20	199,269	27.01
Other Districts	76,090	53,221	1	3	1,037,810	13.64
	1,322,569	736,577	3	16	14,363,255	10.86

PRECIOUS METALS.

Gold.

Nova Scotia.

TABLE 6.

PRECIOUS METALS.

GOLD:—NOVA SCOTIA, DISTRICT DETAILS—CALENDAR YEAR, 1900.

Districts.	Mines.	Mills.	Tons of Ore Crushed.	Total Yield of Gold.			Average Yield of Gold per Ton.		
				Oz.	Dwt.	Grs.	Oz.	Dwt.	Grs.
Brookfield	2	2	9,004	3,097	16	13	..	6	21
Caribou	4	4	8,308	2,187	9	9	..	5	6
Gay's River	1	1	2,646	180	4	9	..	1	8
Harrigan Cove	1	1	2,092	1,853	5	12	..	17	17
Lake Catcha	3	2	833	563	5	17	..	13	12
Leipsigate	3	1	463	144	5	..	..	6	5
Malaga-Barrens	1	1	139	149	14	..	1	1	12
Mills Village	1	1	305	222	..	..	..	14	13
Montague	2	1	530	365	14	10	..	13	19
Oldham	3	1	1,092	996	18	4	..	18	6
Renfrew	2	2	588	5,648	10	10	9	12	3
Salmon River	2	1	4,325	595	4	..	..	2	18
Sherbrooke	4	2	16,659	4,465	..	9	..	5	8
Stormont	5	4	30,742	6,126	19	10	..	3	23
Tangier	1	1	540	276	18	..	..	10	6
Uniacke	1	1	72	207	19	..	2	17	18
Waverly	2	1	3,635	1,306	4	6	..	7	4
Wine Harbour	2	2	4,022	1,803	7	..	..	8	23
Other Districts	7	4	1,395	504	4	19	..	7	5
	47	33	87,390	30,695	..	8	..	7	.

Quebec

QUEBEC.

No returns of gold production were received from the province of Quebec for 1900. Statistics for past years are given in Table 7

TABLE 7.

PRECIOUS METALS.

GOLD—QUEBEC—ANNUAL PRODUCTION.

Calendar Year.	Value.	Calendar Year.	Value.
1877	$12,057	1889	$1,207
1878	17,937	1890	1,350
1879	23,972	1891	1,800
1880	33,174	1892	12,987
1881	56,661	1893	15,696
1882	17,093	1894	29,196
1883	17,787	1895	1,281
1884	8,720	1896	3,000
1885	2,120	1897	900
1886	3,981	1898	6,089
1887	1,604	1899	4,916
1888	3,740	1900	Nil

ONTARIO.

Precious Metals. Gold. Ontario.

There was a falling off in the output of this province from $421,591 in 1899 to $297,495 in 1900. Of this amount over $80,000 was derived from the Deloro, Belmont and Gatling Five Acres mines in Hastings and Peterborough counties, the balance coming from the free-milling ores of north western Ontario, where the more important producing mines in 1900 were the Mikado, Sultana, Golden Star, Olive and Sakoose.

TABLE 8.

PRECIOUS METALS.

GOLD—ONTARIO— ANNUAL PRODUCTION.

Calendar Year.	*Ounces. (fine).	Value.
		$
1887	327	6,760
1888	....	....
1889	....	....
1890	....	....
1891	97	2,000
1892	344	7,118
1893	708	14,637
1894	1,917	39,624
1895	3,015	62,320
1896	5,563	115,000
1897	9,158	189,294
1898	12,864	265,889
1899	20.395	421,591
1900	14,392	297,495

* Calculated from the value at $20·67 per ounce.

NORTH-WEST TERRITORIES.

North-west Territories.

The gold-fields of the North-west Territories, to which attention has so far been chiefly directed are confined to the alluvial workings of the Saskatchewan river, and those of the Yukon river and its tributaries. The difficulty of obtaining anything like accurate statistics of the output from such deposits as these, where thousands of men are independently

PRECIOUS METALS.

Gold.

North-west Territories.

engaged in mining the precious metal, will be easily recognized. Much of the Saskatchewan river gold, finds its way to the local banks, and a basis for an estimation of the product is thus found, while the greater part of the Yukon gold is ultimately sold at the different receiving offices of the United States mint. The receipts of these offices, taken in conjunction with careful estimates by government officers, bank managers, and transportation companies at Dawson, furnish a means of estimating the Yukon output, probably as accurately as it is possible to obtain it.

Statistics of production in the two districts since 1887 are shown in Table 9.

TABLE 9.

PRECIOUS METALS.

GOLD—NORTH-WEST TERRITORIES—PRODUCTION.

Calendar Year.	Yukon District.		Saskatchewan River.	
	*Ounces (fine).	Value.	*Ounces. (fine).	Value.
		$		$
1885 } 1886 }	4,838	100,000	....	....
1887........	3,387	70,000	102	2,100
1888........	1,935	40,000	58	1,200
1889........	8,466	175,000	968	20,000
1890........	8,466	175,000	194	4,000
1891........	1,935	40,000	266	5,500
1892........	4,233	87,500	508	10,506
1893........	8,515	176,000	466	9,640
1894........	6,047	125,000	725	15,000
1895........	12,095	250,000	2,419	50,000
1896........	14,514	300,000	2,661	55,000
1897........	120,948	2,500,000	2,419	50,000
1898........	483,793	10,000,000	1,209	25,000
1899........	774,069	16,000,000	726	15,000
1900........	1,077,649	22,275,000	242	5,000
Total........	2,530,890	52,313,500	12,963	267,946

*Calculated from the value at $20.67 per ounce.

The production of gold in the Yukon in 1900 has been estimated at $22,275,000, being an increase over the output of 1899 of $6,275,000 or 39 per cent. The district has produced in the past four years over $50,000,000. Practically all of the Yukon output finds its way to the United States mints. According to Mr. Frank A. Leach, Superintendant of the mint of the United States at San Francisco, the following shows in standard ounces the actual receipts in gold and silver from the Canadian Yukon deposited in the United States.

PRECIOUS METALS.
Gold.
North-west Territories.
Production.

	Gold.	Silver.	
At Seattle	897,030·430	221,288·08	ounces
At San Francisco	293,287·619	68,174·25	"
At other mints etc.	7,290·000	1,458·00	"
Total	1,197,608·049	290,920·33	

Standard ounces are valued at $18.60 per ounce, and the above quantity of gold at this rate has a total value of $22,275,509. Although a number of other and higher estimates of the output of the Yukon have been given, the above figures are believed to be as close as it is possible to arrive at the truth. In one of the estimates above alluded to, the total of $25,000,000 is arrived at by including $3,000,000 for "dust not reported and dust used in the Territory as a medium of exchange," Now though much gold is carried out in private hands every season, it would practically all eventually arrive at some United States mint. As to the dust used in the district as a medium of exchange this has during the past two or three years naturally been a decreasing quantity, and at present has been mostly replaced by bank bills, currency etc., so that to suppose some of this year's output as absorbed in the district for such purposes is merely to duplicate the allowances on this account already made in the estimates of the earlier years.

A statement compiled in the Timber and Mines branch, and published in the Report of the Department of the Interior for 1900 showing the total gold production, the total exemption, the total amount upon which the 10 per cent royalty was collected and the amount of royalty paid, as shown by returns from May 1st 1898 to June 30th 1900 is given below. Comparison with Table 9 will show that quite a large proportion of the Yukon output escaped the royalty dues.

PRECIOUS METALS.

Gold.

North-west Territories

MONTH.	Total Gold Production.	Total Exemption.	Royalty 10 p.c. Collected on.	Royalty 10 p. c. Paid.
1898.	$ cts.	$ cts.	$ cts.	$ cts.
May	45,277 00	10,850 00	34,427 00	3,442 70
June	3,027,496 20	342,550 00	2,698,501 20	269,850 12
Two months	3,072,773 20	353,400 00	2,732,928 20	273,292 82
July	928,818 00	135,000 00	793,818 00	79,381 80
August	395,045 50	140,000 00	255,045 50	25,504 55
September	251,547 70	64,540 00	187,007 70	18,700 75
October	13,669 65	2,496 00	11,173 65	1,117 37
November	4,851 56	2,912 00	1,939 56	193 95
December	8,719 55	624 00	8,095 55	809 55
Six months	1,602,651 96	345,572 00	1,257,079 96	125,707 97
1899.				
January	6,552 76	4,784 C0	1,768 76	176 94
February	4,868 29	624 00	4,244 29	424 41
March	15,431 40	3,952 00	11,479 40	1,147 93
April	43,889 57	15,400 00	28,489 57	2,848 92
May	844,606 18	180,703 00	663,903 18	66,390 28
June	5,064,282 86	1,148,622 02	3,915,660 84	391,565 92
Six months	5 979,631 06	1,354,085 02	4,625,546 04	462,554 40
July	664,205 72	208,380 82	455,824 90	45,582 49
August	1,521,708 96	311,740 16	1,209,968 80	120,996 88
September	924,907 09	187,413 99	737,493 10	73,749 31
October	371,947 82	63,863 02	308,084 80	30,808 48
November	176,599 48	29,088 48	147,511 00	14,751 10
December	84,531 76	31.976 26	52,555 50	5,255 55
Six months	3,743,900 83	832,462 73	2,911,438 10	291,143 81
1900.				
January	....	....	....	....
February	42,179 62	19,333 22	22,846 40	2,284 64
March	96,968 23	42,500 33	54,467 90	5,446 79
April	59,839 70	21,667 80	38,171 90	3,817 19
May	796,866 25	313,642 65	483,223 60	48,322 36
June	5,069,710 01	1,272,137 91	3,797,572 10	379,757 21
Six months	6,065,563 81	1,669,281 91	4,396,281 90	439,628 19

British Columbia.

BRITISH COLUMBIA.

The production of gold in this province in 1900 amounted to $4,732,105 as compared with $4,202,473 in 1899 an increase of $529,632 or 12 per cent. This increase is entirely due to the production of lode mines, there being in fact a slight decrease in the output of placer gold. The Atlin lake district, which in 1899, was credited with a production of $800,000, produced only $450,000 in 1900. Statistics of production since 1858 are shown in Table 10, while the production for 1900, by districts is shown in Table 11.

PRECIOUS METALS.

Gold.

British Columbia.

TABLE 10.

PRECIOUS METALS.

GOLD—BRITISH COLUMBIA—ANNUAL PRODUCTION.

Calendar Year.	Value.
	$
1858	705,000
1859	1,615,072
1860	2,228,543
1861	2,666,118
1862	2,656,903
1863	3,913,563
1864	3,735,850
1865	3,491,205
1866	2,662,106
1867	2,480,868
1868	2,372,972
1869	1,774,978
1870	1,336,956
1871	1,799,440
1872	1,610,972
1873	1,305,749
1874	1,844,618
1875	2,474,904
1876	1,786,648
1877	1,608,182
1878	1,275,204
1879	1,290,058
1880	1,013,827
1881	1,046,737
1882	954,085
1883	794,252
1884	736,165
1885	713,738
1886	903,651
1887	693,709
1888	616,731
1889	588,923
1890	494,436
1891	429,811
1892	399,525
1893	379,535
1894	530,530
1895	1,266,954
1896	1,788,206
1897	2,724,657
1898	2,939,852
1899	4,202,473
1900	4,732,105

PRECIOUS METALS.

Gold.

British Columbia.

TABLE 11.

PRECIOUS METALS.

GOLD—BRITISH COLUMBIA—PRODUCTION BY DISTRICTS—1900.

DISTRICTS.	GOLD, PLACER.		GOLD, LODE.	
	Ounces.	Value.	Ounces.	Value.
		$		$
Cariboo:				
Cariboo Division	8,100	162,000	....	....
Quesnel "	25,500	510,000	....	....
Omineca "	626	12,527	....	....
Cassiar:				
Atlin Lake Division	22,500	450,000	120	2,479
All other	750	15,000	....	....
East Kootenay:				
Fort Steele Division	500	10,000	....	....
Other Divisions	15	300	....	....
West Kootenay:				
Ainsworth Division	....	....	28	578
Nelson "	30	600	31,612	653,106
Slocan "	....	....	5	103
Trail Creek "	....	....	111,625	2,306,172
All other "	250	5,000	208	4,297
Lillooet	1,845	36,905	2,497	51,588
Yale:				
Osoyoos Division	....	....	18,133	374,628
Similkameen "	240	4,800	....	....
Yale "	2,877	57,542	....	....
Coast and other Districts	703	14,050	2,925	60,430
Total	63,936	1,278,724	167,153	3,453,381

Placer Mining.—The falling off in the output of the Atlin Lake placers was in part compensated for by the largely increased production in the Quesnel division, due chiefly to the successful work accomplished by the Consolidated Cariboo Hydraulic Mining Company, Limited. The product of this company's operations for the season of 1900 amounted to about $350,000, and would have been much higher had it not been that nearly a month's time was lost through delay in getting in explosives over almost impassible roads. In the other districts where placer mining was carried on, much the same success was obtained as during the past two or three years.

On the west coast of Vancouver Island a number of hydraulic leases have been taken out for beach deposits of black sand carrying gold.

PRECIOUS METALS.

Gold.

British Columbia.

Lode Mining.—Over 66 per cent of the gold output from lode mines was obtained from the Rossland Camp. The mines contributing most largely to the output here, were LeRoi, 159,734 tons of ore; Centre Star 40,875 tons; War Eagle 9,886 tons; LeRoi No. 2, 3,013 tons; Iron Mask 2,739 tons; while each of the following had an output of less than a thousand tons each; Evening Star, Giant, I.X.L., Spitzee. In 1899 this camp contributed over 74 per cent of the gold output from lode mines.

The division next in importance is Nelson, though only contributing a little less than 19 per cent. The output of this division in 1900 was nearly double what it was during the previous year and over half the product was derived from the Ymir mines. A little more than 10 per cent of the lode output was obtained from the Osoyoos division (Kettle River and Grand Forks).

The following tables compiled from the Report of the Minister of Mines for British Columbia show the production of the Rossland mines and illustrate the average results attained during the past seven years.

NET PRODUCTION, PER SMELTER RETURNS.

Year.	Ore, tons, 2,000 lbs.	Gold, oz.	Silver, oz.	Copper, lbs.	Value.
1894	1,856	3,723	5,357	106,229	$ 75,510
1895	19,693	31,497	46,702	840,420	702,459
1896	38,075	55,275	89,285	1,580,635	1,243,360
1897	68,804	97,024	110,068	1,819,586	2,097,280
1898	111,282	87,343	170,804	5,232,011	2,470,811
1899	172,665	102,976	185,818	5,693,889	3,229,086
1900	217,636	111,625	167,378	2,071,865	2,739,300
Total	630,011	489,463	775,412	17,344,635	12,557,806

AVERAGE NET SMELTER RETURNS, OR ACTUAL YIELD PER TON.

Year.	Gold.	Silver.	Copper.	Value.
	Ounces.	Ounces.	%	$ cts.
1894	2·00	2·89	2·85	40 69
1895	1·60	2·41	2·10	35 67
1896	1·45	2·34	2·08	32 65
1897	1 42	1·60	1·32	30 48
1898	·78	1·54	2·35	22 10
1899	·596	1·07	1·65	18 70
1900	·513	769	·476	12 58
Average 630,011 tons	·777	1·231	1·376	19 93

PRECIOUS METALS.

Silver.

SILVER.

Production.

The production of silver in Canada in 1900 amounted to 4,468,225 ounces, valued at $2,740,362 or 61·33 cents per ounce, the average market value for the metal for the year in New York. Compared with the previous year this production shows an increase of 1,056,581 ounces or about 31 per cent in quantity and $707,704 or nearly 35 per cent in value. The output in 1900 is, however, still less than that attained in 1897, when a total of 5,558,446 ounces valued at $3,323,395 was produced.

Statistics of production of silver since 1887 are shown in Table 12 below.

TABLE 12.

PRECIOUS METALS.

SILVER :—ANNUAL PRODUCTION.

CALENDAR YEAR.	ONTARIO.		QUEBEC.		BRITISH COLUMBIA.		TOTAL.	
	Ounces.	Value.	Ounces.	Value.	Ounces.	Value.	Ounces.	Value.
1887..	190,495	$186,304	146,898	$143,666	17,690	$17,301	355,083	$347,271
1888..	208,064	195,580	149,388	140,425	79,780	74,993	437,232	410,998
1889..	181,609	169,986	148,517	139,012	53,192	49,787	383,318	358,785
1890..	158,715	166,016	171,545	179,436	70,427	73,666	400,687	419,118
1891..	225,633	222,926	185,584	183,357	3,306	3,266	414,523	409,549
1892..	41,581	36,425	191,910	168,113	77,160	67,592	310,651	272,130
1893..	....	8,689	....	126,439	....	195,000	....	330,128
1894..	....	....	101,318	63,830	746,379	470,219	847,697	534,049
1895 .	....	....	81,753	53,369	1,496,522	976,930	1,578,275	1,030,299
1896..	....	....	70,000	46,942	3,135,343	2,102,561	3,205,343	2,149,503
1897..	5,000	2,990	80,475	48,116	5,472,971	3,272,289	5,558,446	3,323,395
1898..	85,000	49,521	74,932	43,655	4,292,401	2,500,753	4,452,333	2,593,929

PROVINCE.	1899.		1900.	
	Ounces.	Value.	Ounces	Value.
Quebec	40,231	$23,970	58,400	$35,817
Ontario	202,000	120,352	161,650	99,140
Yukon district	230,000	137,034	290,000	177,857
British Columbia	2,939,413	1,751,302	3,958,175	2,427,548
	3,411,644	2,032,658	4,468,225	2,740,362

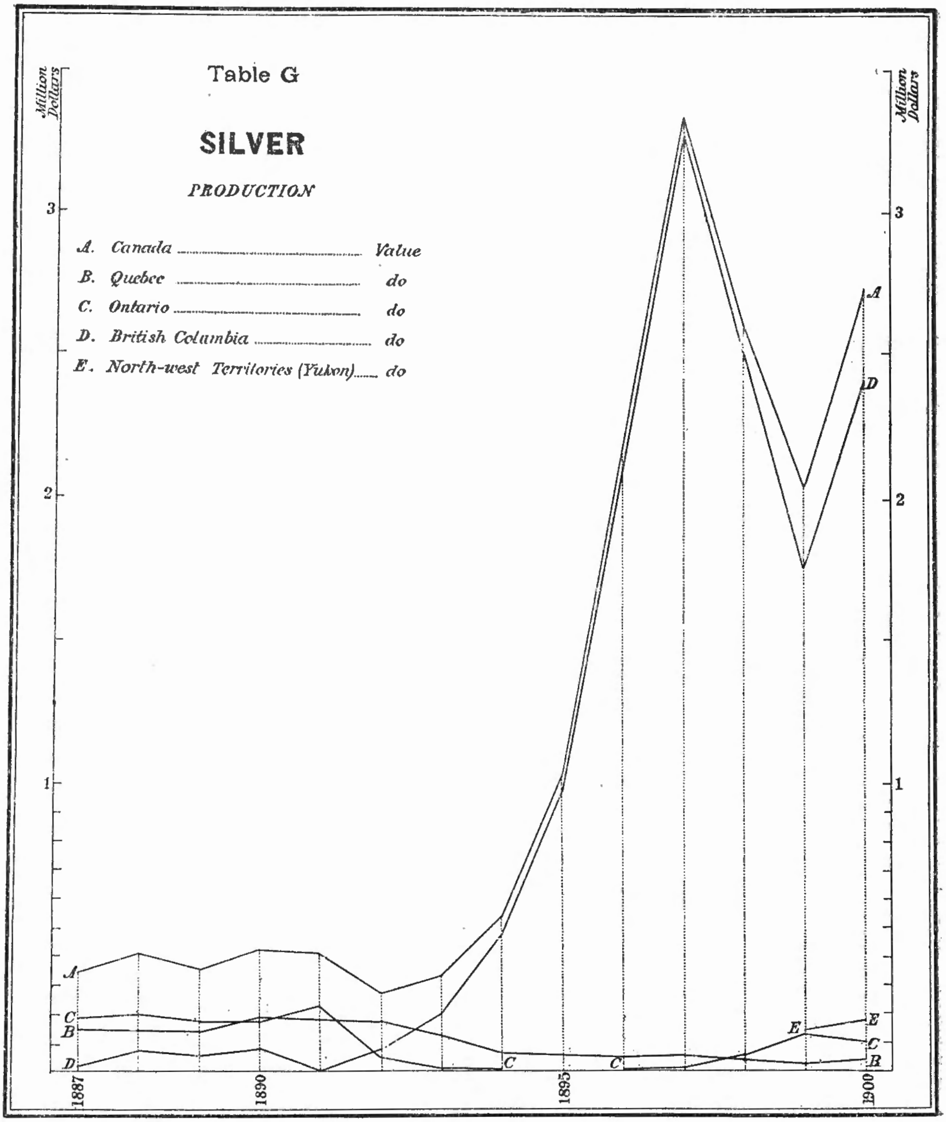
Table G
SILVER
PRODUCTION
A. Canada .... Value
B. Quebec .... do
C. Ontario .... do
D. British Columbia .... do
E. North-west Territories (Yukon)........ do
Million Dollars
3
2
1
1887
1890
1895
1900
A
B
C
D
E

PRECIOUS METALS.

Silver.

Production.

Between 1887 and 1894 the output of silver in Canada was comparatively small, the yearly production never exceeding half a million dollars. Since the latter year, however, the opening up of the various silver-lead and other silver-bearing ores in British Columbia has brought the yearly output to its present proportions.

In Quebec the production is small, and much less now than it was from six to ten years ago. The silver in this province is still represented by the small amount contained in the pyrites ores mined in the vicinity of Capelton, in the "Eastern Townships." The pyrites is extracted primarily as a source of sulphur for acid making, but the silver is saved as a by-product.

In Ontario during the past four years the West End Mines Syndicate has reopened a number of mines in the Thunder Bay district with some success.

The output of silver credited to the Yukon during the past two years represents the silver carried by the placer gold obtained in this district.

British Columbia.

BRITISH COLUMBIA.

The silver production in British Columbia in 1900 was obtained chiefly from the silver-lead ores of the Slocan and Fort Steele mining divisions, while the silver-copper ores of Nelson, the pyrrhotite and chalcopyrite ores of Rossland and the recently opened up gold-silver-copper ores of the Boundary district have also contributed in an important measure to the total.

The production by districts in 1899 and 1900 was as follows :—

District.	1899.	1900.
	Ounces.	Ounces.
Kootenay East		
Fort Steele Division	33,516	960,411
Other divisions	1,627	2,219
Kootenay West		
Ainsworth Divison	268,165	352,167
Nelson "	483,659	109,870
Slocan "	1,891,025	2,121,176
Trail Creek "	185,818	167,378
Other divisions	48,463	96,416
Yale		
Osoyoos	2,719	112,145
Similkameen	16	
Yale	47	
Coast and other districts	24,358	36,393
Totals	2,939,413	3,958,175

PRECIOUS METALS.

Silver.

British Columbia.

The most important changes to be noted in the above tabulation are the very large increases in the Fort Steele and Osoyoos divisions, and a considerable decrease in the output from the Nelson division. The increases are to be ascribed respectively to the opening up, and shipment of large quantities of silver-lead ore from the St. Eugene, North Star and Sullivan mines in the Fort Steele division, and to the large shipments of low grade gold-copper ores carrying silver from the Mother lode, Old Ironside, Victoria, Knob Hill and other mines in the Boundary country. The decrease in the output of silver from Nelson is probably due in a large measure to the suspension of shipments from the Silver King mine.

The following tables show the output and average yield per ton of the Slocan mines for the past six years.

NET PRODUCTION PER SMELTER RETURNS.

Year.	Ore, Tons, 2,000 lbs.	Silver, oz.	Lead, lbs.	Gold. oz.	Values.
1895	9,514	1,122,770	9,666,324	6	$1,045,600
1896	16,560	1,954,258	18,175,074	152	1,854,011
1897	33,567	3,641,287	30,707,705	193	3,280,686
1898	30,691	3,068,648	27,063,595	60	2,619 852
1899	21,507	1,891,025	16,660,910	14	1,740,372
1900	25,520	2,121,176	19,365,743	5	2,063,908
Total	137,359	13,799,164	121,639,351	430	12,604,429

AVERAGE YIELD PER TON.

Year.	Silver,	Lead.	Values,
1895	118·0 oz.	50·8%	$109 90
1896	118·0 "	54·9%	111 95
1897	108·5 "	45·7%	97 73
1898	100·0 "	44·1%	85 36
1899	87·9 "	38·7%	80 92
1900	83·1 "	37·9%	80 87
Average for six years, 137,359 tons	100·4 oz.	44·3%	$91 76

PRECIOUS METALS.

Silver.

British Columbia.

The following Table, No. 13, gives the exports of silver ores as entered in the Customs returns:—

TABLE 13.

PRECIOUS METALS.

SILVER—EXPORTS OF ORE.

Calendar Year.	Value.
	$
1886	25,957
1887	206,284
1888	219,008
1889	212,163
1890	204,142
1891	225,312
1892	56,688
1893	213,695
1894	359,731
1895	994,354
1896	2,271,959
1897	3,576,391
1898	2,902,277
1899	1,623,905
1900	2,341,872

PYRITES.

PYRITES.

Besides the output from the mines of the Eustis Mining Co. and the Nichols Chemical Co., in the "Eastern Townships," province of Quebec, which for many years have been the source of the production of pyrites, there was in 1900 a small output of iron pyrites from the vicinity of Bannockburn, Ont., which was mined by the General Chemical Co., of Buffalo, N.Y., and shipped to Buffalo and Cleveland.

The ore at Capelton, Quebec, mentioned above, consists of iron pyrites carrying about 42 per cent of sulphur, from 3 to 4 per cent of copper, and from 2 to 4 ounces of silver per ton. Although mined for use in the manufacture of sulphuric acid, both the copper and the silver are extracted. A small proportion is used in Canada for making sulphuric acid, but the bulk of the ore is shipped to the manufacturing establishments of the Nichols Chemical Co. and to other plants in the United States.

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
1897	38,910	116,730
1898	32,218	128,872
1899	27,687	110,748
1900	40,031	155,164

TABLE 2.

PYRITES.

IMPORTS.—BRIMSTONE AND CRUDE SULPHUR.

Imports.

Fiscal Year.	Pounds.	Value.
1880	1,775,489	$27,401
1881	2,118,720	33,956
1882	2 375,821	40,329
1883	2,336,085	36,737
1884	2,195,735	37,463
1885	2,248,986	35,043
1886	2,922,043	43,651
1887	3,103,644	38,750
1888	2,048,812	25,318
1889	2,427,510	34,006
1890	4,440,799	44,276
1891	3,601,748	46,351
1892	4,769,759	67,095
1893	6,381,203	77,216
1894	5,845,463	61,558
1895	4.900,225	56,965
1896	6,934,190	63,973
1897	8,672,751	87,719
1898	38,026,798	373,786
1899	24,517,026	265,799
1900 *	21,123,656	215,433

*Brimstone, crude, or in roll or flour, and sulphur in roll or flour. Duty free.

SALT.
Production.

SALT.

The production of salt in Canada in 1900, according to returns received from some ten operators, amounted to 62,055 tons, valued at $279,458, being an increase over the production of the previous year of 2,716 tons in quantity and $25,068 in value. This salt is altogether the product of wells in the counties of Essex, Lambton, Middlesex, Huron and Bruce in the province of Ontario.

Small quantities of brine are occasionally evaporated at Plumweseep N.B., and at Lake Winnipegosis, Manitoba, but nothing was done at either of these places in 1900.

The imports of salt entering into competition with the Canadian product other than that entered free of duty for fisheries are comparatively small, amounting to only $30,180 in 1900.

The fisheries of the seaboard of Canada would provide a market for as much salt again as is at present produced did conditions permit. Unfortunately the long haulage from the salt districts to the coast would raise the price of the commodity at the point of consumption so high that the cost of this necessity of the fishing industries would become prohibitive and foreign salt is therefore allowed in free of duty for this purpose.

Statistics of production exports and imports are given below.

TABLE 1.

SALT.

ANNUAL PRODUCTION.

Calendar Year.	Tons.	Value.
1886	62,359	$227,195
1887	60,173	166,394
1888	59,070	185,460
1889	32,832	129,547
1890	43,754	198,857
1891	45,021	161,179
1892	45,486	162,041
1893	62,324	195,926
1894	57,199	170,687
1895	52,376	160,455
1896	43,960	169,693
1897	51,348	225,730
1898	57,142	248,639
1899	59,339	254,390
1900	62,055	279,458

TABLE 2.

SALT. Exports.

SALT.

EXPORTS.

Calendar Year.	Bushels.	Value.
1880	467,641	$46,211
1881	343,208	44,627
1882	181,758	18,350
1883	199,733	19,492
1884	167,029	15,291
1885	246,794	18,756
1886	224,943	16,886
1887	154,045	11,526
1888	15,251	3,987
1889	8,557	2,390
1890	6,605	1,667
1891	5,290	1,277
1892	2,000	504
1893	4,940	1,267
1894	4,639	1,120
1895	4,865	959
1896	3,842	899
1897	5,383	1,193
1898	5,202	1,252
1899	11,205	2,773
1900	673,846	8,997

TABLE 3.

SALT.

IMPORTS—SALT PAYING DUTY. Imports

Fiscal Year.	Pounds.	Value.	Fiscal Year.	Pounds.	Value.
1880	726,640	$ 3,916	1890	15,135,109	$57,549
1881	2,588,465	6,355	1891	15,140,827	59,311
1882	3,679,415	12,318	1892	18,648,191	65,963
1883	12,136,968	36,223	1893	21,377,339	79,838
1884	12,770,950	38,949	1894	15,867,825	53,336
1885	10,397,761	31,726	1895	8,498,404	29,881
1886	12,266,021	39,181	1896	7,665,257	24,550
1887	10,413,258	35,670	1897	11,911,766	33,470
1888	10,509,799	32,136	1898	11,068,785	32,792
1889	11,190,088	38,968	1899	11,781,453	32,839

		Duty.	Pounds.	Value.
1900	Salt, coarse, N.E.S	5c. per 100 lbs.	5,056,835	13,169
	Salt, fine, in bulk	5c. "	2,270,565	4,514
	Salt, N.E.S., in bags, barrels or other packages	7½c. "	3,700,937	12,497
	Total		11,028,337	30,180

Salt.

Imports.

Table 4.

Salt.

Imports—Salt not Paying Duty.

Fiscal Year.	Pounds.	Value.
1880	212,714,747	$400,167
1881	231,640,610	488,278
1882	166,183,962	311,489
1883	246,747,113	386,144
1884	225,390,121	321,243
1885	171,571,209	255,719
1886	180,205,949	255,359
1887	203,042,332	285,455
1888	184,166,986	220,975
1889	180,847,800	253,009
1890	158,490,075	252,291
1891	195,491,410	321,239
1892	201,831,217	314,995
1893	191,595,530	281,462
1894	196,668,730	328,300
1895	201,691,248	332,711
1896	205,005,100	338,888
1897	215,844,484	312,117
1898	202,634,927	293,410
1899	183,046,365	267,520
1900*	193,554,550	295,253

* Salt imported from the United Kingdom, or any British possession, or imported for the use of the sea or gulf fisheries.

Structural Materials.

STRUCTURAL MATERIALS.

Under this heading are comprised building stone, granites, marbles, slates, flagstone, cements, lime, &c., as well as the manufactures of clay, which include building bricks, tiles, drain-pipe, earthenware and coarse pottery.

The industries based on the stuctural materials are so widespread and are carried on in so many different places, on various scales and often intermittently, that it is impossible to obtain anything like complete returns of quantity or value of the products. The figures of production are therefore to be taken only as rough approximations.

STRUCTURAL MATERIALS.

Production of Building Stone.

TABLE 1.

STRUCTURAL MATERIALS.

ANNUAL PRODUCTION OF BUILDING STONE.

Calendar Year.	Value.
1886	$ 642,509
1887	552,267
1888	641,712
1889	913,691
1890	964,783
1891	708,736
1892	609,827
1893	1,100,000
1894	1,200,000
1895	1,095,000
1896	1,000,000
1897	1,000,000
1898	1,300,000
1899	1,500,000
1900	1,520,000

Exports of Stone and Marble.

TABLE 2.

STRUCTURAL MATERIALS.

EXPORTS OF STONE AND MARBLE, WROUGHT AND UNWROUGHT.

Calendar Year.	Wrought.	Unwrought.
1890	$21,725	$43,611
1891	13,398	46,162
1892	7,698	47,424
1893	9,102	12,532
1894	22,576	34,130
1895	8,587	51,616
1896	4,934	32,897
1897	9,415	42,034
1898	2,526	65,370
1899	5,092	101,931
1900	5,933	115,711

STRUCTURAL MATERIALS.

Imports of Building Stone.

TABLE 3.

STRUCTURAL MATERIALS.

IMPORTS OF BUILDING STONE.

Fiscal Year.	Value.	Fiscal Year.	Value.
1880	$ 35,970	1890	$132,155
1881	58,149	1891	170,890
1882	33,623	1892	95,550
1883	35,061	1893	56,510
1884	51,088	1894	52,908
1885	30,491	1895	44,282
1886	41,675	1896	54,130
1887	54,368	1897	38,714
1888	86,373	1898	28,495
1889	100,314	1899	48,040

1900	Flagstones, granite and rough freestone, sandstone, and all building stone, not hammered or chiselled. Duty 15 p.c.	$63,376
	Granite and freestones, dressed; all other building stone dressed, except marble. Duty 20 p.c.	1,157
		$64,533

Imports of Stone or Granite.

TABLE 4.

STRUCTURAL MATERIALS.

IMPORTS OF MANUFACTURES OF STONE OR GRANITE, N.E.S.

Fiscal Year.	Value.	Fiscal Year.	Value.
1880	$29,408	1890	$84,396
1881	36,877	1891	61,051
1882	37,267	1892	39,479
1883	45,636	1893	49,323
1884	45,290	1894	49,510
1885	39,867	1895	51,050
1886	41,984	1896	51,499
1887	41,829	1897	34,026
1888	47,487	1898	41,240
1889	61,341	1899	60,148

1900	Granite—Sawn only	Duty, 20 p.c.	$ 157
	" Finished and polished	" 35 p.c.	10,371
	" Manufactures of, N.O.P.	" 35 p.c.	28,861
	Manufactures of stone, N.O.P.	" 30 p.c.	17,204
			$56,593

Structural Materials.

Production of 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
1897	Nil.	Nil.
1898	Nil.	Nil.
1899	Nil.	Nil.
1900	Nil.	Nil.

Imports of Marble.

Table 6.

Structural Materials.
Imports of Marble.

Fiscal Year.		Duty.	Value.
1880			$ 63,015
1881			85,977
1882			109,505
1883			128,520
1884			108,771
1885			102,835
1886			117,752
1887			104,250
1888			94,681
1889			118,421
1890			99,353
1891			107,661
1892			106,268
1893			96,177
1894			94,657
1895			83,422
1896			90,065
1897			77,150
1898			95,894
1899			101,879
1900	Marble and manufactures of:—		
	Marble sawn only	20 %	$66,197
	Finished and polished	35 %	13,050
	Rough, not hammered or chiselled	15 %	1,371
	Manufactures of, N.O.P	35 %	13,399
	Total, marble and manufacures of		$94,017

STRUCTURAL MATERIALS.

Production of Granite.

TABLE 7.

STRUCTURAL MATERIALS.

ANNUAL PRODUCTION OF GRANITE.

Calendar Year.	Tons.	Value.
1886	6,062	$63,309
1887	21,217	142,506
1888	21,352	147,305
1889	10,197	79,624
1890	13,307	65,985
1891	13,637	70,056
1892	24,302	89,326
1893	22,521	94,393
1894	16,392	109,936
1895	19,238	84,838
1896	18,717	106,709
1897	10,345	61,934
1898	23,897	81,073
1899	13,418	90,542
1900	....	80,000

Production of 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
1897	....	42,800
1898	....	40,791
1899	....	33,406
1900	....	12,100

STRUCTURAL MATERIALS.

Exports of Slate.

TABLE 9.

STRUCTURAL MATERIALS.

EXPORTS OF SLATE.

Calendar Year.	Tons.	Value.
1884	539	$6,845
1885	346	5,274
1886	34	495
1887	27	373
1888	22	475
1889	26	3,303
1890	12	153
1891	15	195
1892	87	2,038
1893	178	3,168
1894	187	3,610
1895	36	574
1896	301	8,913
1897	Nil.	Nil.
1898	Nil.	Nil.
1899	Nil.	Nil.
1900	Nil.	Nil.

Imports of Slate.

TABLE 10.

STRUCTURAL MATERIALS.

IMPORTS OF SLATE.

Fiscal Year.	Value.	Fiscal Year.	Value.
1880	$21,431	1890	$22,871
1881	22,184	1891	46,104
1882	24,543	1892	50,441
1883	24,968	1893	51,179
1884	28,816	1894	29,267
1885	28,169	1895	19,471
1886	27,852	1896	24,176
1887	27,845	1897	21,615
1888	23,151	1898	24,907
1889	41,370	1899	33,100

		Duty.	
1900	Slate and manufactures of—		
	Mantels	30 %	$ 64
	Roofing sale	25 % not over 75c per square	22,278
	School writing slates	25 %	15,662
	Slate pencils	25 %	3,705
	Slate of all kinds and manufactures of, N.E.S.	30 %	11,998
	Total		$53,707

STRUCTURAL MATERIALS.

Production of Flagstone.

TABLE 11.

STRUCTURAL MATERIALS.

ANNUAL PRODUCTION OF FLAGSTONE.

Calendar Year.	Quantity, Sq. ft.	Value.
1886	70,000	$ 7,875
1887	116,000	11,600
1888	64,800	6,580
1889	14,000	1,400
1890	17,865	1,643
1891	27,300	2,721
1892	13,700	1,869
1893	40,500	3,487
1894	152,700	5,298
1895	80,005	6,687
1896	....	6,710
1897	....	7,190
1898	....	4,250
1899	....	7,600
1900	....	5,250

Imports of Flagstone.

TABLE 12.

STRUCTURAL MATERIALS.

IMPORTS OF FLAGSTONE.

Fiscal Year.	Tons.	Value.
1881	23	$ 241
1882	90	848
1883	10	99
1884	137	1,158
1885	205	1,756
1886	1,602	9,443
1887	1,316	10,966
1888	2,642	21,077
1889	1,669	15,451
1890	5,665	48,995
1891	3,770	36,348
1892	1,571	15,048
1893	884	8,500
1894	218	2,429
1895	15	84
1896	Nil.	Nil.
1897	13	227
1898	587	1,540
1899	Nil.	Nil.
*1900	9	63

* Flagstones, dressed. Duty, 20 p. c. (See Table 3.)

STRUCTURAL MATERIALS.

Production of Cement.

Cement.—The production of cement, more particularly of Portland cement, has been increasing rapidly during the past few years. In 1890 the value of the combined production of natural rock and Portland cements was less than $100,000, while in 1900 the value of the total output was $645,810. The increase in 1900 over 1899 was entirely in Portland, there being a slight falling off in the output of natural rock cement.

The statistics of production of cement since 1887 are shown in Table 13 following :—

TABLE 13.

STRUCTURAL MATERIALS.

ANNUAL PRODUCTION OF CEMENT.

Calendar Year.		Barrels.	Value.	Barrels.	Value.
1887				69,843	$ 81,909
1888				50,668	35,593
1889				90,474	69,790
1890				102,216	92,405
1891				93,473	108,561
1892				117,408	147,663
1893				158,597	194,015
1894				108,142	144,637
1895				128,294	173,675
1896				149,090	201,651
1897	Natural	85,450	$ 65,893	205,213	$275,273
	Portland	119,763	209,380		
1898	Natural	87,125	73,412	250,209	397,580
	Portland	163,084	324,168		
1899	Natural	141,387	119,308	396,753	633,291
	Portland	255,366	513,983		
1900	Natural	125,428	99,994	408,552	645,810
	Portland	283,124	545,816		

Following is a list of the firms engaged in the manufacture of cement in 1900.

Natural rock cement.

The Hamilton Cement Works,	Hamilton, Ont.
The Queenston Cement Works,	Queenston, Ont.
Battle's Thorold Cement Works,	Thorold, Ont.
The Toronto Lime Co.	Toronto, Ont.

STRUCTURAL MATERIALS.

Cement.

Portland Cement.

Crescent Cement Works,	Longue Pointe, Que.
Canadian Portland Cement Co.,	Deseronto, Ont.
The Imperial Cement Co., Ltd.	Owen Sound, Ont.
The Owen Sound Portland Cement Co.,	Shallow Lake Ont.

A number of other works are proposed and in course of construction and the above list will probably be considerably augmented in 1901.

The British Columbia Portland Cement Company, formerly operating works at Vancouver, are reported no longer in business there.

Although the production of cement has been increasing rapidly, there appears to be still considerable room for enlargement, as the imports have been advancing in almost as rapid proportion. The imports of cement in 1900 were valued at over $500,000, about double the value of the imports in 1897.

Statistics of exports and imports are given in the following tables.

Exports.

TABLE 14.

STRUCTURAL MATERIALS.

EXPORTS OF CEMENT.

Calendar Year.	Value.
1891	$ 2,881
1892	938
1893	1,172
1894	482
1895	937
1896	1,328
1897	644
1898	2,117
1899	2,733
1900	3,296

STRUCTURAL MATERIALS.

Cement.

Imports.

TABLE 15.

STRUCTURAL MATERIALS.

IMPORTS OF CEMENT IN BULK OR BAGS.

Fiscal Year.	Bushels.	Value.	Fiscal Year.	Bushels.	Value.
1880	65	$ 28	1891	11,281	$ 2,890
1881	579	298	1892	14,351	3,394
1882	386	86	1893	12,534	2,909
1883	1,759	548	1894	9,027	2,618
1884	4,626	1,236	1895	....	2,112
1885	4,598	1,315	1896	....	3,672
1886	6,808	1,851	1897	....	4,318
1887	5,421	1,419	1898	....	3,263
1888	23,919	5,787	1899	....	8,929
1889	32,818	10,668	1900*	....	10,452
1890	21,055	5,443			

*Cement, N.E.S., duty 20 per cent.

There was also an importation of manufactures of cement valued at $3,870.

TABLE 16.

STRUCTURAL MATERIALS

IMPORTS OF HYDRAULIC CEMENT.

Fiscal Year.	Barrels.	Value.
1880	10,034	$ 10,306
1881	7,812	7,821
1882	11,945	13,410
1883	11,659	13,755
1884	8,606	9,514
1885	5,613	5,396
1886	6,164	6,028
1887	6,160	8,784
1888	5,636	7,522
1889	5,835	7,467
1890	5,440	9,048
1891	3,515	6,152
1892	2,214	2,782
1893	4,896	8,060
1894	1,054	985
1895	5,333	7,001
1896	5,688	8,948
1897	2,494	3,937
	Cwt.	
1898	16,033	7,097
1899	1,678	694
1900 (Cement hydraulic or waterlime)*	10,418	4,711

*Duty 12½c. per 100 lbs.

Structural Materials.

Cement.

Imports.

TABLE 17.

STRUCTURAL MATERIALS.

IMPORTS OF PORTLAND CEMENT.

Fiscal Year.	Barrels.	Value.
1880	....	$ 55,774
1881	....	45,646
1882	....	66,579
1883	....	102,537
1884	....	102,857
1885	....	111,521
1886	....	120,398
1887	102,750	148,054
1888	122,402	177,158
1889	122,273	179,406
1890	192,322	313,572
1891	183,728	304,648
1892	187,233	281,553
1893	229,492	316,179
1894	224,150	280,841
1895	196,281	242,813
1896	204,407	242,409
1897	210,871	252,587
	Cwt.	
1898	1,073,058	355,264
1899	1,300,424	467,994
1900 (Portland or Roman)*	1,301,361	498,607

* Duty 12½c. per 100 lbs.

Production of Roofing Cement.

TABLE 18.

STRUCTURAL MATERIALS.

PRODUCTION OF ROOFING CEMENT.

Calendar Year.	Tons.	Value.
1890	1,171	$ 6,502
1891	1,020	4,810
1892	800	12,000
1893	951	5,441
1894	815	3,978
1895	....	3,153
1896	86	430
1897	Nil.	Nil.
1898	Nil.	Nil.
1899	Nil.	Nil.
1900	Nil.	Nil.

STRUCTURAL MATERIALS.

Lime.

Production.

TABLE 19.

STRUCTURAL MATERIALS.

ANNUAL PRODUCTION OF LIME.

Calendar Year.	Value.
1886	$283,755
1887	394,859
1888	339,951
1889	362,848
1890	412,308
1891	251,215
1892	411,270
1893 estimated	900,000
1894 "	900,000
1895 "	700,000
1896 "	650,000
1897 "	650,000
1898 "	650,000
1899 "	800,000
1900 "	800,000

Exports.

TABLE 20.

STRUCTURAL MATERIALS.

EXPORTS OF LIME.

Calendar Year.	Value.
1891	$119,853
1892	121,535
1893	86,623
1894	83,670
1895	71,697
1896	70,820
1897	53,177
1898	49,594
1899	73,565
1900	80,852

Structural Materials.

Lime.

Imports.

TABLE 21.

STRUCTURAL MATERIALS.

IMPORTS OF LIME.

Fiscal Year.	Barrels.	Value.
1880	6,100	$ 6,013
1881	5,796	4,177
1882	5,064	5,365
1883	7,623	9,224
1884	10,804	11,200
1885	12,072	11,503
1886	11,021	9,347
1887	10,835	8,524
1888	10,142	7,537
1889	13,079	9,363
1890	8,149	5,360
1891	6,259	4,273
1892	6,132	4,241
1893	6,879	4,917
1894	6,766	4,907
1895	12,008	5,743
1896	10,239	7,331
1897	16,108	10,529
1898	12,850	9,002
1899	15,720	11,124
1900 ....Duty 20 p.c.	12,865	11,211

Production of 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
1897	1,600,000
1898	1,900,000
1899	2,195,000
1900	2,275,000

STRUCTURAL MATERIALS.

Exports of Brick.

TABLE 23.

STRUCTURAL MATERIALS.

EXPORTS OF BRICK.

Calendar Year.	M.	Value.
1891	246	$1,163
1892	1,963	12,192
1893	6,073	44,110
1894	1,095	7,405
1895	1,655	8,665
1896	983	5,678
1897	573	2,679
1898	65	442
1899	172	1,351
1900	546	4,528

Imports of Building Brick

TABLE 24.

STRUCTURAL MATERIALS.

IMPORTS OF BUILDING BRICK.

Fiscal Year.	Value.
1880	$ 2,067
1881	4,281
1882	24,572
1883	14,234
1884	20,258
1885	14,632
1886	5,929
1887	2,440
1888	20,720
1889	24,585
1890	12,500
1891	9,744
1892	5,075
1893	14,108
1894	18,320
1895	4,705
1896	23,189
1897	10,336
1898	6,652
1899	21,306
1900..........Duty, 20 p.c.	19,305

Imports of paving brick in 1898: Value, $2,337; duty, 20 p.c.
" " 1899: " 23,648; "
" " 1900: " 35,644; "

STRUCTURAL MATERIALS.

Production of Terra Cotta.

TABLE 25.

STRUCTURAL MATERIALS.

PRODUCTION OF TERRA COTTA, &c.

Calendar Year.	Value.
1888	$ 49,800
1889	Not available.
1890	90,000
1891	113,103
1892	97,239
1893	55,704
1894	65,600
1895	195,123
1896	83,855
1897	155,595
1898	167,902
1899	220,258
1900	259,450

Production of 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
1897	164,250
1898	181,717
1899	161,546
1900	231,525

STRUCTURAL MATERIALS.

Imports of Drain tiles and Sewer pipes.

TABLE 27.

STRUCTURAL MATERIALS.

IMPORTS OF DRAIN TILES AND SEWER PIPES.

Fiscal Year.		Value.
1880		$ 33,796
1881		37,368
1882		70,065
1883		70,699
1884		71,755
1885		69,589
1886		57,953
1887		71,203
1888		101,257
1889		83,215
1890		77,434
1891		87,195
1892		59,537
1893		39,001
1894		24,625
1895		21,053
1896		19,296
1897		34,286
1898		29,611
1899		33,898
	Duty.	
1900 — Drain tile, not glazed	20 %	$ 1,383
1900 — Drain pipes, sewer pipes, chimney linings or vents, chimney tops and inverted blocks, glazed or unglazed	35 %	37,766
Total		$39,149

Production of Pottery.

TABLE 28.

ANNUAL PRODUCTION OF POTTERY.

Calendar Year.	Value.
1888	$ 27,750
1889	Not available
1890	195,242
1891	258,844
1892	265,811
1893	213,186
1894	162,144
1895	151,588
1896	163,427
1897	129,629
1898	214,675
1899	185,000
1900	200,000

STRUCTURAL MATERIALS.

Imports of Earthenware.

TABLE 29.

STRUCTURAL MATERIALS.

IMPORTS OF EARTHENWARE.

Fiscal Year.	Value.	Fiscal Year.	Value.
1880	$322,333	1890	$695,206
1881	439,029	1891	634,907
1882	646,734	1892	748,810
1883	657,886	1893	709,737
1884	544,586	1894	695,514
1885	511,853	1895	547,935
1886	599,269	1896	575,493
1887	750,691	1897	595,822
1888	697,082	1898	675,874
1889	697,949	1899	916,727

Year	Article	Duty.	Value
1900	Earthenware and china:—		
	Baths, tubs and washstands, of earthenware, stone cement or clay, or of other material, N.O.P.	30 %	$ 24,516
	Brown or coloured earthen and stoneware, and Rockingham ware	30 %	11,661
	Decorated, printed or sponged, and all earthenware, N.E.S.	30 %	234,104
	Demijohns, churns and crocks	30 %	6,617
	White granite or ironstone ware, C.C. or cream coloured ware	30 %	203,382
	China and porcelain ware	30 %	263,312
	Earthenware tiles	35 %	46,575
	Manufactures of earthenware, N.E.S.	30 %	169,359
	Total		959,526

Exports of Sand and gravel.

TABLE 30.

STRUCTURAL MATERIALS.

EXPORTS OF SAND AND GRAVEL.

Calendar Year.	Tons.	Value.
		$
1893	329,116	121,795
1894	324,656	86,940
1895	277,162	118,359
1896	224,769	80,110
1897	152,963	76,729
1898	165,954	90,498
1899	242,450	101,640
1900	197,558	101,666

MISCELLANEOUS.

Miscellaneous.

Antimony. Production.

Antimony.—The last reports of production of antimony in Canada were in 1898 from the Rawdon mines, Nova Scotia.

Information concerning antimony deposits and work accomplished in former years, will be found in past reports of this Section.

The following tables are given showing the statistics of production, exports and imports of antimony and antimony ores.

TABLE 1.

MISCELLANEOUS.

ANNUAL PRODUCTION OF ANTIMONY ORE.

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
1892 to 1897	Nil.	Nil.
1898	1,344	20,000
1899	Nil.	Nil.
1900	Nil.	Nil.

Exports.

TABLE 2.

MISCELLANEOUS.

EXPORTS OF ANTIMONY ORES.

Calendar Year.	Tons.	Value.	Calendar Year.	Tons.	Value.
1880	40	$ 1,948	1888	352½	$ 6,894
1881	34	3,308	1889	30	695
1882	323	11,673	1890	38	1,000
1883	165	4,200	1891	3½	60
1884	483	17,875	1892 to 1897	Nil.	Nil.
1885	758	36,250	1898	1,232	15,295
1886	665	$31,490	1899	6¾	190
1887	229	9,720	1900	210	3,441

MISCELLANEOUS.

Antimony.

Imports.

TABLE 3.

MISCELLANEOUS.

IMPORTS OF ANTIMONY.

Fiscal Year.	Pounds.	Value.	Fiscal Year.	Pounds.	Value.
1880........	42,247	$ 5,903	1890........	117,066	$ 17,439
1881........	....	7,060	1891........	114,084	17,483
1882........	183,597	15,044	1892........	180,308	17,680
1883........	105,346	10,355	1893........	181,823	14,771
1884........	445,600	15,564	1894........	139,571	12,249
1885........	82,012	8,182	1895........	79,707	6,131
1886........	89,787	6,951	1896........	163,209	9,557
1887........	87,827	7,122	1897........	134,661	8,031
1888........	120,125	12,242	1898........	156,451	12,350
1889........	119,034	11,206	1899........	289,066	16,851

	Duty.	Pounds.	Value.
1900 { Antimony, or regulus of, not ground pulverized or otherwise manufactured.	Free.	143,072	$15,064
1900 { Antimony salts	"	43,925	4,937
Total........	....	186,997	20,001

Arsenic.

Production.

Arsenic.—The production of arsenic in Canada in 1900, amounted to 303 tons, valued at $22,725. This was about five times the product turned out in 1899. The arsenic is recovered as a by-product in connection with the mining of the gold ores of the Deloro mine, Hastings county, Ontario. The deposists are irregular vein-like masses of quartz, containing a considerable amount of arsenopyrite (mispickel), and smaller amounts of other sulphides, etc. Various attempts have been made to work this ore for both gold and arsenic, and a certain amount of the latter product was obtained during several years preceding 1888, in connection with the chlorination of the ore. Small amounts were also produced in 1890 and 1891. Nothing further was accomplished, however, until the advent of the present operators, the Canadian Gold Fields, Limited. The method of treatment employed may be described briefly as follows.

The ore is crushed with gravity stamps, and a portion of the gold saved by amalgamation. The pulp is then concentrated and treated for gold contents by the bromo-cyanide process, which in conjunction with the amalgamation extracts from 85 to 90 per cent of the gold values in the ore. The concentrates, after leaching by bromo-cyanide, are transferred to the arsenic works, where they are calcined.

The product from the calcination consists of crude arsenic of different degrees of purity and is collected in a series of condensing chambers.

The crude arsenic is then refined, producing white arsenic which collects in the condensing chambers, partly as crystals and the balance as a fine powder. The crystals and fines are then ground together to a very fine powder, and the product packed in kegs containing from 400 to 450 pounds each.

MISCELLANEOUS.

Arsenic.

Production.

Tables of production and imports follow.

TABLE 4.

MISCELLANEOUS.

ANNUAL PRODUCTION OF ARSENIC.

Calendar Year.	Tons.	Value.
1885	440	$17,600
1886	120	5,460
1887	30	1,200
1888	30	1,200
1889	Nil.	Nil.
1890	25	1,500
1891	20	1,000
1892	Nil.	Nil.
1893	"	"
1894	7	420
1895	Nil.	Nil.
1896	"	"
1897	"	"
1898	"	"
1899	57	4,872
1900	303	22,725

TABLE 5.

MISCELLANEOUS.

IMPORTS OF ARSENIC.

Imports.

Fiscal Year.	Pounds.	Value.	Fiscal Year.	Pounds.	Value.
1880	18,197	$ 576	1891	115,248	$ 4,027
1881	31,417	1,070	1892	302,958	9,365
1882	138,920	3,962	1893	447,079	12,907
1883	51,953	1,812	1894	292,505	10,018
1884	19,337	773	1895	1,115,697	31,932
1885	49,080	1,566	1896	664,854	27,523
1886	30,181	961	1897	152,275	8,378
1887	32,436	1,116	1898	291,967	14,270
1888	27,510	1,016	1899	582,383	24,203
1889	69,269	2,434	1900...Duty free.	230,730	11,035
1890	138,509	4,474			

MISCELLANEOUS.

Production of Felspar.

TABLE

MISCELLANEOUS.

PRODUCTION OF FELSPAR.

Calendar Year.	Tons.	Value.
1890	700	$3,500
1891	685	3,425
1892	175	525
1893	575	4,525
1894	Nil.	Nil.
1895	....	*2,545
1896	972	*2,583
1897	1,400	3,290
1898	2,500	6,250
1899	3,000	6,000
1900	318	1,112

* Exports.

Production of Fire-clay.

TABLE 7.

MISCELLANEOUS.

PRODUCTION OF FIRE-CLAY.

Calendar Year.	Tons.	Value.
1889	400	$4,800
1890	Nil.	Nil.
1891	250	750
1892	1,991	4,467
1893	540	700
1894	539	2,167
1895	1,329	3,492
1896	842	1,805
1897	2,118	5,759
1898	670	1,680
1899	599	1,295
1900	1,245	4,130

Miscellaneous.

Production of Moulding sand.

TABLE 8.

MISCELLANEOUS.

PRODUCTION OF MOULDING SAND.

Calendar Year.	Tons.	Value.
1887	160	$ 800
1888	169	845
1889	170	850
1890	320	1,410
1891	230	1,000
1892	345	1,380
1893	4,370	9,086
1894	6,214	12,428
1895	6,765	13,530
1896	5,739	11,478
1897	5,485	10,931
1898	10,572	21,038
1899	13,724	27,430
1900	6,181	12,316

Peat.

Peat.—Various attempts have been made during the past few years to utilize the numerous peat bogs found throughout the country, more especially in the provinces of Ontario and Quebec. A number of the companies recently organized appear to be about to achieve some success in the compression of the peat for fuel purposes, &c. A small quantity was made and disposed of in 1900, amounting to about 400 tons and valued at $1,200.

Platinum.

Platinum.—There was no production of platinum reported in 1900, though the metal is said to have been found in the neigbourhood of Dease Lake, in the extreme northern part of the province of British Columbia, as well as in the Thompson and North Saskatchewan rivers.

The production of platinum, as represented by the following table, has been derived altogether from the province of British Columbia.

MISCELLANEOUS.

Platinum.

Production.

TABLE 9.

MISCELLANEOUS.

ANNUAL PRODUCTION OF PLATINUM.

Calendar Year.	Value.
1887	$ 5,600
1888	6,000
1889	3,500
1890	4,500
1891	10,000
1892	3,500
1893	1,800
1894	950
1895	3,800
1896	750
1897	1,600
1898	1,500
1899	825
1900	Nil.

Imports.

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	6,185
1897	9,031
1898	9,781
1899	9,671
1900*	57,910

*Platinum wire and platinum in bars, strips, sheets or plates: platinum retorts, pans, condensers, tubing and pipe, imported by manufacturers of sulphuric acid for use in their works. Duty free.

MISCELLANEOUS.

Production of Quartz.

TABLE 11.

MISCELLANEOUS.

ANNUAL PRODUCTION OF QUARTZ.

Calendar Year.	Tons.	Value.
1890	200	$ 1,000
1891	....	....
1892	....	....
1893	100	500
1894	....	....
1895	....	....
1896	10	50
1897	....	....
1898	284	570
1899	600	1,260
1900	....	....

Imports of Silex.

TABLE 12.

MISCELLANEOUS.

IMPORTS OF "SILEX"—CRYSTALLIZED QUARTZ.

Fiscal Year.	Cwt.	Value.
1880	5,252	$ 2,290
1881	3.251	1,659
1882	3,283	1,678
1883	3,543	2,058
1884	3,259	1,709
1885	3,527	1,443
1886	2,520	1,313
1887	14,533	5,073
1888	4,808	2,385
1889	5,130	1,211
1890	1,768	2,617
1891	3,674	1,929
1892	1,429	1,244
1893	2,447	1,301
1894	2,451	1,521
1895	2,882	1,881
1896	3,289	2,174
1897	2,564	3,415
1898	3,104	2,773
1899	3,951	2,595
1900 .... Duty free.	4,021	2,876

MISCELLANEOUS.

Production of 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
1897	157	350
1898	405	1,000
1899	450	1,960
1900	420	1,365

Imports of Tin and Tinware.

TABLE 14.

MISCELLANEOUS.

IMPORTS OF TIN AND TINWARE.

Fiscal Year.	Value.	Fiscal Year.	Value.
1880	$ 281,880	1890	$ 1,289,756
1881	413,924	1891	1,206,918
1882	790,285	1892	1,594,205
1883	1,274,150	1893	1,242,994
1884	1,018,493	1894	1,310,389
1885	1,060,883	1895	973,397
1886	1,117,368	1896	1,237,684
1887	1,187,312	1897	1,274,108
1888	1,164,273	1898	1,550,851
1889	1,243,794	1899	1,372,813

		Duty.	
1900	Tin crystals	Free.	$ 2,819
	Tin in blocks, pigs and bars	"	580,855
	Tin plates and sheets	"	1,683,788
	Tin foil	"	44,173
	Tin strip waste	"	5,078
	Tin and manufactures of :—		
	Tin plate in sheets, decorated	25 %	2,141
	Tinware, plain, japanned, or lithographed, and all manufactures of tin, N.E.S	25 %	99,601
	Total		$2,418,455

MISCELLANEOUS.

Tripolite.—The following table shows the production of tripolite in Canada, of which there has been a small annual output since 1896. According to returns received, the production in 1900 was 336 tons, valued at $1,950. The output has all been derived from the Nova Scotia deposits.

TABLE 15.

MISCELLANEOUS.

PRODUCTION OF TRIPOLITE.

Production of Tripolite.

Calendar Year.	Tons.	Value.
		$
1896	664	9,960
1897	15	150
1898	1,017	16,660
1899	1,000	15,000
1900	336	1,950

TABLE 16.

MICELLANEOUS.

IMPORTS OF WHITING.

Imports Whiting.

Fiscal Year.	Cwt.	Value.
1880	84,115	$26,092
1881	47,480	16,637
1882	36,270	16,318
1883	76,012	29,334
1884	76,268	28,230
1885	67,441	23,492
1886	65,124	25,533
1887	47,246	15,191
1888	76,619	20,508
1889	84,658	22,735
1890	96,243	27,471
1891	84,679	27,504
1892	102,985	26,867
1893	88,835	25,563
1894	103,633	26,649
1895	102,751	25,441
1896	113,791	27,322
1897	102,453	22,541
1898	166,293	25,761
1899	134,884	34,310
1900*	127,455	34,575

Whiting or whitening, gilders whiting, and Paris white. Duty free.

MISCELLANEOUS.

Imports of Chalk.

TABLE 17.

MICELLANEOUS.

IMPORTS OF CHALK.

Fiscal Year.	Value.	Fiscal Year.	Value.
1880...........	$2,117	1891...........	8,193
1881...........	2,768	1892...........	9,558
1882...........	2,882	1893...........	9,966
1883...........	5,067	1894...........	11,308
1884...........	2,589	1895...........	7,730
1885...........	8,003	1896...........	6,467
1886...........	6,583	1897...........	7,432
1887...........	5,635	1898...........	9,338
1888...........	5,865	1899...........	10,461
1889...........	5,336	1900*..........	12,212
1890...........	7,221		

* Chalk prepared. Duty 20 p. c.

Zinc.

Zinc.—The Grand Calumet Mining Company of Ottawa, made a small shipment of ore from the Calumet Island mine, Que., and also continued to work the Zenith mine, north of Nipigon Bay, Lake Superior, Ontario.

The total production of zinc for the year amounted to 106 tons valued at $9,342.

In 1899 the production was 407 tons, valued at $46,805, and in 1898 394 tons, valued at $36,011.

Statistics of imports of zinc are given below :

Imports of Zinc.

TABLE 18.

MISCELLANEOUS.

IMPORTS OF ZINC IN BLOCKS, PIGS AND SHEETS.

Fiscal Year.	Cwt.	Value.	Fiscal Year.	Cwt.	Value.
1880.........	13,805	$67,881	1891.........	17,984	105,023
1881.........	20,920	94,015	1892.........	21,881	127,302
1882.........	15,021	76,631	1893.........	26,446	124,360
1883.........	22,765	94,799	1894.........	20,774	90,680
1884.........	18,945	77,373	1895.........	15,061	63,373
1885.........	20,954	70,598	1896.........	20,223	80,784
1886.........	23,146	85,599	1897.........	11,946	57,754
1887.........	26,142	98,557	1898.........	35,148	112,785
1888.........	16,407	65,827	1899.........	18,785	107,477
1889.........	19,782	83,935	1900 Duty free	28,748	156,167
1890.........	18,236	92,530			

MISCELLANEOUS.

Imports of Spelter.

TABLE 19.

MISCELLANEOUS.

IMPORTS OF SPELTER.

Fiscal Year.	Cwt.	Value.
1880	1,073	$ 5,310
1881	2,904	12,276
1882	1,654	7,779
1883	1,274	5,196
1884	2,239	10,417
1885	3,325	10,875
1886	5,432	18,238
1887	6,908	25,007
1888	7,772	29,762
1889	8,750	37,403
1890	14,570	71,122
1891	6,249	31,459
1892	13,909	62,550
1893	10,721	49,822
1894	8,423	35,615
1895	9,249	30,245
1896	10,897	40,548
1897	8,342	32,826
1898	2,794	13,561
1899	5,450	29,687
1900* ....Duty free	5,836	29,416

* Spelter in blocks and pigs.

Imports of Zinc.

TABLE 20.

MISCELLANEOUS.

IMPORTS OF ZINC MANUFACTURES OF.

Fiscal Year.	Value.	Fiscal Year.	Value.
1880	$ 8,327	1890	6,472
1881	20,178	1891	7,178
1882	15,526	1892	7,563
1883	22,599	1893	7,464
1884	11,952	1894	6,193
1885	9,459	1895	5,581
1886	7,345	1896	6,290
1887	6,561	1897	5,145
1888	7,402	1898	10,503
1889	7,233	1899	14,661

	Duty.	Value.
1900 { Zinc seamless drawn tubing	Free.	$ 1,870
1900 { " manufactures of, N.O.P.	25 %	9,605
Total		11,475

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(New Series).

ABBREVIATIONS.

Al.	District of Alberta.	N.W.T.	North-west Territory.
B.C.	Province of British Columbia.	O.	Province of Ontario.
N.E.T.	North-east Territory.	Q.	Province of Quebec.
Man.	Province of Manitoba.	Sask.	District of Saskatchewan.
N.S.	Province of Nova Scotia.	Mack.	District of Mackenzie.

Addendum.—Part DD.