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

SUMMARY REPORT

ON THE

OPERATIONS OF THE GEOLOGICAL SURVEY

FOR THE YEAR 1898

BY

THE DIRECTOR

OTTAWA
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OTTAWA, 15th January, 1899.

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

SIR,—In accordance with the provisions of the Act relating to the Geological Survey, I have the honour to submit the subjoined Summary Report of the work carried out by the Survey during the calendar year 1898, giving, in abstract form, an account of the explorations and surveys completed or in progress, together with a record of the investigation conducted in the office, publications, additions to the collections, organization, changes in the staff and other matters relating to this Department of the public service.

Information given in Summary Report.

In work like that carried on by the Geological Survey, much is necessarily dependent on the initiative of individual members of the staff, and these gentlemen are consequently requested to embody in the preliminary reports on their operations, in as much detail as may appear to be desirable, the more important results of their investigations, particularly such as may be of immediate value to the public from an economic standpoint. This is the more appropriate and necessary in view of the fact that the complete examination of any particular district or subject, must often occupy several years of field-work before it can be completed, and further time may have to be occupied in the examination of specimens, the collation of results and the compilation and engraving of maps before the whole can be prepared for issue in the form of a comprehensive report.

Separate publication of completed reports.

In order to facilitate as far as possible the early appearance of such finished reports, it has been the custom for some years to print and issue each of these in separate form, as soon as completed. Such separate issues are subsequently collected in an annual volume, for per-

manent record and for distribution to Parliament and to such libraries, public institutions and exchanges as are entitled to receive it.

Issue of Volume IX.

In consequence of pressure of work in the Printing Bureau, it was not possible to complete Volume IX. of the new series of Annual Reports in the early part of the past year, but this volume has now been printed, bound and issued in English, while the French edition is approaching completion. It contains, as usual, the Summary Report of the year which gives nominal date to the volume, (thus carrying on the general record of the operations of the Department,) and six other separate reports, as follows :—

Contents.

Summary Report of the Geological Survey Department for the year 1896, by the Director.

Report on the Doobaunt, Kazan and Ferguson Rivers and the North-west Coast of Hudson Bay, by J. B. Tyrrell.

Report on the Geology of the French River Sheet, Ontario, by R. Bell.

Report on a traverse of the northern part of the Labrador Peninsula from Richmond Gulf to Ungava Bay, by A. P. Low.

Report on the Geology of South-west Nova Scotia, by L. W. Bailey.

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

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

The volume comprises 816 pages, and is accompanied by five maps and illustrated by twenty plates, besides a number of figures in the text.

Reprint of Yukon reports.

The reprint of the Report on the Yukon District, from Volume III. (N.S.) with parts of a subsequent report on the same district from Vol. IV. (N.S.) together with that of the three large map-sheets accompanying the first-mentioned report, was completed early in the year. This publication of 244 pages, practically embodied all the geological information available on the district to date, and the maps were corrected to January last.

Other publications.

In the palæontological series of publications, Part V. completing Volume I. of *Contributions to Canadian Palæontology*, was issued at the end of November.

The preliminary statistical abstract of the mineral production of Canada, for 1897, was completed and sent to the printer on February 23rd, 1898.

The number of maps actually printed during the year, is thirteen. Particulars are given of these and of those in progress, on a later page. The new general geological map of the Dominion, referred to in a previous Report, has been somewhat delayed by difficulties connected with the engraving work, but is now again progressing satisfactorily.

Progress of Volume X.

The printing of Volume X. of the new series of reports is now in progress, the following constituent parts being in press :—

Report on the Geology and Natural Resources of the area included by the Nipissing and Temiscaming map-sheets.

Report on the Surface Geology and Auriferous Deposits of South-eastern Quebec, by R. Chalmers.

The Mineral Resources of the Province of New Brunswick, by L. W. Bailey.

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

Progress also continues to be made in the printing of the General Index of the reports of the Geological Survey, from 1863 to 1884, alluded to in the last Summary Report, and it is hoped that this may now shortly be published.

Increasing production of minerals.

The aggregate value of the production of minerals in Canada during the year 1897, as finally corrected and published, is $28,661,430, being an increase of about 27 per cent over that of the previous year. This is largely accounted for by the great development of gold mining, particularly in the Yukon district, the value of the gold produced being more than double that for 1896. Several other mineral products, however, likewise show a very significant growth, the percentage increases in value of some of these being as follows, according to the figures obtained by the Section of Mineral Statistics and Mines :—lead 93·7, silver 54·6, copper 46·9, gypsum 37·3, cement 36·5, nickel 17·7.

The returns for 1898 are at this time by no means complete, but they are sufficiently known to indicate that a further increase of 25 to 30 per cent in value will appear in this year as compared with 1897. As before, however, a large proportion of this increase is attributable to placer gold mining in the Yukon district.

Collection exhibited at Omaha.

A small representative collection of Canadian ores and minerals of economic value, with photographs of mines, etc., was prepared early in the year for display at the Trans-Mississippian Exhibition at Omaha. This was despatched, together with other exhibits, in charge of officers appointed by the Minister of Agriculture. From accounts since

received and from correspondence relating to this collection, it appears that it attracted a good deal of attention on the part of miners and prospectors from the Western States of the Union.

Preparations for Exhibition at Paris.

The collection has since been returned, and some part of it will now be available for the much larger and more complete display of the mineral resources of Canada which it is intended to make at the International Exhibition in Paris in 1900. Much additional material will, however, be needed for this purpose, and toward the accumulation of this some preliminary steps have already been taken. It is hoped that the active co-operation of all those engaged in mining or metallurgical industries in Canada may be counted on in the effort to make the mineral and geological exhibit a thoroughly creditable and representative one, as the occasion afforded by this exhibition appears to be one of which the greatest possible advantage should be taken.

Importance of this Exhibition.

Communications are invited, in the above connection, from those interested in mining matters. It is desired, not only to exhibit mineral products for which markets may be found in Europe, but those also in which the numerous visitors from all other parts of the world may be interested; and it may be pointed out that, even in the case of products for which the chief market is to be sought in adjacent parts of the United States, no better means can be adopted of making them known than that of their proper representation at Paris. It is also to be borne in mind that the adequate display of substances of purely local consumption, will at least evidence their existence in the Dominion and that of the industries depending on them, attracting the attention of those engaged in similar industries or interested in connected processes and machinery, as well as inducing the immigration of workmen skilled in such industries.

Specimens sent to Imperial Institute.

Specimens of minerals of commercial importance have been sent from time to time, during the year, to the Imperial Institute in London, some in response to inquiries, others, when there appeared to be a good prospect of establishing a profitable market for them. Some trouble has been taken, for instance, to obtain representative

Felspar.

specimens of Canadian felspars from deposits capable of yielding this mineral in large quantity, and some of these have been experimentally fused in the kilns of the Ottawa Carbon and Porcelain Company and forwarded in that condition, together with the crude material. Felspar is extensively employed in the manufacture of pottery and porcelain, and if it can be laid down at the works in England at a satisfactory price, although the percentage of profit to be anticipated is small, there is no reason why the industry may not assume very large

proportions, the Canadian material being apparently quite equal to that produced in Scandinavia. Considerable shipments have already occurred to potteries in the United States.

Molybdenite. Molybdenite is another mineral for which a considerable and growing demand appears to have been established, particularly in connection with the employment of molybdenum in alloys of iron and steel. Mr. Willimott was instructed in July to visit and report upon some of the best known and most accessible occurrences of this mineral, and specimens of the more important of these deposits were sent to the Imperial Institute. As a result of this, prices were quoted for the mineral, in England, that appear to afford a good margin of profit for the working of some at least of these deposits. Large samples were also obtained from a couple of the deposits, for the purpose of ascertaining whether it might not be possible to crush and concentrate the ores containing a comparatively small amount of molybdenite. The concentration of this ore has not, so far as I am aware, yet been attempted, but acting on the kind offer of Professor J. B. Porter of McGill University, Montreal, the samples referred to have been transmitted to him and are now being made the subject of experiment in the mining laboratory of the University.

Speculative holding of mineral deposits. In connection with the above and other mineral substances which Canada is capable of producing and supplying to new markets, I may add that the greatest difficulty has been found in inducing the owners of deposits of the kind, not previously worked, to make even trial shipments of their products. Many proprietors are ready to sell undeveloped properties at good prices, but are either unable or unwilling to put the matter on a commercial basis. The inquiries received are not as a rule directed to the acquirement of deposits, but to the practical question—at what price and in what quantity can a given mineral be delivered at a stated market. The acquisition and locking up of mineral deposits for purposes of speculation only, has in fact become a serious deterrent to the development of Canadian mining, to which the attention of the proper authorities in the several provinces might, it is believed, be usefully directed.

Minerals specially inquired for. Among the minerals for which special inquiries have been received during the year, the following may be mentioned. Some of these have not yet been found in Canada, or not in quantities that appear to be of commercial importance, but most of them may be looked for, in different parts of the Dominion, with prospects of success, while others are already well known.

Asbestus, Antimony ores, Bismuthenite, Corundum, Chromic Iron, Felspars, Fire Clays in British Columbia and the North-west Territories,

Fluorspar, Graphite, Gypsum, Iron-pyrites, Iron Ores (Bessemer and titaniferous), Limestone (pure, for manufacture of calcium carbide and dolomitic or magnesian limestone for use in connection with wood-pulp manufacture), Molybdenite, Mispickel in Ontario, Mica, Marble for ornamental purposes, Magnesite, Natural Gas in Quebec, Nickel, Osmium, Platinum, Pottery-clay in the North-west, Peat, Phosphate or Apatite, "Quartz" for paviers of grinding-pans, Sand for glass-making and for "sand-blasting," Steatite or Soap-stone, Talc, Tungsten ores (wolframite or scheelite), Zinc ores.

Nearly all the substances above noted were required for purchase or immediate utilization in connection with different industries, and a large proportion of the inquiries came from Great Britain, the United States and the continent of Europe. Whenever possible the inquirers have been either placed in correspondence with persons working or owning the minerals asked for, or have been informed of the localities and under what conditions these minerals are known to occur.

Information supplied by the Department.

As usual, a very large number of applications have been received by the Department for information of various kinds, referring to mines and minerals, geological and geographical points and a wide range of other technical subjects. Much of the correspondence of the office relates to such questions, many of which require some time and research in order to obtain or collate the facts asked for. This is particularly the case in connection with boring operations, and the very numerous samples of rocks, ores, fossils, botanical and geological specimens, etc., sent in for examination or determination. It may be added, that, while the Department is ready to undertake such examination and determination of minerals, etc., as may appear to be necessary or reasonable in each case, assays or analyses of ores and minerals are made only in the case of those that appear to be of public interest or importance.

Educational collections.

During the past year, twenty-five collections, comprising an aggregate number of over 2000 specimens, have been prepared and presented gratuitously to approved educational institutions in various parts of Canada. The number of such collections that can be made up being necessarily limited, while the demand for them appears to be a continually growing one, more care is now necessarily taken than in former years to ascertain that the institutions supplied are of such a grade that specimens of the kind can be beneficially employed in them. In the case of schools in which natural science forms no part of the curriculum, it would appear that but little use can be made of such collections, the cost of which to the Department is considerable, in time and work, as well as in the expenditure annually necessary to procure suitable material.

Museum building required.

While it is necessary in this Report to again allude to the ever-present danger of the loss by fire of the valuable collections and records of the Survey, still housed in the old and inadequate building on Sussex Street that has been occupied since the removal from Montreal, it may be added that there now appears to be some prospect of the early erection of a new and spacious fire-proof building. It should be fully recognized that the loss of the collection, with its numerous "type" specimens, resulting from the work of the staff for more than fifty years, would not only be a national calamity, but one which would be deplored by scientific workers the world over. The rapidly increasing importance of mining in Canada, alone, should ensure the immediate provision of suitable quarters for the museum and staff of the Survey, in which it may be possible to afford something like an adequate presentation of the mineral resources of the country to all visitors to the capital.

Safeguarding of type specimens.

In connection with the value of type specimens, of whatever kind, the following observations by Professor O. C. Marsh, being part of a communication made by him to the International Congress of Zoology at Cambridge, England, in August last, may be quoted here, as the importance of such specimens is not so generally understood as it should be :—

"The careful preservation of their own type specimens is a sacred duty on the part of all original investigators, and hardly less so of those who are the custodians of such invaluable evidences of the progress of natural science. * * * For the preservation of type specimens, fire-proof buildings are indispensable. I recall no less than five Museums of Natural History, in America, that have either been destroyed, or their contents consumed, or seriously damaged by fire, since I became actively interested in natural science."

Work of the Director,

Necessary routine work in the office, together with the supervision of the publication of the reports, has occupied the greater part of my own time during the year, but it was found possible also to make some excursions in the field, in connection with the general control of the work there in progress and for the purpose of correlating the surveys and observations of different members of the staff. This forms a very necessary part of the scheme of the Survey, which implies a uniformity of plan in the definition and mapping of the formations of all parts of Canada. It is recognized that such supervision should not be confined merely to the published matter of the several reports, but should include an actual knowledge of the main facts, of such a character as to enable the Director to assist the individual workers in reaching a concurrent rendering of their results for presentation to the public. An extension

of consultary relations of the geologists working in adjacent fields, is also to be desired and it is hoped that this may be more fully attained in future.

Visit to Rivière Blanche.

Early in May, at the request of and in company with the Hon. Sir Henri Joly de Lotbinière, a day was spent in a visit to the scene of a disastrous landslip that had occurred on the Rivière Blanche, in Portneuf county, Quebec. The peculiar features of this landslip appearing to merit further investigation, Mr. R. Chalmers was subsequently instructed to visit and examine the place. Some notes on the occurrence are given in his report, below, and I have also presented a short account of the disturbance, dealing particularly with its geological aspects, to the meeting of the Geological Society of America, lately held in New York.

Mines at Calumet Island.

At a later date, advantage was taken of an excursion to the Calumet Mining Company's property, to visit the interesting deposits of lead and zinc ores which are being worked by that company on Calumet Island in the Ottawa River. Dr. R. W. Ells has embodied some notes on this mine in his report, given on a later page.

Inspection of boring work, etc.

In August, it became desirable that a personal inspection should be made of the boring operations in progress in northern Alberta, and on the 10th of that month I left Ottawa for that purpose, going as far as Victoria, on the Saskatchewan, and spending a few days at Edmonton and in its vicinity. Subsequently, visits were made to Kamloops and Vernon in British Columbia, in connection with further details required for the Shuswap map-sheet, now nearly ready for issue, after which the Crow Nest Pass railway was taken to Fernie, for the purpose of noting the progress made in opening up the coal-field traversed by this line, with a view to further geological surveys. Ottawa was reached on my return, on September 13th.

Localities visited in Nova Scotia.

Leaving Ottawa again on September 25th, nearly two weeks were spent in Nova Scotia in connection with the geological questions which have arisen in regard to the mapping of some of the rock-series in that province. In company with Dr. H. M. Ami, who had been instructed to continue his work of obtaining all possible palæontological evidence on the points at issue, visits were made to representative sections in the vicinity of Wolfville, Horton, Parrsborough, Harrington River, Union and McAras Brook, Arisaig. Dr. Ami in his report presented in a later part of this Summary, gives some account of the results so far reached by him in the investigation, on which he has been employed for a part of each summer during several years. These results are of importance, inasmuch as the issue of several maps, now

engraved, had to be delayed pending the determination of the taxonomic position to be assigned to some of the formations included by these sheets. The inspections which I have made in this connection, enable me to characterize the stratigraphical work, which on these map-sheets has been chiefly carried out by Mr. H. Fletcher, as most complete and accurate; so that whatever differences of opinion may still remain in regard to the age to be assigned to the formations in question, must depend upon the weight to be given to the fossils contained in these rocks in their relation to palæontological standards, recognized by geologists generally in other parts of the world.

Gold on the North Saskatchewan.

While at Edmonton, I embraced the opportunity of gaining some further information in regard to the gold of the North Saskatchewan. Much interest is now being taken in this question in connection with the introduction of dredging machinery on a considerable scale, and a short general review on the subject may thus appropriately be given here.

Previous reports.

The occurrence of placer gold on the Saskatchewan and other rivers in Alberta and Athabasca, its distribution and the sources from which it may have been derived, have been referred to in several previous reports of the Geological Survey; but recent systematic efforts to establish dredges for gold mining on the North Saskatchewan, together with certain late additions to our knowledge of the problems involved, seem now to warrant a further notice of the subject.

Occurrence of the gold.

Gold in fine scales and particles, generally so minute as to require the employment of mercury in collecting it, is now known to occur on almost all the rivers running eastward from the Rocky Mountains, to the north of the International boundary, wherever these have been prospected. To the south of the Peace River, this gold, in any workable quantity, seems invariably to characterize a portion of the length of each of the rivers, giving out to the westward before the base of the Rocky Mountains is reached, and to the eastward along a less well defined line, but one probably due, in this case, to the local substitution of sand and clay banks and bed for the gravel bars of the upper and more rapid parts of the streams. The Peace River and the Liard, rising to the west of the Rocky Mountains proper, among rocks known to be auriferous, contain more or less gold throughout their lengths, or to points in their lower courses where the changed conditions of flow, above alluded to, render the collection of any minutely divided gold which they may still carry practically impossible. In other words, in these two rivers, and possibly also in some still further to the north, a considerable part at least of the contained gold comes directly from their upper tributaries; while in the case of the Athabasca, the North

Saskatchewan and other rivers further to the south, the evidence at first sight appears to be entirely against the possible derivation of gold from the mountains to the westward.

Dr. Selwyn on Saskatchewan gold.

In the Report of Progress for 1873-74, (p. 58) Dr. Selwyn, who had descended the North Saskatchewan in a boat in 1873, notes that the first signs of gold washings were observed rather more than forty miles below the mouth of the Brazeau, and continued for some miles below Edmonton. He states his belief that the gold is not derived from the mountains, as none of the miners had ever been able to find any above Rocky Mountain House, and his conclusions are that it came as a part of the glacial drift, with the Laurentian and other crystalline rocks derived from the belt which extends north-westerly from Lake Superior to the Arctic Sea.

Gold in southern Alberta.

In my report on the southern part of Alberta, contained in the Report of Progress for 1882-84 (p. 152 c.) it is noted that fine gold is found, when looked for in favourable localities, in all the streams in that region, but ceases to occur before the base of the mountains is reached, at or near the western limit of the glacial drift from the eastward. The facts are considered fully to confirm the hypothesis advanced by Dr. Selwyn.

Mr. Tyrrell on Saskatchewan gold.

Mr. J. B. Tyrrell's report on Northern Alberta, forming part of the Annual Report, Vol. II. (N.S.) 1886, (pp. 109, 164, 131 E,) contains additional observations on the occurrence of gold. Near Goose Encampment, on the Saskatchewan, about fifty-five miles above Edmonton by the river, on Sections 35 and 36, Township 50, Range IV., west of the Fifth Meridian, are extensive exposures of the Lower Laramie rocks, including a very thick bed of lignite-coal. At this place the coal has been largely burnt out, leaving mounds and slopes of vitrified materials baked shales, etc., and specimens of these and of the ash of the coal-bed were proved on assay to contain traces of gold. The gold must, of course, have existed in these rocks previous to the combustion of the coal, but it may have been to some extent concentrated in the specimens showing actual fusion. It is noted by the author that this is about the highest point at which gold in paying quantity has been found on the river, and that the miners state it is in this vicinity found in a somewhat coarser form than usual. The occurrence of gold in the Laramie rocks, Mr. Tyrrell points out, involves, in connection with the origin of gold on the Saskatchewan, the origin of the materials of these rocks; and this, he explains, may have been in the Selkirk Ranges of British Columbia, at a time antecedent to the elevation of the Rocky

Mountains proper. He finds no reason to deny, however, that some part of the gold may have been received from the eastern glacial drift.

Observations in 1895.

In 1895, when for a short time at Edmonton, some further notes on the gold industry on the Saskatchewan were obtained by the writer. These are referred to in the Summary Report for that year (p. 16 A), where it is stated that the principal paying bars occur along that part of the river extending from about sixty miles above to about sixty miles below Edmonton, but that in late years bars had been worked as far down as Battleford, some 250 miles below Edmonton. The number of men employed in gold mining, for longer or shorter periods in that year, was estimated at about 300. In consequence of favourable reports brought back by a few miners from the Athabasca, a rush occurred also to that river, but without leading to any important results, as the men going there were for the most part inexperienced in gold washing.

First dredge constructed.

In the same year, the first dredge of any considerable size was built at Edmonton, with the intention of working the submerged bars and the bed of the river, although previous to this time hand dredges and scoops of various kinds had been operated with some success.

Gold in old gravel deposits.

The writer was then also informed of the working of certain gravel deposits by drifting, in the banks of the river, and of the occurrence of gold in gravels met with in sinking wells in the prairie land at some distance from the Saskatchewan. It appeared to be probable that, while some of these gravels were recent and strictly fluviatile, such as those underlying flats along the river-valley, others were referable to the deposit named "Saskatchewan gravels" by Mr. R. G. McConnell; a deposit that underlies the glacial drift of the Great Plains. As no opportunity occurred at that time of testing the last-mentioned conjecture, it was not referred to in the Report cited; but when, in the following year, Mr. McConnell had occasion to visit Edmonton in connection with the selection of a site for boring operations, he was requested also to examine the places at which such drifting had been carried on in the gold-bearing gravels.

Mr. McConnell's observations.

Mr. McConnell's examination then made, proved the existence of gold in workable quantity in some parts of the "Saskatchewan gravels" underlying the boulder-clay of the plains. At a point about ten miles above Edmonton, he noted the following section in the bank, in descending order :—

	Feet.
1. Silts and clays	7
2. Boulder-clay	50
3. Cross-bedded sands	60
4. Sandy gravel carrying gold	3
5. Laramie sandstones and shales to water level	50
	170

He also reported that another deposit, evidently of the same character from descriptions received, was about to be worked some sixty miles above Edmonton.

Character and origin of the old gravel deposits.

Without entering into details which have been presented elsewhere, respecting the "Saskatchewan gravels," it may be explained that the deposit so named is widely distributed in the North-west, and that it has been shown to be connected with the earliest period of glaciation there, during which the western mountain region was the main source of ice. These gravels and associated sandy beds, rest directly upon the Cretaceous or Laramie rocks, and have been carried far eastward by rivers and streams discharging from the glaciers of the eastern slopes of the mountains. Their material is consequently almost entirely derived from the mountains, but none of it can be proved to have come from ranges west of the Rocky Mountains proper. They do not contain débris from the crystalline rocks of the Laurentian axis to the east and north-east, but underlie the boulder-clays characterized by an abundance of such material in the area of the Great Plains. The gold occurring in these gravels must, consequently, have been derived either from the Laramie rocks, noted as slightly auriferous by Mr. Tyrrell, or from the Rocky Mountains proper, or in part from both sources.

Possible secondary derivation of gold.

It may be pointed out that, although no auriferous veins have been found in the Rocky Mountains proper, the sandstones and conglomerates of the Cambrian rocks of these mountains have in long past ages been built up of débris from the Selkirks and connected ranges to the west, that are known to comprise ancient crystalline and metamorphic rocks and to carry gold. It is therefore not at all improbable that, in the wearing down of the Cambrian strata of the Rocky Mountains, considerable quantities of gold originally derived from the Selkirks has again been liberated and has been washed down with the material of the "Saskatchewan gravels." To this cause may probably be attributed the occurrence of small quantities of gold on the Miette River, a tributary of the Athabasca in the mountains, as mentioned by Mr. McEvoy in his report on a following page. It is noteworthy,

however, although these gravels, or the boulder-clay of western origin with which they are connected, continue to the base of the mountains, that, as already stated, gold practically ceases to the west of a certain line. This appears to show that the gold in these gravels is either far from abundant or that its distribution is local,—possibly that it is due more largely than one would be inclined to believe, to denudation of the underlying Laramie rocks. In this connection it may be added that, while at Calgary last autumn, Mr. J. McEvoy, at my request, tested the Saskatchewan gravels there for gold with entirely negative results.

Not everywhere found in older gravels.

The result of recent observations appears, therefore, to indicate that the gold found in the Saskatchewan and other rivers of the North-west, has come in part from several sources, but has been derived chiefly from the crystalline rocks of the Laurentian axis or plateau to the eastward or north-eastward, from which it has been transported with the fragments of these rocks that now form so conspicuous a part of the "drift" of the Great Plains. The recognition in late years, of the Huronian as a distinctly gold-bearing formation, in itself goes far to establish the correctness of the hypothesis originally advanced on this subject, as rocks of this formation occupy considerable areas of the Laurentian plateau.

General result of inquiry.

The gold, in workable quantities, characterizes parts of the rivers crossing a belt of country that extends from the vicinity of the base of the mountains, for a variable distance eastward. This distribution has led to a popular belief that some ancient system of streams has carried the gold from north-west to south-east, or in the opposite direction, parallel to the base of the mountains, forming a wide belt of auriferous alluvium in the direction of its flow. What has already been said will, however, show that the existence of such a belt is in all probability due to other circumstances, and that the gradual cessation of payable bars along the rivers to the eastward, results chiefly from the diminished slope of the country and the consequently reduced erosive and sorting power of the existing rivers.

The North Saskatchewan, has hitherto been by far the most important stream upon which gold mining operations have been carried on, and is the only one which has offered a continuous and somewhat considerable output of gold. The length of the river upon which work has been found to pay, under favourable conditions, is, as already defined, about 120 miles; Edmonton being situated almost in the centre of this length of the river. Up to the present time, gold washing has been prosecuted almost entirely by hand or with the aid only of very rude mechanical appliances for lifting small quantities of gravel from

Gold mining on North Saskatchewan.

the submerged bars and bed of the river. The prosecution of this work has been desultory, being practically limited to the low-water stages of the river, and even then conducted by a number of men who, generally, wish to devote only a part of their time to such work; influenced largely by the inducements offered by employment in other directions. It must be added, however, that experience here, as elsewhere in regard to river-bar mining, shows that the best returns are obtained from the first working of such bars, and that, although more or less re-arrangement of material and renewal of accessible gold is brought about each year when the river is in flood, the naturally exposed bars rapidly deteriorate in their yield. For this reason, except at unusually low water, a number of the miners now devote themselves to the working of layers of gravel covered by lighter sandy deposits along the banks of the river, and that these often carry a considerable amount of gold, is shown by the fact that some men were engaged, with profit, during the past year (1898) in removing from five to eight feet of sand, shovelling underlying gravel from the pit thus formed, wheeling it thirty or forty yards to the edge of the river and washing it there by hand with an ordinary "grizzly."

First work on bars most remunerative.

Dredges on the North Saskatchewan.

The steam dredge constructed in 1895, and to which allusion has already been made, was at the time of my visit to Edmonton last autumn, laid up some way up the river, and no favourable accounts were received of the results so far attained. I was able, however, to visit the other steam dredges on this part of the Saskatchewan, beginning with that of the Star Mining Company of South Edmonton.

Star Mining Company.

This was found at work about two miles above Big Island (or thirteen miles above Edmonton). It has a twelve horse-power engine and is capable of raising gravel from a depth of about ten feet. Three men and a boy were employed and the returns were stated to amount to from $25 to $40 worth of gold per diem. The gravel is said to average about 40 cents worth of gold to the cubic yard, without the very fine gold, which is known to be lost because of the comparatively imperfect construction of this small dredge. This dredge is stated to be paying well.

Loveland Brothers.

A much larger dredge, belonging to Loveland Brothers, was found at work in the channel south of Big Island. This is a well constructed machine, with two twenty horse-power engines, one to actuate the bucket, the other to pump water for washing the gravels raised. It had just been completed and some of the appliances were of a temporary character, and no records of work were available. About two miles above Edmonton, a small dredge belonging to Dr. Bowers was visited, but was not at work. Like those above described, it is a

dipper dredge, but is provided with a truck drawn upon inclined rails to the stern, where the gravel is screened in a revolving perforated drum before washing.

Other dredges on the river.

Another dredge, belonging to Mr. Braithwaite, was lying at the bank of the river near Edmonton. This is provided with a small engine for pumping water. It has two longitudinal wells in the hull, in each of which a bucket or scoop attached to a beam is operated. Another dredge, belonging to Mr. Brindley, lay not far from the last, but is still simpler in construction. It is said to produce about $10 worth of gold a day when at work, but had lately been employed in connection with the foundations of the piers of the bridge under construction. There are also several small hand dredges of primitive construction employed by miners at various places along the river. not specially noted.

Dredges under construction.

All the dredges above referred to are dipper dredges of varying construction. On the south side of the river, at Edmonton, a large new dredge, the first of several which it is intended to build, was approaching completion. This belongs to the Saskatchewan Gold and Platinum Proprietory, (limited,) Mr. A. E. Hogue, general manager, and is in every way a great advance upon any dredge heretofore placed upon the river. It is to be provided with four engines, one to actuate an endless chain of buckets, one for the winches by means of which the dredge will be moved from place to place, and a couple to pump water to wash the gravel. It is intended to raise the gravel to a height of twenty-five feet above the deck, where, after the removal of the larger stones by a grizzly, it will be screened in revolving drums and the finer residue treated on blanket-covered Frue vanners placed on the after-part of the deck. This dredge was completed late in the autumn, but not in time to practically test it. Its working capacity is stated to be 3100 cubic yards of gravel in twenty-four hours.

Gold dredging in New Zealand.

The chief progress in river-dredging for gold, in late years, has been accomplished in New Zealand, where work of this kind has been carried out extensively, improved methods have been devised and an important industry established. An interesting synopsis of this work has recently been given by Mr. J. B. Jaquet, of the Geological Survey of New South Wales.*

Progress and improvements.

It appears that in New Zealand, spoon dredges, rigged on scows and operated by hand windlass, were first employed with some success

* Notes on gold dredging by J. B. Jaquet, Geological Survey of N.S.W. Government Printer, Sydney, 1898. Price 1s. 6d.

locally. Sand-pumps or suction-pumps were then tried, but, as in the western part of the United States, proved to be unsatisfactory. Steam bucket-dredges were then introduced and successfully worked. These soon superseded all others, and the tendency now is to build them of increasing size and capacity. Electric motors have also been employed with advantage. A great improvement was effected by the introduction of what is known as a tailing-elevator, which prevents the tailings from finding their way back into the excavation made by the buckets, and enables them to be stacked, from the stern of the dredge, where desired ; in the case of the larger dredges to a height of forty feet above the water-level. By means of this arrangement the dredges can work the low river-flats, cutting channels for themselves, and can even attack gravel banks twenty-five feet in height.

Saving the gold.

In saving the gold, various ingenious devices are employed, in regard to the details of which reference should be made to Mr. Jaquet's report. The greatest advance recorded is that of the introduction of revolving screens with water-jets.

Economy of working.

By perfected appliances of the kind above alluded to, extremely finely divided gold may be saved, actual experiments having shown that particles as minute as one-thousandth of a grain in weight are successfully collected. An instance is quoted showing profitable work in ground yielding only 1·35 to 1·41 grains (5½ to 5¾ cents) per cubic yard, and in Montana, the running cost of working gravels with steam power has been reduced to 9 cents per cubic yard, or with electric power, as low as 4½ cents.

Favourable prospects on the Saskatchewan.

There appears to be no reason to doubt that satisfactory results, comparable with those achieved in a number of cases in New Zealand, may be obtained on several rivers in the North-west, and more particularly on the North Saskatchewan. Properly constructed dredges of adequate size and capacity will permit work to be carried on continuously during about half the year. It is to be remembered that such dredges enable the working not only of the bars and bed of the river, but also of the adjacent river-flats, where these do not possess a greater and more permanent value for agricultural occupation. Many of these flats are known to be underlain by auriferous gravels which have never yet been touched.

Annual yield of gold.

The approximate annual yield of gold from the North Saskatchewan, since 1887, is thus given in the report of the Mining and Statistical Section of the Survey for 1898. It must be borne in mind that very considerable amounts had been recovered in still earlier years, for which no figures are available ; also, that practically the whole of the yield stated up to the present time has been the result of hand work.

Value of Gold obtained from the North Saskatchewan River.

Year.	
1887	$ 2,100
1888	1,200
1889	20,000
1890	4,000
1891	5,500
1892	10,506
1893	9,640
1894	15,000
1895	50,000
1896	55,000
1897	50,000
	$222,946

Mammoth and musk-ox remains in the older gravels.

Before leaving the subject of the auriferous drifts of this part of Alberta, occasion may be taken to allude to a couple of interesting finds lately made in connection with the old gravel deposit specifically named the Saskatchewan gravels. In 1895, I obtained from Mr. J. Gibbons, the tooth of a mammoth, which had been discovered in the workings carried on in these gravels some six miles above Edmonton. This is probably referable to *Elephas primigenius* or *Americanus*. A rather small but well preserved mammoth tusk was also seen by me at Edmonton last year. This was picked up on a river-bar near Goose Encampment, but from which of the beds in the river-banks it may have been derived is uncertain. Last autumn, from Mr. D. W. Macdonald, of Edmonton, portion of a skull was received which proved to be that of a musk-ox. This was from the roof of a drift, run into the bank for coal-mining purposes about a mile below Edmonton in which a fall had occurred in connection with the work. It, in all probability, was likewise derived from the Saskatchewan gravels, which here, with a variable depth, directly overlie the coal-bearing Laramie rocks. A preliminary examination of this somewhat imperfect specimen, develops no points of difference between it and the old adult skull of *Ovibos moschatus*. Although a long way south and west of the present range of the musk-ox, it is to be noted that two species of this animal have previously been described from Pleistocene beds in Kentucky and on the Arkansas River, which Flower and Lyddeker suggest may be referable to the existing form.*

Date of these remains.

It is possible that the remains above noted from the Saskatchewan gravels, may have been derived from superficial deposits antedating

* Mammals Living and Extinct, p. 330.

these gravels and therefore of Pliocene age, but it is much more probable that the mammoth and musk-ox actually inhabited the region in the early Pleistocene, at a time when the mountains to the west were buried under the mass of the Cordilleran glacier.

Crow Nest Pass coal-field.

The following notes refer to the development of the Crow Nest Pass coal-field, now in progress.

Fernie Station, on the Crow Nest Pass Railway, is situated in the Elk River valley where Coal Creek enters this valley from the east. A range of 100 coking-ovens of approved type was in construction here at the time of my visit, early in September, and since then fifty of these ovens have been completed and the actual manufacture of coke has commenced by the Crow Nest Pass Coal Company (limited). Houses for the miners have also been constructed at Fernie and a town-site has been laid out. From Fernie, a spur line has been built up the valley of Coal Creek for about five miles, to the place at which the actual mining operations are in progress. Although bounded on both sides by mountains several thousand feet in height, the valley here opens out considerably, affording ample room for a large loading yard, as well as for the construction of the necessary bins, screens and other appliances for handling the coal. Work upon these appliances was actively in progress when seen.

Mining work in progress.

Here, under the immediate superintendence of Mr. W. Blakemore, the outcrops of the coal-seams have been uncovered and drifts have been run in on both the north and south sides of the valley. The beds here belong to the west side of the coal-basin and have an easterly dip at an angle of about twenty degrees. The principal seam opened on the north side of the valley, according to Mr. Blakemore, yields 5 feet 6 inches of workable coal, while that on the south side is about 6 feet thick. The relative stratigraphical position of these two seams has not been accurately determined, owing to landslides at the base of the mountain slopes, but it is believed that the seam on the south side (known as No. 2) is from 80 to 100 feet above the other, the intervening rocks being chiefly sandstones, but possibly, in accordance with Mr. Fernie's views, including a third and much thicker coal-seam. It is proposed to decide this point, at an early date, by further work.

Exploratory work on Michel Creek.

Exploratory work was also being carried out by Mr. Fernie in the valley of Michel Creek where followed by the main line of railway, about sixteen miles to the north-east. The coals here opened on, occupy positions considerably higher stratigraphically in the Kootanie series of the Cretaceous. A trial heading has here been run into a seam 13 feet thick, which is believed to represent the Peter seam,

openings upon the outcrop of which were made some years ago near Marten Creek, on the line of the old trail. This heading is about five miles west of the summit of the pass, or practically at the junction of the East Fork of Michel Creek with the main valley. Prospecting operations are also in progress in adjacent parts of the Michel valley on other beds of the fine series of coal-seams that characterized the Crow Nest basin. The great value of this remarkable field is, in fact, now in a fair way to be realized, and from this time onward continuous shipments of excellent coke will no doubt be made from it to the smelters and metalliferous mines of West and East Kootenay.

Shipments of coke.

The geological structure of the Rocky Mountain ranges proper, or that part of the western mountain region that lies between the eastern foot-hills and the great Columbia-Kootenay valley on the west, assumes a great practical importance in view of the opening up and working of the coal-beds included within its area. On the map accompanying my Preliminary Report on that portion of the Rocky Mountains between Latitudes 49° and 51° 30′, forming part of Volume I. (1885) of the new series of Annual Reports of the Geological Survey, the areas of the Cretaceous coal-bearing rocks are represented with approximate accuracy and in so far as the work carried out up to that date allowed. Several sectional diagrams were also given; but at the time the explorations to which this report relates were made, the existence of extensive "overthrust faults" as a factor in mountain structure had scarcely been recognized by geologists. At a later date, the importance of such faults was very strikingly demonstrated, particularly in connection with the geology of Scotland, and it was realized that by tangential pressure, acting on the earth's crust, older beds may be bodily thrust forward upon newer formations for distances measured in miles.

Geological structure of coal-fields.

Overthrust faults.

The position of the Cretaceous coal-bearing rocks at and within the eastern edge of the mountains on the Bow and Elbow rivers, appeared to indicate the existence of an overthrust of the kind, but it was not until Mr. R. G. McConnell made his detailed examination of the Bow Pass, in 1886, that it was actually possible to state that the Palæozoic rocks had, in that vicinity, along the eastern point of the mountains, been thrust forward over the Cretaceous beds and up a gently inclined fault-plane for a distance of about seven miles, by pressure acting from the westward. This feature, as demonstrated in the vicinity of the Bow, is clearly shown in the sections accompanying the report cited.*

First determined on Bow River.

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

Bearing on structure of Rocky Mountains.

It had heretofore been supposed that a great normal fault, with downthrow to the eastward, defined the eastern base of the Rocky Mountains in this vicinity and separated the rocks of the mountain region from the wholly Cretaceous and Laramie rocks of the foot-hills; but the structural discovery above alluded to, at once threw doubt on the earlier supposition, as well as upon several of the sketch-sections drawn in conformity with it in other parts of the mountains.

Application to Crow Nest field.

In the map above referred to, the approximate western boundary of the Crow Nest coal-basin is shown to closely follow the Elk River. Later, but as yet very incomplete observations, seem to indicate that a not inconsiderable width of the Cretaceous rocks may, in some places, occur to the west of that river, between it and the high mountain range which is evidently composed of Palæozoic limestones. It further appears to be, at least quite possible that the coal-bearing rocks may be found to pass beneath these older rocks by overthrust of the latter, and that another development of the coal-seams already known east of the Elk may be discovered there. It is obvious that if the coal-bearing formation could thus be shown to underlie the limestone range to the west of the Elk to any considerable extent, and to contain unbroken coal-seams of a workable character there, the area of this already very important coal-basin might prove to be, for practical purposes, materially greater than has been supposed.

Other possible lines of overthrust.

Further east on the Crow Nest Pass, is another similar line of possible overlap of the older rocks upon the newer coal-bearing Cretaceous, where these meet near the east end of the Crow Nest Lake. It is not, however, so likely that conditions of this kind occur where rocks of the same series come together at the eastern entrance to the pass, along the base of the Livingstone Range, as both the older and newer rocks here stand at very high angles, not suggestive of any extensive overthrust.

Practical bearings.

The questions thus stated, arising from the scientific study of the section met with on the Bow Pass, have obvious practical bearings in regard to the coal lands, and seem to call for examination and decision, by means of surveys more exact than have hitherto been feasible.

May explain occurrence of petroleum.

It further appears to be quite possible that overthrusts of the kind referred to may serve to explain the otherwise somewhat anomalous occurrence of petroleum in the southern part of the Rocky Mountains, between the Crow Nest and South Kootenay passes. The actual existence of small quantities of petroleum in several places in this portion of the mountains was verified, some years ago, by the personal

observations of Dr. Selwyn.* The petroleum was actually found in parts of the mountain region characterized at the surface by very ancient rocks, probably of Lower Cambrian age. If it may be assumed, however, that these rocks possibly overlie, in some places, those of the Cretaceous series, by reason of overthrusts, it is easily conceivable that the petroleum in question may have originated in consequence of heat, at considerable depths in the earth's crust, acting upon the fixed hydrocarbons contained in the rocks of that series.

Test borings suggested.

Now that the completion of the Crow Nest Pass Railway has rendered it possible to transport boring appliances to the Flathead valley without great difficulty, it is likely that test wells will soon be sunk there. The indications certainly seem to be sufficiently promising to warrant some outlay in work of the kind, notwithstanding the generally disturbed and broken character of the formations of the region.

Synopsis of Field Work.

Distribution of field-parties

In laying out the field-work for the past year, it was evident that special attention should be given to the Yukon District, and Mr. McConnell and Mr. Tyrrell were both consequently assigned to different parts of this district. Their reports are given on a later page. The number and distribution of parties in the field, engaged in work that occupied the greater part of the season, is given below :—

British Columbia	1
Yukon District	2
Alberta (boring operations and collecting)	2
Ontario	4
Quebec	1
New Brunswick	2
Nova Scotia	3
Ungava (East coast of Hudson Bay)	1
	16

Dr. H. M. Ami and Mr. L. M. Lambe, both occupied in palæontological work, are here counted with the field parties.

Shorter periods were spent in field-work by Mr. J. White, who ran transit and chain lines from Ottawa to Sharbot Lake, and from Carleton Junction to Chalk River, thus completing a base-line, for geographical purposes, between Ottawa and Georgian Bay. Mr. Willimott

* Summary Report, 1891, p. 10 A.

also visited a number of localities in Quebec and Ontario for the purpose of obtaining specimens for collections and for the museum, and Professor J. A. Dresser of Richmond, Quebec, was afforded facilities for the prosecution of a petrographical examination of Shefford Mountain in the "Eastern Townships" of that province, from which it is anticipated that interesting results will follow.

Review of explorations in 1898.

The main features of the field-work accomplished during the year, may be epitomized briefly as follows, further details being contained in the reports handed in by the officers engaged in it and printed on later pages of this Summary. The reports are taken up, as usual, in order from west to east.

Yukon District west of Lewes River.

To Mr. J. B. Tyrrell was assigned the preliminary examination of a portion of the Yukon district, to the west of the line of the Lewes River and south of Fort Selkirk. Considerable difficulty was experienced in this work, on account of the failure of the horses depended upon for transport, but about 300 miles of new surveys were made and geological and other facts noted respecting the vicinity of the Dalton trail which had previously been mapped by Mr. McArthur of the Dominion Lands Survey. Mr. Tyrrell also joins with Mr. McConnell in a short report, giving the result of their united observations on the actual mode of occurrence and methods of working the gold placers of the Klondike region.

East of Lewes River.

To Mr. R. G. McConnell was entrusted the task of making a geological reconnaissance and exploration of part of the Yukon district to the east of the Lewes and south of the latitude of Fort Selkirk, together with the line of route from Teslin Lake to the Stikine River, in the northern part of British Columbia. He was also requested to make, if possible, a preliminary study of the mode of occurrence of gold in the Klondike region itself, where such important mining operations are already in progress. In the course of these operations the Big Salmon and Nisutlin rivers were ascended to their sources, and surveyed wherever necessary, and Teslin River and the borders of Teslin Lake were examined. The results indicate the existence of several new tracts of country which appear to warrant close examination on the part of prospectors, besides affording approximate outlines for the geological formations over a large region in which these had previously remained unknown.

Edmonton to Yellow Head Pass.

A general reconnaissance survey has been made by Mr. J. McEvoy, from Edmonton westward to the upper waters of the Fraser and Canoe rivers, with special reference to that part of the Rocky Mountains in this vicinity. Practically all the geological information heretofore

available for this region was that gained by Sir James Hector, many years ago, under the unfavourable circumstances of rapid winter travel. The knowledge since obtained of the general structure of the mountains, both to the south and north, renders it comparatively easy to understand that of the intermediate district, and the facts observed by Mr. McEvoy will enable what has been a considerable gap in all previous maps, to be filled with approximate accuracy. Notes were also obtained respecting prospecting and mining operations in the district, the character of the various routes, forests, agricultural value of the lands, etc. A notable point is the approximate determination of the height of Robson Peak, which, as stated on a subsequent page, appears to be the highest submit in the Canadian Rocky Mountains.

West Kootenay.

In West Kootenay, the mapping work referred to in previous reports was continued and extended by Mr. R. W. Brock and Mr. W. W. Leach. The laying down of the topographical features of this exceptionally rugged mountainous district, is here a necessary adjunct to the geological mapping, and the smoke from forest fires seriously impeded this work by interfering with the utility of the various transit stations. Substantial progress was, however, made in the work. The area to which particular attention was given, being between Slocan and Lower Arrow lakes, is almost entirely mountainous, culminating in the ragged crests of the Valhalla Range. The rocks met with are chiefly granites, referable to several periods; and in regard to their relations and those of the contained areas of altered sedimentary rocks and later dykes, some valuable information, bearing directly upon the mode of occurrence of the ore-deposits of the district, was obtained. Further evidence was also noted, at heights between 7000 and 8000 feet of the passage of the great Cordilleran glacier over the entire district in a south-easterly direction.

Western Ontario.

Surveys of the gold-bearing region of Western Ontario were continued by Mr. W. McInnes, and directed to the completion of a new map-sheet to the north of that known as the Seine River sheet, and east of the Manitou sheet, now in course of compilation. These surveys necessarily involve the mapping of the lakes and rivers of the region to be covered, and although good progress has been made in the work, it will be necessary to devote another season to the area in question before it can be definitely laid down and completed for publication. It has already been pointed out on several occasions, that the work of the trained geologists of this Survey would be carried on to much greater advantage and with less delay, if the geographical outlines were in advance laid down by the provincial authorities. This is especially to be desired where, as in the region here parti-

Assistance in surveys required.

cularly referred to, prospectors and miners are urgently requiring geological maps for their guidance.

Lake Nipigon. In order to complete the work necessary for the compilation of a general geological map of Lake Nipigon, north of Lake Superior, Mr. D. B. Dowling was engaged in surveys on that lake and in its vicinity. The outlines of the Nipigon and Huronian rocks were defined and the numerous large islands were laid down, some of them for the first time.

Michipicoten. In the Michipicoten region, about the north-east coast of Lake Superior, Dr. R. Bell was employed, during several months, in ascertaining the boundaries and character of the Huronian rocks and other features of the geology, the recent discovery of gold in the district having rendered this particularly desirable. The distribution of the Huronian—here as elsewhere the gold-bearing series—had previously been but imperfectly determined, and the additional information now gained should be of importance in guiding the future work of prospectors and miners.

Central Ontario. In Central Ontario, detailed geological work has been continued on the Haliburton map-sheet by Mr. A. E. Barlow and Dr. F. D. Adams, with a view to making this a typical sheet for the entire region, and also for the purpose of determining, as far as possible, important questions bearing on the relations and mode of mapping the Grenville, Hastings and Huronian formations. This investigation is now well advanced, but definite statements respecting its results are deferred pending its completion. The occurrence of certain remarkable conglomerates met with, has been found to depend on the internal movements of masses composing them, and some of the highly crystalline limestones, have been traced continuously into beds of limestone but little altered. Several additional areas of nepheline-syenite have also been discovered, and these obtain some economic importance because of the association of corundum and muscovite mica with them.

Three Rivers map-sheet. A part of the season of field-work was employed by Dr. R. W. Ells, in obtaining some additional details that proved to be required for the Perth and Ottawa City map-sheets of the Ontario series, and in visiting some localities within these sheets where minerals of economic value had been reported. The greater portion of his time was, however, given to further examinations in the area of the Three Rivers map-sheet in Quebec, now in the hands of the engraver. The general character of the crystalline rocks of this region, has already been described, but the work now done, in conjunction with that previously accomplished by other members of the staff, has enabled Dr. Ells to prepare a short descriptive report for publication with the map-sheet.

Explorations in Hudson Bay.

Mr. A. P. Low was entrusted with the task of continuing and completing the exploration and survey of the eastern coast of the northern part of Hudson Bay, together with that of the northern islands in the Bay. It appeared to be necessary for the proper prosecution of this work that the available seasons of both 1898 and 1899 should be employed in it, arrangements being made to pass the present winter on the shore of Hudson Bay. The small yacht employed by Mr. Low in Hudson Strait in 1897, had been stored at Nachvak on the Labrador coast. He therefore left Quebec in the Hudson's Bay Company's schooner for Rigolet, on the Labrador coast, on June 30th. At Rigolet he was picked up by the steamer *Erik* belonging to the same company, on her arrival from England, and taking the yacht on board at Nachvak, he proceeded through Hudson Strait, leaving the steamer in a bay east of Cape Wostenholme. A letter written at that time, under date 30th July, is the latest information received in regard to this expedition. Early in the season an ample supply of provisions for the winter was despatched via Missinaibi and Moose River, in charge of the Hudson's Bay Company for transportation to their post at the mouth of Great Whale River, where Mr. Low intended to winter. From this place it is also intended that he should carry out such exploratory trips inland as may be found possible, during the winter and spring. A short report has since been received from Mr. Low which will be found on a later page.

New Brunswick.

The mapping of the surface geology of New Brunswick, was resumed last summer by Mr. Chalmers, in portions of York, Sunbury and Carleton counties, and in connection with this several interesting facts relating to the St. John River and valley were noted. Professor Bailey was also employed in New Brunswick in obtaining further notes on economic minerals and in investigating the age of the great slaty band of the interior of the province. Some new facts relating to the coal measures of New Brunswick, which have come under his observation, will be made the subject of a future report.

Nova Scotia.

In Nova Scotia, Mr. Fletcher has been engaged during the season chiefly in the vicinity of the Springhill coal-field. The principal result of this work, and one having great economic importance, is the tracing out of the coal seams upon which mining is now in progress, for a distance of more than two miles further than these were previously known to extend. Mr. Faribault also continued his work in this province, the greater part of his time being devoted to the gold-bearing districts east of Halifax, upon which he has a special report now in course of preparation, On a later page of this Report

preliminary details are given bearing on the Waverly, Montague, Lawrencetown, Lake Catcha, Tangier and Cow Bay gold districts.

Experimental Borings in Northern Alberta.

Boring operations in Alberta.

The second and third of the experimental borings in search of petroleum in the northern part of Alberta, were begun early in the summer of 1897 near the mouth of Pelican River, on the Athabasca, and at Victoria, on the Saskatchewan, below Edmonton, respectively. The sites selected for these borings were determined largely by the knowledge of the stratigraphical succession and thickness already gained in the first bore-hole at Athabasca Landing. The borings at Pelican and Victoria had reached depths of 820 and 705 feet respectively before winter. Operations were resumed at both places in the spring of 1898, as soon as the requisite arrangements could be made.

It will be remembered that work had to be suspended at Pelican in 1897, because of a very heavy flow of natural gas, under great pressure. It was hoped that most of this gas might blow off during the winter, and it was in fact found to be considerably reduced in amount when the locality was again reached by Mr. Fraser in 1898. Work was resumed, but additional and very strong flows of gas were soon met with in the underlying beds, and after exhausting every method of mastering these and continuing the boring, it became necessary again to suspend operations.

Difficulties met with at Pelican.

Some particulars of the attempts here made are given below in Mr. Fraser's report, from which it appears that the practically insuperable obstacle met with, was the clotting of the casing and tools with the heavy tarry petroleum, or maltha, mixed with sand, which was thrown up by the discharge of gas. It had been hoped that, at a greater depth, and particularly in the Devonian limestones from which the oil has been originally derived, it might be found in a more fluid state, but it has proved to be impossible to penetrate the "tar-sands" at the base of the Cretaceous at this place, and it appears probable that this could only be accomplished by beginning at the surface with a hole of much larger diameter.

Progress at Victoria.

Meanwhile, the boring operations at Victoria were steadily continued, without notable incident, but progressing slowly in depth on account of the exceptionally difficult character of the crumbling clay-shales to be penetrated. When the circumstances rendered it advisable to close the work here for the season, the depth obtained was 1650 feet. The hole is cased to this depth with $4\frac{5}{8}$-inch casing, and is in good condition for the resumption of work in the spring, when it

will be necessary to introduce 3⅝-inch casing, a sufficient quantity of which has been delivered at Edmonton.

At 1600 feet, the temperature in the bore-hole was found to be 76° F., as determined by special maximum thermometer manufactured by Casella. Temperature in boring.

It is believed that it will be necessary to carry this boring down to a depth of about 2000 feet, in order to make a fully satisfactory test of the rocks to the base of the Cretaceous in this place. The work so far has been confined to penetrating the great mass of overlying shaly rocks of this formation that it was known would be found here, and in which no developments of economic importance were anticipated.

At the request of several gentlemen in Edmonton, I visited Big Egg Lake, about twenty-five miles north-west of Edmonton, on August 22nd, in company with Mr. W. A. Fraser and Mr. E. Lyons, for the purpose of examining the indications of petroleum which had been found there. The place had already been examined by Mr. J. B. Tyrrell and by Dr. A. R. C. Selwyn, in 1893 and 1894 respectively, but it seemed possible that the facts since ascertained by means of the experimental borings might throw some further light on the conditions at Egg Lake. Tarry or pitchy matter is stated to have been here first found in ploughing on the north-west quarter of section 30, township 56, range XXV., west of the 4th meridian. Several small excavations were then made, and veins or layers of hardened pitch and pitch-saturated sand were found. The pits had, however, become filled before the time of my visit, and nothing could be seen but lumps of pitchy material which had been thrown up in digging them. Visit made to Big Egg Lake.

When Mr. Tyrrell visited the place the pits were still open, and as his report on observations then made was not published, the following may be quoted from it:— Previous observations by Mr. Tyrrell.

"On an almost level plain, declining very gently towards Egg Lake, several pits had been dug from three to four feet deep and in all 200 yards apart in a north-and-south line. On the side of the most northern pit, a narrow vertical vein of rather hard pitch, in places about an inch wide, could be seen running through the clay. Another pit, fifty feet south of the last, had been dug to a depth of nine feet six inches, but at the time had six feet of water in it. A large amount of sand saturated with tar was lying beside this pit. We baled the water out of this pit, when the unstratified material with pebbles was found to extend down to a depth of eight feet, and through it were running many veins of hardened pitch. Below this, a coarse, moderately even-grained and apparently horizontally bedded sand is reached. This sand is saturated with tar."

Search for oil.

Subsequent to the date of Mr. Tyrrell's note, a boring to a depth of 120 feet was made, about 150 yards to the north-eastward of the pit last described, by Mr. W. Pearce, who states that after passing through eight feet of soil and clay he found eight inches of tarry sand; after which he appears to have penetrated boulder-clay to a depth of forty feet, then layers of sand and gravel with water and below this soft sandstones of the Laramie formation.

Indications of a line of fault.

About three-quarters of a mile distant from the field in which the pits were sunk, on the south-west quarter of section 31, in the same township, is a rather remarkable spring and mire-hole. The outflow is not copious, but is accompanied by the emission of sulphureted hydrogen. Another spring of the same kind, and slightly saline, occurs about half-way between the first and the place where the tarry matter was found, and all three localities lie in a nearly due north-and-south line. The circumstances are in fact such as to favour the belief that the underlying strata have here been cut through by a small fault, by means of which the waters of these springs, and at an earlier date, the tarry matter, have forced their way to the surface.

Deductions from observations.

If this supposition be correct, it would follow that the petroleum from the deeper beds of the Cretaceous must have been in a sufficiently fluid state to rise through a fissure of the kind and locally saturate beds of sand traversed by it, as well as to fill narrow veins in the boulder-clay, subsequent to the glacial period; and it would appear probable that, in this part of the region at least, it may still remain in a similar condition. It does not follow, however, that this would be a specially favourable locality in which to test the lower beds of the Cretaceous by boring, for, on the contrary, our knowledge of the geological structure of this part of the country indicates that the depth at which these beds lie is here very great, probably at least 2500 feet and possibly much more.

Objects and progress of boring operations.

The experimental boring operations were initiated with the object of seeking for petroleum in quantities of commercial importance, at localities not too far removed from settlements and means of communication. The indications of the existence of petroleum, in the form of enormous deposits of "tar-sands" appearing along the natural outcrop of the lowest Cretaceous beds of the region, on the Athabasca, fully warranted the experiments entered on. The actual boring operations, have, in consequence of many unforeseen difficulties met with and the time lost in consequence of the remoteness of the work, been attended by regrettable delays, and have so far failed to demonstrate the existence of petroleum of economic value in respect to quality and quantity. They have, however, as pointed out in previous reports,

demonstrated the regularity and the great extent of the probably oil-bearing beds, and have indicated the occurrence of natural gas in important amount over a large tract of the North-west.

Petroleum of commercial value not yet discovered.

In regard to the actual existence of petroleum, the results have not up to the present stage been so satisfactory. The boring first begun, at Athabasca Landing, was unavoidably abandoned at a depth of 1770 feet, without reaching the probably oil-bearing beds at the base of the Cretaceous formation, but within a short distance of attaining these beds. The boring near the mouth of the Pelican River, penetrated the lower sandy beds of the Cretaceous for some distance and demonstrated the existence in these beds of a thick tarry petroleum or maltha, besides that of great reservoirs of natural gas. It has proved impossible to carry this boring to the very base of the Cretaceous and into the underlying formation, in which the existence of a more fluid and merchantable oil was still to be hoped for. The appearance of maltha at a distance of some sixty miles behind the natural outcrop of the "tar-sands" and where these basal beds of the Cretaceous are so well under cover, at a depth of 800 feet, is, it must be confessed, somewhat disappointing. It may possibly be that all the petroleum, derived from the underlying Devonian rocks, has, after saturating the porous beds at the base of the Cretaceous, passed into this tarry condition; but this is by no means probable, and the facts already described as seen at Egg Lake, appear to show that at a very late period, geologically considered, petroleum in a liquid form has existed, locally at least, in the underlying rocks.

Great area which may yield petroleum.

Taking the proved existence of tarry petroleum at the Pelican and the indications at Egg Lake together, we appear to have a demonstration of the occurrence of such hydrocarbons for a distance of over 150 miles from, and nearly at right angles to the direction of the natural outcrops of the "tar-sands" on the lower Athabasca. The locality at which the first experiment was attempted, Athabasca Landing, lies nearly in a line with these occurrences and not far from midway between the Pelican and Egg Lake, with the advantage over the latter of a much less depth of strata to be penetrated in order to pass through the whole thickness of the Cretaceous. The boring now in progress at Victoria, lies about fifty miles to the east of the line above referred to. This boring is in good condition for prosecution to the required depth next summer, and it is believed that it should be continued and completed. It is also believed that, in further prosecuting the work, a new boring should be undertaken at Athabasca Landing, beginning with a diameter somewhat greater than the last. With the experience now gained of the character of the shales to be penetrated,

Future operations.

it should not be difficult to carry the boring to the required depth without much loss of time.

Should the borings at Victoria and at Athabasca Landing find only maltha in the lower porous beds of the Cretaceous, and should the underlying Devonian rocks, to a moderate further depth not yield a liquid oil, it would be necessary to admit that the probabilities of developing petroleum of commercial importance in this part of Alberta are small. So far, however, the only discouraging feature met with is the appearance of tarry oil at the Pelican, while the proved continuity over a great area of the oil-bearing conditions, is most important, and the outlook generally is such as to be well worth any further effort that may be necessary to fully test the matter.

Report by W. A. Fraser.

The following account of the actual progress of the boring work is from Mr. Fraser's report on the same.—

"Both the bores commenced during the season of 1897 had been left uncompleted at the end of that season. The bore at Victoria had been carried down to a depth of 705 feet, and was discontinued in the autumn at that depth, being still in the dark shales which overlie the other strata, and which have a thickness of a thousand feet or more.

Boring near Pelican River, Athabasca River.

Pelican boring stopped by gas.

"The bore at Pelican River had been stopped at 820 feet owing to the striking of an immense flow of gas, which made it impossible to work while it continued to flow with such force. It was thought that by the spring of 1898 it would have exhausted itself sufficiently to permit further boring, and to this end the casing, $4\frac{5}{8}$-inches in diameter, was left quite free and open to permit the escape of the gas. It was estimated that before a depth of 1000 feet was encountered the Devonian limestone would be pierced.

Resumption of work.

"Upon investigation in the early part of the present season, the flow of gas seemed to have very materially decreased; but upon operations being resumed, the seeming decrease was found to be in a great measure due to the closing up of the outlet at the bottom part of the casing by an asphalt-like mixture, composed of maltha, or petroleum tar, and sand. In fact, when boring operations were resumed on June 17th, the difficulty was found to be intensified by the accumulation of this asphalt-like maltha in the bottom of the bore.

Difficulties met with.

"The rapid expansion of the gas produced a very low temperature, and this chilled and solidified the tar, or maltha, until it became as

adhesive as wax. As the tools cut it loose the gas would carry it up through the bore, until from bottom to top, it was almost one mass of sand and tar. The only way it could be extracted from the sand-pump was by heating the latter over a fire; even then very little could be got out at one time, it being so thick that it was almost impossible to force it up into the pump. I used different sorts of tools to cut it off the walls and clean it out, but the longer we worked at the bore the greater the quantity of tar accumulating on the sides of the casing and tools.

"We then pulled the 4⅝-inch casing out, thinking we might be able to ream down past the flow of gas, and thus shut it off, but the gas, which had increased in power with the cleaning of the hole, cut the walls down and blew great clouds of sand and gravel higher than the derrick. The men were forced to put the 4⅝-inch casing back in the hole without being able to ream past the strata from which the gas came. Great force of gas.

"While this was being done, I proceeded to Athabasca Landing, and sent down to the works by boat 1050 feet of 3⅝-inch casing. I then continued on to Edmonton to get a patent 4-inch drill bit which I had ordered by telegraph from Petrolia.

"After putting back the 4⅝-inch casing, the driller succeeded in getting the bore down seven feet below the formation from which the gas came. This filled in with maltha, and when they put down the 3⅝-inch casing to the bottom, it being wedged tightly in this maltha, shut off the flow of gas from the inside of this casing. The gas was then escaping between the 3⅝ and 4⅝ inch casing. Further depth obtained.

"Owing to the shutting off of the gas, it became possible to get water down inside the 3⅝-inch casing, and the men drilled ten feet very fast, through a soft sandstone. At this depth, 830 feet, another small flow of gas was encountered, but by using a casing-head, and a short piece of 1-inch pipe, they still managed to get water down inside the 3⅝ inch casing to drill with. In this manner another seven feet was drilled, when a strong flow of gas and maltha was struck in a conglomerate formation. This flow of gas, at 837 feet, was nearly as strong in volume as that met with at 820 feet.

"The 3⅝-inch casing could be carried no deeper, owing to the strength of the gas and the impossibility of getting water down, and as a smaller size of casing could not be used, nothing remained but to wire to Ottawa the condition of affairs, and wait for instructions. Upon receipt of your instructions to suspend operations, I did so at once, and returned the men to Petrolia. Drilling stopped by outburst of gas.

Character of the gas.

"I proved the general excellence and utility of the gas during the season, using it for my boiler, cook-stove and for lighting. I had only a 1-inch pipe, tapped into the side of the casing, and probably did not use the one-hundredth part of the gas coming from the bore, but there was sufficient to make all the steam necessary on my twenty-five horse-power boiler, keep fire in the stove, and also to supply a strong flare-light. The gas burned beautifully clean.

Its force.

"In working at the bore, the screeching and hissing of the gas, when at all confined by the presence of the tools inside the casing, or from other causes, was so great that the men complained of pains in their ears and heads.

"All that could be done was done to get the bore down the couple of hundred feet necessary to make a complete test in this place, and though failure was the result, it has, perhaps, shown how a bore may be carried down so as to get through these extraordinary gas veins. To ensure success, a new bore at the depth of 820 feet, where the first large gas-vein was encountered, should be at least ten inches in diameter; then it would be possible to reduce the casing four or five times, giving that many different lines of pipe to be used in getting by these gas-veins.

Extent of gas-field proved.

"The bore also furnishes additional evidence of the existence in the North-west Territories of a vast gas-field. The seemingly uniform continuity of the Cretaceous beds, makes it almost certain that gas-wells may be obtained by boring, over a great area, as pointed out in the Summary Report of the Geological Survey for last year, (pp. 18-19). Unfortunately the Pelican bore, like the boring at Athabasca Landing, did not penetrate deep enough to furnish reliable information as to the existence, or non-existence, of petroleum of a high quality. The presence of the low quality petroleum—maltha—is demonstrated, but as the more liquid oil may very probably underlie this, and as we did not reach a sufficient depth to determine the point, the result is unsatisfactory.

Section.

"The formation, from 820 to 837 feet, is a continuation of the "tar-sands" as under:—

820–830 feet.		Soft sandstone.
830	"	Hard streak and light flow of gas.
830–836	"	Soft sandstone.
837	"	(Conglomerate) — Iron-pyrites nodules embedded in cement-like sandstone. Very strong flow of gas.

"Upon closing down the work, the rig, derrick, and all machinery were left standing in place, and the casing was left in the bore-hole.

Boring at Victoria.

"It was decided, in the latter part of the winter, to take to Edmonton only the gang of men intended for Victoria, leaving the bringing up of a gang for the Pelican boring until such time as the said boring might be inspected and the utility of further operations decided upon. So, early in May, I proceeded to Edmonton with a drilling gang for the boring at Victoria. We reached Edmonton on May 7th, and proceeded to commence work at Victoria at once. Boring at Victoria.

"The 6⅝-inch casing had been put down previously to a depth of 700 feet. It was impossible to drive it beyond that depth owing to the great pressure of the caving shale, consequently the 5⅝-inch casing was inserted, and the bore continued of this diameter. Drilling was slow, owing to the continuous caving of these soft, dark shales, which correspond to the La Biche shales of the Athabasca bore. Casing reduced in size with depth.

"The 5⅝-inch casing was carried down to a depth of 1012 feet, when it became fast owing to the great pressure. Then the 4⅝-inch casing was inserted and carried down to the present depth of the bore, 1650 feet.

"It was thought, judging from the progress this latter size was making, that it would be possible to continue it to probably 2000 feet, but at the above depth it rather suddenly ceased going, and I am of opinion that one of the small, hard, concretionary nodules, that we encountered from time to time, dropped in beside it, and wedged it over against the wall. Casing stopped at 1650 feet.

"The pressure of the caved walls was so great on the casing that it was impossible to pull it up, otherwise we might have succeeded in clearing it. A patent under-reaming bit was used during the whole of the boring from 705 feet to 1650 feet, and gave good results.

"The continual caving of the shales made the drilling very slow, it being impossible at any time to drill more than ten or fifteen feet ahead of the casing. Saline water was encountered and also small flows of gas. At the present depth, there is a fairly strong gas-vein.

"Very little of unusual interest occurred during the season's work at Victoria. The driller I had, Mr. Wm. Slack, of Petrolia, proved a most careful, faithful and efficient man. This relieved me of a great deal of responsibility, and enabled me to devote more time to the operations at Pelican River.

"During the summer, it was decided that it would be advisable to have on hand at least 2400 feet of 3½-inch casing, to carry on the boring in case the 4⅝-inch should cease going. This was ordered, and Smaller sized casing procured.

is now at Edmonton, ready to be sent down to Victoria for use in the bore during next season's operations. The 3⅝-inch drill tools which were at the Pelican River boring were also brought up, and are now at Edmonton."

Strata bored through.

Subjoined is a record of strata bored through at Victoria :—

705– 960	feet.	Soft dark shale.
960– 970	"	" " " with layers of sand and a little gas.
970–1000	"	" " "
1000– 20	"	" " " streaks of sandstone.
102 – 30	"	Dark shale. Gas.
1030– 90	"	" Increased gas.
1090–1230	"	Soft black shale.
1230– 50	"	" " streaks of sandstone.
1250–1320	"	" " caving badly.
1320– 40	"	Brown shale, with sandstone layers
1340– 90	"	Sort dark shale.
1390–1410	"	Bluish shale. Thin streaks of sandstone.
1410– 28	"	Black shale.
1428– 30	"	Hard sandstone.
1430– 60	"	Black shale.
1460–1500	"	Bluish shale.
1500– 65	"	" Streaks of sandstone with gas
1565– 75	"	Hard sandstone.
1575– 85	'	Dark shale mixed with sandstone.
1585–1600	"	Hard sandstone.
1600– 45	"	Shale and sandstone strata mixed.
1645– 50	"	Hard sandstone.

Yukon District.

(With adjacent parts of British Columbia.)

Work by Mr. J. B. Tyrrell.

During the winter of 1897-98, Mr. J. B. Tyrrell was at first engaged in labelling and arranging the specimens collected during the preceding summer. Afterwards his time was devoted to examining and correlating the large series of Archæan rocks collected on Lake Winnipeg and in its vicinity during the summers of 1890, 1891 and 1895; to collecting the material for a final report on the Lake Winnipeg district, and to writing part of the report.

In the spring, he was instructed to undertake a reconnaissance survey of the south-western portion of the Yukon District, and with regard to this work he reports as follows :—

"On the 9th of May I received from you instructions for the season's work in the field, of which the material part was as follows:—

His instructions.

"'The principal object of your exploration will be to obtain as much geological and general information as possible respecting that part of the Yukon district between the line of the Lewes River and the 141st meridian, and to the south of the latitude of Fort Selkirk. The so-called Dalton trail will probably prove to be your most convenient base of operations, more particularly as it has already been mapped with some accuracy by Mr. McArthur of the Dominion Lands Survey.

"'Should good geological sections be met with, it may be well to devote some time to their particular examination, but, generally speaking, the work will require to be of a reconnaissance character, with the main purpose of ascertaining in what parts of the region the formations and conditions are such as to encourage search for payable gold deposits, ores and coal. Information of this nature will undoubtedly possess great value in directing the operations of prospectors in the season of 1899, by which time entrance to the entire Yukon District will probably have become comparatively easy.

"'The glacial and other superficial deposits will not escape your attention as these are likely to have intimate relations to the occurrence of placer gold.

"'If found to be convenient, at some time during the season it might be advisable to pay a brief visit to the Klondike region, for the purpose of comparing conditions there with those in the region more particularly under examination; but it would be unwise to allow this to materially interrupt the main work, in view of the shortness of the season, the necessary cost of the outfit for the expedition, and the probability that the horses, etc., may not be available for further operations in a following year. The same circumstances will render it proper to continue work in the autumn as late as the conditions remain reasonably favourable.'

Assistance from Mr. McArthur.

"Mr. J. J. McArthur, D.L.S., of the Topographical Branch of the Department of the Interior, had travelled over part of the Dalton trail last year, and was going over it again this year on his way to Stewart River. He kindly offered to purchase horses for me and to take them to Pyramid Harbour with his own; as he was acquainted with the district, and where feed, if any, could be obtained, this was a favour which would assist me very materially at the beginning of the exploration.

Preparations for work.

"Mr. J. F. Shaw, of Ottawa, was employed to look after the horses, and on the 26th of April I sent him west to join Mr. McArthur in Van-

couver, with instructions to render any assistance in his power in the purchase and care of the horses. On the 12th of May I left Ottawa and proceeded to Kamloops, where I obtained some saddles and blankets belonging to the Survey that had been stored there some years before.

"Thence I went to Vernon, and there employed two men, Cameron and Redmond, the former as packer, and the latter as cook. With these men I went to Vancouver, where I found that Mr. McArthur had gone on with the horses on the steamer *Islander* a few days before. After obtaining the supplies necessary for the summer, we followed in the steamer *City of Seattle*, and on 28th May arrived at Mr. McArthur's camp on the bank of the Chilkat River, not far from Haines Mission. As yet the grass had scarcely began to grow, and the country afforded very little feed for the horses, so that it was necessary to supply them with feed brought from the south. Dalton's new trail was not yet cut out on the west side of the river, and the flats by the river were so wet that they were scarcely passable.

Assistance from Mounted Police.

"Mr. McArthur obligingly agreed to continue in charge of both parties until the 12th of June, during which time he was able to move about twenty-five miles up the Chilkat River to the crossing of Salmon River. From here he was obliged to return to Dyea, while I pushed on to the camp of the North-west Mounted Police at Pleasant Camp, and then over the summit to Rainy Hollow, being the first to reach there with horses this summer. At the Mounted Police station, Inspector Jarvis kindly had all our horses shod, for many of them had dropped their shoes among the stones in the beds of the streams that had been followed or crossed. Our party, on leaving Pleasant Camp, consisted of myself, three men, and fourteen horses. On account of the scarcity of food the horses had failed in flesh very considerably.

"The Summit."

"The hill just west of Pleasant Camp, forming the high land known as 'The Summit,' is a spur of gray hornblende-granite projecting out into the valley. It is 1700 feet in height and rises with a slope of 22° from a small grassy plain surrounded by dense coniferous forest, to a barren alpine plateau, entirely devoid of trees. The luxuriant flora of the Pacific Slope extends up the Klaehini valley to this hill, and to some extent around it, and up the valley to Rainy Hollow, but beyond that point the flora of the drier interior plateau takes its place.

Dalton post.

"We continued on to Dalton post, on the Tatshenshini River, where we arrived on June 24th. The Indians of the surrounding country were collected in the adjacent village of Wesketahin to await the arrival of the salmon up the stream.

"On the way, I had made as careful an examination as possible of the general geology of the region, but since the sides of the wide valley were covered with glacial detritus up to height of from two to three thousand feet, it often required the expenditure of a great amount of time to see the underlying rock at all. As a general rule, however, the valley was found to run between a range of granite mountains to the north-east, and a range of mountains of schist, quartzite, etc., to the south-west. Rocks.

"The main branch of the valley, which we had been following, continues on towards the north-west from Dalton post, but we turned northward up the valley of Unahini River, and followed the banks of this stream, or climbed along the slopes of the mountains, to Klukshu Lake. Here a trail turns westward towards Shorty, Roberts and Alder creeks, but the Dalton trail, which we were following, continued northward, up the east side of the lake, and then across the wide Shakwak valley, through which Messrs. Glave and Dalton first reached this country in 1890. Lake Dezadash lies in the angle where the two valleys cross, and from it flows one of the longest branches of the Alsek, at first northward, then westward and afterwards southward to the Pacific. After leaving Lake Dezadash it flows through a deep and comparatively narrow valley, between Mount Kelvin, a magnificent granite mass that rises to a height of 5000 feet above the river on the east, and Mount Bratnober, about a thousand feet lower, on the west; this latter mountain appearing to be composed chiefly of dark mica-schists. Near Hutshi, the sources of the Nordenskiöld River, one of the tributaries of the Yukon, were reached. Up to this time no attempt at a survey had been made, but at Mr. McArthur's request I had taken a few observations for latitude. Continuation of Dalton trail.

"At Hutshi I began a compass and paced survey of the trail down the Nordenskiöld River, and continued this survey down to the Lewes River, where we arrived on July 12th.

"Although the greatest possible care had been taken of the horses they were now very much run down. I therefore left them here in charge of the men and in good pasture, and descended the river to Dawson, where I arrived on the 16th of July. Mr. McConnell, of this Department, had arrived there the day before, and together we examined Bonanza, Eldorado and part of Dominion creeks. Our report on this work is given on another page. Visit made to Dawson.

"On the 7th of August, I again reached my camp at the mouth of the Nordenskiöld River, but unfortunately some inflammatory disease had broken out among all the horses there, Mr. Dalton's as well as mine, Rejoin the party.

and instead of being in good condition for the work of the rest of the season they were lean and weak.

"At Dawson Mr. S. N. C. Treadgold, who was visiting the country in the capacity of a special correspondent of the *Mining Journal*, offered to accompany me for the rest of the season, and being rather short of men I was glad to avail myself of his services.

Travel westward.

"Acting on a suggestion made by Mr. McArthur, we returned up the Nordenskiöld River for a short distance, and then turned westward up the west branch of that stream, for which I would suggest the name Wright River, after Professor R. Ramsay Wright of Toronto University. We ascended the valley of this stream for most of its length, and then turned south-westward, through a ridge of rounded granite mountains, to a valley in which is a stream flowing towards the west. This valley was descended to the point where it is crossed by a trail from Hutshi to Fort Selkirk, and here the stream was recognized as that which had been called the Tahté by Mr. McArthur. We then travelled south to the Indian village of Aishihik, hoping to meet some Indians who would indicate to us the most feasible route into the country further west, but the place was found to be entirely deserted, so that we were thrown back on our own resources.

Trail by Tahté River.

"Finding a foot-trail leading to the west, we decided to follow it. It led us into a mountainous country underlain by mica-schist, limestone, etc. The second day we came to a creek flowing westward, but after following it, it turned to the north, and three days afterwards brought us to a wide valley which was evidently that of the Tahté River, and not far from the place where we had left that river a week before.

Reach White River valley.

"We descended this magnificent wide valley, which has finely terraced sides, for five days, until we found it opening out into the valley of White River. We thus found that the stream which we had been following was the Nisling River, which had been crossed by Dr. Hayes in 1889, on his overland journey from Fort Selkirk to the Copper River.

Return journey.

"It was now the 29th of August, and a hard frost on the night of the 27th had begun to strip the leaves from the poplars, warning us that the summer was over, and that the Chilkat Mountains, near the coast, would soon be covered with snow. We therefore turned back up the Nisling River, followed it up to the crossing of the Selkirk trail, and then followed that trail southward to Aishihik. From Aishihik we followed the high ridge west of Aishihik Lake, crossed the Aishihik River, and reached the west side of Hutshi Lake, just as Mr. Hanley camped on its eastern side with a large band of horses.

"The next morning, Sept. 12, we came up with Mr. Hanley, and as most of the horses that we had left were about used up, we hired three fresh ones to help us out to Pyramid Harbour. On September 17th, we reached Dalton post, and on the 21st the post of the North-west Mounted Police at Pleasant Camp. Besides the horses that we had hired from Mr. Hanley, there were six of our own remaining. We had spared them all summer as much as possible, by carrying just what was absolutely necessary for the work in hand, and by walking almost all the time ourselves, but the change in their conditions of life from southern British Columbia to the Yukon district, had proved too much for them, and they had dropped off one by one. Three of the six could go no farther, and Inspector Jarvis kindly loaned us three others in their place to take us down to the coast. Pyramid Harbour was reached on September 25th, Skagway on the 26th, and Ottawa on the 13th of October. Animals exhausted.

"During the season, from the time of leaving Pyramid Harbour until my return to the same place, I travelled about 1300 miles. A geological examination of the country was made throughout most of this distance, and new surveys were made aggregating 300 miles in length. A large number of photographs were also taken, showing the general character of the country traversed, the appearance of the rocks underlying the country, the gravel terraces, the hill and valley gold-claims, the mode of sinking shafts, of making open cuttings, of rocking and sluicing gold, etc. New surveys made.

"Fifty-one species of plants were collected, and these have since been determined by Mr. J. M. Macoun. Of these (1) *Parrya macrocarpa*, (2) *Phlox Richardsonii*, and (3) *Gentiana frigida* had not before been found in the Yukon district, and the last-named not before in any part of Canada. The localities at which they were found were, respectively: (1) summit of Father Mountain, about 6000 feet, (2) Selkirk Trail, and (3) tributary of Nisling River, above the tree-line. Plants collected.

The Dalton Trail and its Vicinity.

"The country in the vicinity of the Dalton trail, may be divided into two parts, with topographical characters sufficiently distinct and persistent to be almost everywhere recognizable, viz.:—The Chilkat Ranges, a name here proposed for the high range of mountains extending north-westward and westward from the Lynn Canal and the table-land of the interior. Topography of Dalton trail.

"The Chilkat Mountains form a rough irregular range, extending inland for about a hundred miles from the main coast-line of the Pacific Ocean, which coast-line stretches south-eastward from Yakutat Bay to Cross Sound, and thence onward along the outer side of the Alaskan Archipelago.

"In the district at present under consideration, which lies north-west of the head of Lynn Canal, these mountains form an elevated region whose outer side descends more or less steeply towards the ocean, while many jagged, rocky peaks rise to heights of 6000 to 8000 feet above the sea.

Effect of glaciers.

"The mountains are intersected by deep valleys, of which the higher parts, lying at some distance back from the coast, are for the most part filled with vast fields of snow and ice, from which glaciers radiate in all directions, some descending steeply towards the coast, while others move landwards and give rise to some of the largest streams draining the country, notably to White River, and to many of the tributaries of Alsek River. The ice has, however, withdrawn or melted away from some of the valleys, and has left their sides with beautiful smooth well-rounded slopes. Of these ice-free valleys, none is more conspicuous or persistent than that which, in its outer coastal portion, is drained by the Chilkat and Klehini rivers; while farther inland its waters are collected into the Tatshenshini, or most easterly branch of the Alsek River.

Old Indian trail.

"In this valley, the Chilkat Indians of the village of Klukwan, and of the other villages on the banks of the Chilkat River, have for ages had a foot-path by which they travelled between the coast and the interior, in order to trade with the more remote tribes living on the upper waters of the Alsek River. This path has been cut out and improved by Mr. J. Dalton, until there is now an excellent trail for pack-horses from the coast into the interior, appropriately known as the Dalton trail.

Height-of-land.

"This trail follows the above-mentioned valley from Pyramid Harbour to Klukshu Lake, a distance of about 120 miles, running in a general north-westerly direction diagonally through the Chilkat Mountains. In this valley the height-of-land, which is at a distance of seventy miles from Pyramid Harbour, has an approximate elevation of 2650 feet above the sea, being more than 200 feet lower than the summit of the White Pass, and 850 feet lower than the summit of the Chilkoot Pass, while at the same time, being more distant from the coast, the approach to it is much more gradual.

Character of wide valley followed.

"The height-of-land, or water-parting, is hardly recognizable as such, being only a wide, flat, swampy portion of the bottom of the valley.

Beyond it, the valley declines gradually north-westward, with a slope of about twenty-five feet to a mile, without any abrupt break or dip of any kind. Its bottom varies from half a mile to a mile or more in width, and its sides rise in gentle grassy slopes and terraces for a couple of thousand feet, above which tower mural precipices, and broken rocky cliffs.

"For about fifty miles from Pyramid Harbour, the valley is everywhere, except on the flooded land besides the streams, wooded with a dense coniferous forest; but on the upland country, for the next fifty miles, very little timber is anywhere to be seen, the lower lands and the mountain sides being alike covered with short grass, or a dense growth of dwarf birch and willow.

Interior country.

"The interior table-land is also a decidedly mountainous country, but the slopes are more gradual. Most of the peaks are gently rounded, and there are no glaciers or permanent snow-fields, so that while a great number of peaks may be in view at one time, and though these peaks may in some cases rise as high as from three to four thousand feet above the bottoms of the adjoining and intervening valleys, the whole landscape has the appearance of a hilly or lumpy upland, the higher portions covered with grass or scrub, while groves of dark, green spruce may partly cover the bottom-lands. In many places, level terraces follow along the sides of the mountains, forming wide and easy steps, which are usually thinly wooded with poplar, or covered by a rich grassy turf. These dry, thinly wooded terraces, and in fact much of this inland region, reminds one strongly of parts of the attractive country near the banks of the Saskatchewan River, east of the Rocky Mountains.

Continuation of wide valley.

"The wide valley mentioned above, continues northward through this interior table-land. North of Dalton post, it is drained by the Unahini River, beyond which lies Lake Dezadash, and that branch of the Alsek River which flows from it. From the north bend of the Alsek, one branch of it continues across to the Mendenhall, and thence down the Nordenskiöld to the Lewes, but another branch would appear to turn northward down the Alsek, then northward up the Aishihik River to Aishihik Lake, over Aishihik Lake, and along the wide flat valley north of it to Nisling River, down Nisling River to White River, and down White River to the Yukon River; having a remarkably direct course throughout the whole distance. This valley, whether entered at Pyramid Harbour, or at some point which may be easily reached by the White Pass, is undoubtedly the shortest and easiest known route from the coast to the heart of the gold district of the Klondike.

A direct route.

Plants and animals.

"Many natural fruits common east of the mountains, here grow and ripen in great profusion, and it seems not at all impossible that most, if not all, the grains, fruits and vegetables that will ripen in the Edmonton country will also ripen along this portion of the Dalton trail.

"Wild animals, as a rule, are rather scarce, but one small mammal proved to be of more than ordinary interest. This was a ground-squirrel, (*Spermophilus empitra*), which was very common on the terraces, everywhere from Rainy Hollow north to Rink or Five Finger Rapids, its burrows being conspicuous on all the dry places. In these burrows the animals live and continue active both in summer and winter, and in order that they may be warm and comfortable, the burrows invariably descend below the limit of frost. Consequently, wherever they are found, the frost cannot be more than a few feet deep, or such a depth as the ground would freeze in winter and thaw again in summer. Now where the ground is permanently frozen the frost extends to great depths, and therefore, wherever these ground-squirrels can burrow and live the ground is not permanently frozen. On all the dry benches and uplands, as far north as Rink at all events, there is no permanently frozen ground, although many of the boggy places, whether in the bottoms or on the sides of the valleys, are certainly underlain by frozen ground throughout the year. The fact that these benches are not permanently frozen, removes one of the strongest objections that has been raised to successful hydraulic mining in the Yukon District.

Rink or Five Finger Rapids.

Geological features.

"The rocks observed in the south-western portion of the Yukon district, range in age from the Archæan up through the Palæozoic, Mesozoic and Tertiary to Pleistocene sands and gravels, and in character they include granite, diorite, porphyry, porphyrite, diabase, trachite, rhyolite, basalt, lava, volcanic ash, mica-schist, sericite-schist, argillite, marble, quartzite, conglomerate, sandstone, etc., the last seven being more or less altered aqueous sediments which had been deposited one above another in the seas of the different geological epochs.

Granites.

"A massive gray and reddish-gray granite forms the main structural axis of this country, extending as it does north-westward from the head of Lynn Canal, past Lake Dezadeash, and away to the westward of Aishihik Lake. This is doubtless a continuation northward of the granite of the Coast Range of British Columbia, and like it is very barren of minerals of economic value.

Rocks overlying granites.

"Resting on or against the granite, and often very much disturbed and altered by it, is a dark argillite, interstratified with heavy beds of white crystalline limestone. In many places the argillite passes

below into a highly crystalline mica-schist. These schists and argillites are usually cut by veins and stringers of quartz. Wherever they underlie the country, gold can usually be washed out of the sand in the bottoms of the valleys. Thus they appear to be everywhere, to some slight extent at least, impregnated with gold. They are very widely distributed, extending from the west side of Lynn Canal up the west side of the Chilkat and Klehini rivers, along the north-west side of Tatshenshini River, through the Dalton Range, and northward, past Aishihik Lake to the Nisling or Tahté River, beyond which they are probably continuous with the schists that outcrop along the banks of the Yukon, from the mouth of Selwyn River to Dawson.

Porphyrites.

" One of the most conspicuous and wide-spread rocks in the district, is a dark-green porphyrite, which has broken through and altered the argillites and limestones above mentioned. It composes the mass of many of the highest and most conspicuous mountains in this portion of the interior, among which are mounts Maloney and Fairview, while the Sifton Mountains are said to consist largely of the same material.

Glaciation.

"North-eastward, as far down the Lewes River as Rink Rapids, the country has been more or less severely glaciated, by an ice-sheet that extended inwards from the high ranges bordering its coast. This ice-sheet pared down many of the inequalities of the surface, and deposited a thick coating of unstratified boulder-studded clay or till in the bottoms of the valleys. Where the till has been chiefly derived from the argillites or mica-schists, as in parts of the valley of the Kaskawulsh River, it appears to contain a small amount of fine gold, some of which may eventually be recovered by inexpensive hydraulic processes.

Terraces.

" Terraces of stratified clay, sand or gravel are common on the sides of some of the valleys, where they have been formed in lakes that existed at the foot of the great ice-sheet, or by streams that flowed from it. Some of these contain gold, where the deposits composing them have been derived from argillites or mica-schists.

Gold.

" Specimens of coarse gold, were shown to the writer as having been taken from Alder Creek and other streams in its vicinity. The country-rock is reported to be an argillite or mica-schist, and the gold has doubtless been derived from it. Whether it occurs in large quantities or not is as yet uncertain, but the question is deserving of further investigation.

Native copper

" For some years past, it has been reported that native copper was to be found on some of the upper tributaries of White River. An effort was made to visit the locality, but the coddition of our horses, rendered

our progress through the country very slow and thwarted this object, though we reached the valley of White River at the mouth of Nisling River. Here some Indians whom we met, and who had some small masses of native copper in their possession, reported that the copper country was still six days' journey distant, and that the copper was invariably picked up in the gravel on the stony flats beside the stream. This report of its mode of occurrence agrees closely with other accounts which were received. Its occurrence *in situ* is not yet known, but quite probably it is associated with a basic igneous rock such as the porphyrite mentioned above.

Copper ores.

"Early in the year, fragments of copper-pyrites were observed among the gravel-wash from a glacier, a short distance south of Glacier Camp. On my return in the autumn to the camp of the Mounted Police at Pleasant Camp, I was shown some fine specimens of bornite and chalcopyrite, with galena, which were said to have been found near Rainy Hollow. These discoveries would appear to indicate the existence of deposits of native copper or copper ore which may, in the near future, be of great economic importance."

Work by Mr. R. G. McConnell.

After his return from the field in 1897, Mr. R. G. McConnell was employed during the greater part of the winter and spring in working up the notes and collections made by him and his assistants in West Kootenay. When it was determined to undertake explorations in the Yukon District, part of which he had previously traversed in 1887, he was assigned to this work. His instructions were to make a geological reconnaissance by the chief eastern tributaries of the Lewes River and of the country adjacent to these, as well as a preliminary examination of the geological features of the route between Teslin Lake and the Stikine. He was also to devote a portion of the season to a general inspection of the geological conditions on the richly auriferous creeks of the Klondike region. All the main objects thus outlined were successfully covered during the rather short available season. The results are given as follows by Mr. McConnell:—

"I left Ottawa on May 13th for the Yukon district, accompanied by two Indians from Lake Temiscaming, who acted as boat-men and proved to be both capable and trustworthy. We reached Vancouver on May 19th and Dyea on May 27th. Our outfit, consisting of four months' supplies for three men, a Peterborough canoe and a canvas boat, was taken across the Chilkoot Pass from Dyea and landed at the head of Lake Bennett by the Chilkoot N. & T. Co. in three days. The ice on the lake broke up in the first week in June, and we were able to proceed immediately down the river. We left the head of Lake Bennett carrying our outfit in the canoe and

Crossing the Chilkoot Pass.

canvas boat, and reached the mouth of the Big Salmon without accident on June 12th. From this point a traverse and geological examination was made up the Big Salmon to the head of Quiet Lake.

Big Salmon River.

"The Big Salmon has an approximate length of 142 miles, to the chain of lakes at its head, or, including the latter, a length of about 170 miles. Its width varies from thirty to a hundred yards. In a few reaches, it is a smooth, placid stream with an easy current, but for most of its length it is shallow and rapid, interrupted by numerous sand-bars and gravel-bars, over some of which the river has a fall of several feet. Rapids occur at the mouth of the North Fork and at another point about seventy miles further up, but can be easily run by small boats, except at low water. The Big Salmon cannot be considered a navigable stream for steamers, even at high water, and at low water small boats, when loaded, find difficulty in navigating it.

Character of the valley.

"For forty five miles above its mouth, the Big Salmon occupies a wide wooded valley bordered by rounded hills. Above that point it turns to the east and enters a wide range of mountains, through which its valley runs from its source in Quiet Lake. The direction of the river for the first thirty or forty miles above the South Fork, is generally transverse to that of the mountain ranges, but is parallel to them further up. The valley becomes much narrower after the mountains are entered, being in some places reduced to a width of less than a third of a mile, and is bordered by steep-sided mountains and mountain ranges from 3000 to 4000 feet in height above it, on some of which patches of snow exist in sheltered nooks throughout the year. It is terraced up to heights of from two to four hundred feet along its entire course.

Tributaries.

"The main tributaries of the Salmon are the North Fork, entering about twenty-five miles above its mouth, the South Fork, which comes about twenty miles further up, and a stream which joins it from the east a short distance below the lake. Besides these a number of large streams, heading in the adjoining mountain ranges, join it at various points along its course.

Lakes at head.

"The Salmon River heads in a chain of lakes about twenty-eight miles in length, connected by short streams with little current. The highest lake is the largest and is known as Quiet Lake. It is about nineteen miles in length with a maximum width of two and a half miles. The depth was not measured, but the lower, or Island Lake, gave a maximum sounding of 138 feet. Quiet Lake is bordered on the west by high mountains, and on the east by a rolling plain that extends to the Nisutlin River, four to five miles distant, and is broken by a number of rocky hills, the highest of which rises 1900 feet above it. The

valleys of the Salmon and the Nisutlin are united at the upper end of Quiet Lake and also at Island Lake. The longer diameter of the latter is transverse to the general direction of the rivers, and follows an old valley connecting the two streams, now filled up with glacial deposits.

Forest

"The valley of the Salmon is generally fairly well forested along the bottoms and up the mountain slopes to heights of from 1500 to 2000 feet above the river. The principal forest trees are the white and black spruce, the former often attaining a diameter of a foot or more, the black pine, a variety of fir, birch, aspen and balsam poplar.

Geological section.

"The Salmon River valley, except for the first forty miles, affords a very good geological section. Below the North Fork, the valley is wide and exposures are infrequent. The rocks seen consist of greenish tufaceous sandstones, passing into agglomerates and slates, cut by diabases, and a whitish porphyritic rock of geologically recent appear-

Granites.

ance. At the North Fork, a range of hills four miles east of the Salmon, consists of reddish medium grained granites, and the same rock is reported to occur eastward along this stream for a number of miles. Between the North and South forks, no outcrops were noticed. Above the South Fork, the valley enters the mountains, becomes narrower,

Stratified rocks.

and exposures are frequent. The rocks above the South Fork consist of micaceous schists, quartzites, greenish schists and limestones, cut by granitic dykes. The dips are vertical or to the west. The green schists and associated rocks are succeeded, in going up the river, by a wide band of dark slates and schists interbanded with green schists, and further on by whitish granular limestones. The limestones are cut by a wide band of grayish granite. They dip to the east, except near the granite, where they are vertical, and are underlain by a great thickness of quartzite and micaceous schists alternating with bands of

Great anticline.

crystalline limestone. These rocks resemble the Shuswap series of the Selkirk Range. They are bent up into a great anticline, and are exposed, with little variety in composition, for many miles along the valley. The axis of the anticline crosses the Salmon near a great bend which the latter makes to the north. Above that point the dips are to the east. The Shuswap schists are overlain about forty miles below the lakes, by a limestone band similar to that which occurs in the western limb of the anticline. The limestone is exposed along the river for some miles and forms conspicuous mountain ranges on both sides of the valley. It is succeeded, in ascending the river, by dark slates and schists holding bands of greenish tufaceous beds and some limestones. The tuffs in places have been altered into serpentines. The slates and associated green schists are exposed along the Salmon to the

lakes and along the lakes to a point about half way up Quiet Lake, where they are cut off by a great granite area which can be traced southward along the Nisutlin River to Teslin Lake. Another granite mass.

"The rocks of the Salmon River anticline consist, in a general way, of three great divisions. A basal series of quartzitic and micaceous schists and crystalline limestones, an intermediate granular limestone, and an upper division consisting of dark slates, green schists, tuffs, limestones and serpentines. No fossils were found and it is impossible to fix the age of these formations with any certainty. Sequence of strata.

"A number of prospectors ascended the Salmon during the summer, but most of them were inexperienced, and little effective work was done. Several shafts were commenced, but the influx of water prevented deep sinking, and none of them reached bed-rock. Fine gold is found all along the Salmon, and a number of the bars below the North Fork have been worked sucessfully during low water in former years. Coarse gold was stated to have been found in a couple of places in the lower part of the river, but I was unable to verify the reports. Fine colours were obtained in the wash of many of the streams emtying into the Salmon, and on a bar at the mouth of the stream which joins the latter three to four miles below the lakes, a very good prospect was obtained. Small quartz veins cut the schists in a number of places, and at one point west of Island Lake, several large veins cutting a dolomite band were noticed. Specimens of this quartz were collected but have not yet been assayed. An angular fragment of drift quartz, holding gold, was found at the mouth of a stream about twenty miles below the lake. The country in the neighbourhood of the upper part of the Salmon, based as it is on old schists cut by great eruptive masses, offers a very favourable field for prospecting, both for quartz and placer gold. It was run over by a number of people during the past summer, most of whom, however, had little knowledge of any branch of mining, and very little genuine prospecting was carried out. Prospecting for gold. Quartz veins.

"After finishing the examination of the Salmon, I went down the Yukon to Dawson, and spent two weeks in a hasty examination of a part of the Klondike region, some notes on which is given in another part of this report. From Dawson I came up the Yukon in a steamer to the mouth of the Salmon, and spent the remainder of the season on Teslin River, Teslin Lake, the Nisutlin River and the Teslin trail. Descend river to Dawson.

"The Teslin or Hootalinqua River is one of the main feeders of the Yukon. It is a large stream, averaging about 125 yards in width when confined, but widening out around islands, and with a length, according to Mr. St. Cyr's survey of 1897, of about 100 miles. The current is pretty Teslin or Hootalinqua River.

swift for the first seventy miles, running from three to five miles per hour, with occasional accelerations where bars cross the stream. Thirty miles below the lake, the grade lessens and the current drops to less than two miles an hour. No rapids occur on the Teslin, but bars are frequent and on some of these the water in the autumn is so shallow as to interfere with navigation. The steamer *Anglian* which was built on Teslin Lake, descended without much difficulty in the early summer, but was unable to ascend again towards the end of August, on account of the shallowness of the water on the bars. The Teslin differs altogether in character from the Lewes. The latter is fed largely from the glaciers of the Coast Ranges and remains fairly high until the cold weather sets in. The Teslin, on the other hand, has no such reserves to draw upon. It rises in May with the melting of the snows, is in full flood about the first week in June, and then falls steadily, as the lakes are gradually emptied, throughout the season. The summer of 1898 was an exceptionally dry one, and it is claimed that the Teslin was lower than usual on this account, and that in ordinary seasons its navigation is practicable until late in the autumn. This is quite possible, but as no good records for preceding years exist it is still an open question.

Navigation of Teslin.

Teslin valley.

"The valley of the Teslin averages about a mile in width, from the mouth up to within a few miles of the lake, where it widens out to about two miles. It is bordered by high lumpy hills and low mountain ranges throughout its whole length. Between the river and the base of the hills, is a series of flats, the highest of which has a remarkably uniform elevation all along the river of from 300 to 320 feet. The immediate banks of the river are generally terraced, but high cut-banks of white and light-yellowish silts and boulder-clay occur at the elbows of some of the bends.

Geological section.

"The geological section along the Teslin is not very satisfactory, as the course of the river is almost parallel to the strike of the rocks. Near the mouth, and for some miles up the river, a recent volcanic rock outcrops, the character of which has not been determined. It incloses fragments of slate and is succeeded by a band of crushed and altered slates. The slates are followed by reddish-weathering tuffs and agglomerates, and frequent exposures of these rocks, alternating with slates, appear along the river or on the hill-sides nearly all the way to the lake. They inclose occasional bands of nodular limestone. At the mouth of Boswell River, which enters the Teslin from the east, a conspicuous range of bold mountains is built almost entirely of grayish and reddish-weathering limestone. Above Boswell River, dark and greenish slates and schists, tuffs and other old volcanic fragmental rocks resume and continue to the head of the river.

"Fine gold is found in a number of bars and beaches along the Teslin, but as a rule in inconsiderable quantities. Some work was done on a few of the bars during the past season, but the results were stated to be not very satisfactory. The streams entering the Teslin are few in number and with one or two exceptions insignificant in size, and as they do not as a rule traverse an especially promising gold country, it is probable that the gold in the Teslin gravels is largely derived, from the washing away and concentration, by the river, of the glacial and stream deposits which floor the valley. Occurrence of gold.

"The Nisutlin River was traced into the Pelly Mountains, and the branch followed was found to head within twenty miles of the Pelly River. The Nisutlin enters Teslin Lake about thirty miles above its lower end, and is its principal feeder. It has a width of from 200 to 400 feet. The current is swift to the first fork, a distance of about three miles, above which, for many miles it does not exceed two to three miles an hour. The river winds, in its lower reaches, through a low alluvial plain, apparently a filled-up bay of the lake, which gradually narrows to the north. The valley is wide, often exceeding ten miles, and is bordered by low round-topped mountains rising from 3000 to 4000 feet above it. A wide forested plain spreads from the immediate valley of the river to the foot of the mountains. The river is crossed by numerous shallow sandy bars in this lower part, and by gravel bars further up where the current is swifter. The water on many of these was found to be too shallow to allow of the navigation of the river by steamers of any size, late in the season. Nisutlin River. Nisutlin valley. Navigation of Nisutlin.

"The Nisutlin valley has a nearly north-and-south direction from Teslin Lake to a point opposite Quiet Lake on Salmon River, a distance of about seventy-five miles. The valley still continues to the north above this point, and is occupied by a fork of the Nisutlin, but the main river bends suddenly to the east and follows a north-easterly course through a wide range of mountains that extends north-eastward almost to the Pelly. The Nisutlin, after entering the mountains, becomes narrower and swifter, steep bars are frequent, and long bouldery rapids render its navigation, even with small boats, difficult and dangerous. We cached our canoe at the foot of one of these rapids and continued the exploration on foot. Rapids.

"About twenty-five miles from the point at which the mountains are entered, the river again forks. The main branch comes from the east and appears to head in a wide lake-dotted plain, a view of which was obtained from the summit of a high mountain at the forks. The route from the Liard leads down this branch. The left fork, which was the one followed, as it promised a better geological section, breaks through Plain.

the range in a north-easterly direction. Above the forks just mentioned, the branch we ascended dwindles rapidly in size as numerous feeders from both sides are passed. About twenty miles from the forks we turned up a small stream flowing from the summit range, and five miles further on reached the Nisutlin-Pelly watershed. This was crossed by a good pass about 4000 feet above the sea, flanked by rugged mountains about 3000 feet higher. We continued on down a stream to the north, for about seven miles, and then returned. From the summit of a mountain opposite our last camp, the Pelly was seen flowing in a wide valley, at a distance of about twenty miles. The Pelly Range, where crossed, runs nearly east-and-west. South of the divide, it consists of a number of well-defined subordinate ranges striking east-and-west. North of the watershed, it has been carved into a confused mass of mountains and mountain groups by a number of branching streams tributary to the Pelly. Some of the peaks in the watershed and adjoining ranges exceed 7000 feet in height. The valley and lower slopes of the mountains are generally wholly or partially wooded up to a height of about 3000 feet above the sea. Above that point, grassed and moss-covered slopes and bare peaks and ridges prevail.

Pelly River.

Character of Pelly Range.

Geological section on Nisutlin.

"The Nisutlin River, until it leaves the main valley east of the Salmon lakes, does not afford a good geological section. The valley is wide, and the river is bordered by wide wooded flats composed of alluvial or glacial materials. Occasional traverses were made to the mountain ranges, on both sides, on the way up, and some data were collected, but the section is incomplete. Greenish volcanic rocks, usually more or less schistose, occur along Nisutlin Bay. At the head of the bay, a wide band of granite crosses the valley. In the lower reaches of the river, green schists outcrop in a few places along the valley, and then exposures cease. The mountains west of the valley are composed principally of grayish granite and form part of the great granite area, mentioned before, that stretches from Quiet Lake south, to, and along Teslin Lake. The granite crosses the valley and outcrops in the mountains east of the Nisutlin above the first fork, and extends north about half way to Quiet Lake. Above that point, green schists interbanded with limestone come in, and are exposed in the ridges east of the river for many miles to the north. Greenish schists, cut by granite dykes from the Quiet Lake granite area, also outcrop in some small hills on the portage from the Nisutlin River to Quiet Lake.

"Above the point at which the Nisutlin bends to the north-east and cuts across the mountain ranges, exposures become more frequent. Green schists and dark slates, interbanded with some limestone or

dolomite, outcrop for several miles, and are succeeded by a coarse-grained, reddish porphyritic granite which continues almost to the upper forks. Beyond the granite, green schists resume, and are succeeded by lead-coloured and black slates and schists and then by quartzites and dolomites. The dip is to the west and the section is a descending one. The quartzites and associated rocks are followed by a band of heavy limestone beds that forms a conspicuous range, and then by dark slates and schists, and green schists and limestones which continue to the summit of the Pelly Range. At the summit, the beds have an anticlined attitude. They consist there mostly of dark slates and schists, with some agglomerates, succeeded, on the north slope of the range, by green schists and limestones. A band of limestone three miles east of the summit contained some corals and fragments of other fossils which are probably of Carboniferous age. Old Cambrian schists such as occur on the upper part of the Big Salmon River, were not found on the Nisutlin, and the stratified rocks seem to belong mostly to the Upper Palæozoic, while some may even be of Mesozoic age.

Occurrence of gold.

"Mining operations on the Nisutlin, so far, have been confined to prospecting. Fine gold occurs along it at various points, but up to the present has not been found in paying quantities. A great development of quartz veins occurs south of the summit on the branch ascended. The veins are small but exceedingly numerous. They occur mostly in the dark slates, and schists and greenish schists. Quartz boulders and pebbles form the principal constituents of the gravels in the streams flowing from the range. The streams and mountains in this vicinity seem well worth prospecting.

Teslin Lake.

"The shores of Teslin Lake were hastily examined on the way out. This lake was surveyed by Mr. St. Cyr, D.L.S., of the Dominion Lands Branch, in 1897. It is a long, narrow sheet of darkish water, from one to two miles wide, and with a length, according to survey, of about sixty miles. A line of soundings across the lake north of Dawson Peaks gave a maximum depth of 435 feet. The bottom of the lake, outside the steep shore-slope, is a nearly level plain covered by about 400 feet of water. The lake is almost completely encircled by medium-sized mountains and mountain ranges, the most prominent of which are the Dawson Peaks, known locally as the 'Three Aces which are situated about half way up the lake, on the west shore, and have an elevation of 3800 feet above the lake. The mountains are separated from the shore of the lake by a wooded plain of varying width, and at Hall River a lake-sprinkled area of rolling country extends some distance to the south-west.

Rocks on Teslin Lake.

"The rocks along Teslin Lake are very similar to those on the Nisutlin River. They consist of green schists, tuffs, agglomerates and limestones. Grayish granite, somewhat similar to the gray granite of the Kootenay country, occurs along the east shore of the lake, south of Nisutlin Bay, and a spur crosses the lake and is exposed opposite to and in the Dawson Peaks. Granite also comes in on the west shore of the lake two miles below the Narrows and extends south to near Hayes River. Above Hayes River, dark slaty rocks, tuffs and limestones resume, and continue to the head of the lake.

Trail to Telegraph Creek.

"From the head of Teslin Lake we came out by the Teslin-Stikine trail to Telegraph Creek. This trail has a length of about 151 miles, and with the exception of about fifteen miles in the vicinity of Spruce Mountain, has been well graded and corduroyed throughout during the past summer, and is now in excellent condition. A partial examination was made of the rocks along the trail. From the head of Teslin Lake to the Naylin River, a distance of about fifty-seven miles, the beds consist of a succession of rusty-weathering, dark, slaty rocks, tuffs, green schists and grayish limestones. The Naylin River valley, at the trail-crossing, cuts into yellowish-weathering, soft sandstones of Tertiary age. Drift lignite occurs on the bars, but no beds were seen. South of the Naylin River, the Tertiary sedimentaries are succeeded by dark and greenish massive volcanic rocks, often slightly schistose and occasionally partly serpentinized, and further on by dark slates and greenish tuffs and conglomerates. At the 'Hudson's Bay' summit and for some miles to the north, the surface is covered by comparatively recent sheets of volcanic rocks. Three distinct flows are represented by an older compact basalt, a light-coloured acidic rock, probably a rhyolite, and a younger vesicular basalt. The wide plateaux of Level Mountain on the east and the Heart Mountains on the west of the trail are composed, in part at least, of similar rocks. East of the Hudson's Bay post, the valley of Hacket Creek is bordered above by basaltic cliffs on the north side, and by andesites and other porphyritic volcanics below. Pyrite, pyrrhotite and chalcopyrite are found in small quantities in these rocks. Farther to the east, tuffs, agglomerates and allied rocks partly replace the massive volcanics. At the 30-mile post, a band of yellowish-weathering dolomite crosses the trail. From the Tahltan River across the Telegraph summit to the Stikine, the rocks consist principally of fine-grained greenish tuffs, agglomerates and conglomerates, cut in places by augite-porphyrites and other massive volcanics of greater antiquity than those above referred to.

Drift lignite.

Basaltic rocks.

"While delayed at Telegraph Creek, an examination was made of some claims on Nine-mile Creek, nine miles above Telegraph Creek, that have excited considerable interest. These claims have been staked out on a boss of eruptive rock, probably a diorite, about a third of a mile in width. The diorite varies from fine to coarse-grained in texture, is very basic and is filled in places with magnetic iron. It is bordered by greenish volcanic rocks, probably altered tuffs, on the west, and by a syenitic or granitic area on the east. Dykes of the last-named rocks penetrate the diorite in all directions, and occasionally carry small pockets of bornite and other copper minerals. A few small quartz veins also occur, but are unimportant. A number of specimens of the diorite, collected at different points along the face of the exposure, have been assayed, and are stated to have yielded from traces up to over a hundred dollars in gold to the ton. A further examination of a larger quantity of the gold-bearing rocks is now being made by Mr. J. C. Field, M.E., for the North American Exploration Company, and if the results of the previous assays are borne out, it will have an important bearing on the district, as the supply of material is almost unlimited. Assays of the specimens collected by myself will also be made in the Survey laboratory. Claims on Nine-mile Creek.

"Work for the season was finished at Telegraph Creek. From that point we came down the Stikine in a small boat to Wrangel, and returned to Ottawa."

Preliminary Note on the Gold Deposits and Gold Mining in the Klondike Region, Yukon District.

Messrs. R. G. McConnell and J. B. Tyrrell are jointly responsible for the following memoranda and observations bearing more directly on the question of the gold deposits and connected matters, the principal gold-bearing creeks of the Klondike having been visited by these gentlemen in company.— Klondike region.

"The productive part of the Klondike Gold District, as at present known, covers an area of 1000 square miles, and is situated between the Klondike and Indian rivers, tributaries of the Yukon, and east of the latter river. The region is traversed by a multitude of streams, flowing for the most part in deep trough-like valleys, among the most important of which are Bonanza Creek, (with its rich tributary Eldorado,) Bear, Hunker, Too Much Gold, and All Gold creeks, flowing into the Klondike; and Dominion, Sulphur and Quartz creeks, branches of Indian River. The larger creeks are separated by long ridges gashed by the smaller streams and terminating upwards in even slopes or lines Topography of the region.

of rounded hills. The general aspect of the district, viewed from one of the higher elevations, is hilly, owing to the fact that the main ridges and creeks radiate out in a general way from a central point known as the Dome. The main ridges rise above the valleys from 1200 to 1500 feet, and in places are somewhat higher. The Dome, a name given to the prominent hill surmounting the ridge separating the tributaries of Indian River from the Klondike, and one of the highest points in the region, has an elevation above the Yukon River of about 3000 feet. East of the hilly region centring in the Dome, at a distance of eight to ten miles, is a wide plain drained by a branch of the Klondike, beyond which, and closing in the horizon, runs a high range of rugged peaks. The district, with the exception of the higher peaks and ridges and occasional flats along the streams, is covered with a fairly heavy forest growth, consisting principally of the white and black spruce with some birch and poplar.

Productive area.

"*Productive area.*—The approximate area of 1000 square miles, given above as the probable extent of the known gold-field, refers to the district traversed by the gold-bearing creeks, and not to the actual area of pay gravels. The latter are confined to the bottoms of a few of the valleys and the lower slopes of the adjoining ridges and occupy a much smaller area. The rich creeks, so far, are only four in number, viz.: Eldorado, Bonanza, Hunker and Dominion, and by far the greater proportion of the remarkable yield of the last two years has come from Eldorado and Bonanza. The proved portions of the four producing creeks have an aggregate length of about thirty miles. A number of tributaries of the producing creeks, and other streams such as Bear, Sulphur, Two Much Gold, All Gold and many more, have yielded small amounts, and it is confidently expected that the prospecting work now in progress will result in large additions to the producing area.

Occurrence of gold.

"*Mode of occurrence of gold.*—The gold occurs in the gravels flooring the bottom of the valleys, in stream-terraces lining the lower slopes of the valleys and in a remarkable moraine or glacial deposit that occurs along the southern slopes of Eldorado and Bonanza creeks for some miles, and was also found north of the latter creek for some distance above its junction with Eldorado.

Stream-gravels.

"The stream-gravels are very uniform in character throughout the district. They consist mainly of flattened sub-angular schist pebbles, ranging in size from small scales up to rounded or elliptical plates a foot or more in width, coarse round pebbles and boulders of quartz and occasional layers of clayey vegetable mould. The gravels rest on a slightly irregular floor of decomposed mica-schist and quartz-schist. They have a thickness of from two to eight feet and a width along the

most productive portions of Eldorado and Bonanza creeks of from one hundred to four hundred feet. They extend across the valley-bottoms and increase in width with the gradual enlargement of the latter towards their mouths.

"The gravels are overlain in all cases by a layer of black argillaceous vegetable matter of three feet or more in thickness.

"The gravels are everywhere more or less auriferous, but, as in other placer camps, the concentration is very irregular, and the gold increases in quantity towards the bottom of the section, the greater part of the pay being found usually within eighteen inches or two feet of bed-rock. A considerable portion of the gold is also found in the soft decomposed and shattered country-rock on which the gravels rest, into which it has sunk often to a depth of two feet. The pay-streaks range in width from a few feet to a hundred feet or more. They are interrupted along the length of the creek by comparatively barren stretches, and in places more than one pay-streak is found in prospecting across the rocky bottom. The minimum richness of the gravels considered as 'pay' by the miners, on an average claim, is given at about $5 to the cubic yard, but varied according to different informants from $4 to $7. Width of pay-streak.

"The bench-gravels are of less importance than the stream-gravels and so far are only worked to an inconsiderable extent along Bonanza and the lower part of Eldorado Creek. The benches only occur at intervals along the sides of the valley and as a rule are rock-cut and not built up by stream deposits. They are found at varying heights up to an elevation of seventy-five feet or more above the bottom of the valley. Bench gravels.

"In ascending Bonanza Creek the first bench claims were found opposite No. 60 below Discovery, on the south side of the valley. The bench has an elevation of seventy-five feet above the bottom of the valley and consists of sixty-seven feet of schists of various kinds terminating upwards in a flat surface and overlain by eight feet of gravels. The bench is wide, as it occurs on a projecting point, but does not extend far along the valley. The gravels are mixed with sand and consist of flat and sub-angular pebbles of schist often a foot or more across and rounder quartz pebbles. The gold is fine, but nuggets up to a value of $1.35 are reported to have been found. The average yield of the gravels is stated to vary from 5 cents to 20 cents to the pan. Several bench claims similar in character to the one just described, but at lower elevations, were being worked further up on Bonanza Creek and on the lower part of Eldorado. On Hunker Creek, only one claim of the kind was being worked at the time of our visit, and on Dominion Creek none were in operation.

Hill claims.

"Hill claims, situated on the moraines mentioned above as occurring along Bonanza and Eldorado creeks, are being extensively worked and in some cases have proved extremely rich. The moraines are situated at an elevation of from 150 to 200 feet above the bottom of the valley, have a width of from 200 to 300 feet or more and a thickness in the centre of 50 feet or more. The most productive claims occur along the lowest edge of the deposit and are worked by open cuts. The gravels are washed in rockers as the water supply is insufficient for sluicing. The morainic material is auriferous throughout, but the greater part of the gold is found at or near the sloping surface of the bed-rock at the bottom of a bed of coarse gravel, which consists of rock-flour, sand, pebbles and boulders. The gold, which is often in large nuggets, usually includes much quartz, and is rough and unrounded.

Character of deposits.

"*Conditions of working.*—As stated above, the stream deposits consist of beds of gravel varying from two or three to fifteen or twenty feet in thickness, overlain by a mass of vegetable material, locally known as 'muck,' from four to eight feet or more in thickness. This muck is chiefly sphagnum bog, or peat, which has suffered little decay since it grew where it now rests. Both the peat and the gravel are permanently frozen, and as the peat is an excellent non-conductor of heat, the gravel continues frozen as long as it remains covered by even a thin coating of peat.

Prospecting.

"After the prospector has found indications favourable enough to induce him to stake off a claim, he can readily prospect it thoroughly in winter by building a fire on the surface, removing the thawed earth, building another fire on the same spot, again removing the ground that has been thawed, and so on down to bed-rock. The sides of the shaft so sunk remain firm and solid. In summer, however, it is difficult to sink a shaft in this way, as the sides are likely to cave in, so that prospectors then build a fire upon the open ground, heat stones very hot and throw them down the shaft, covering them with brush or anything else that will prevent the heat from ascending. These stones will, in a night, thaw the ground to a depth of from 6 to 9 inches. This thawed ground is taken out, and the process is repeated until bed-rock is reached. If pay gravel is struck it may be thawed and removed from around the bottom of the shaft until a large circular 'room' is ormed in the gravel. The gravel raised is afterwards sluiced, and the gold extracted from it.

Working creek claims.

"The most economic method of working creek claims is by open cuts. The barren muck overlying the gravels is got rid of early in the season by the simple device of damming up the stream and leading it by several channels across the claim. The frozen muck dissolves readily

and is usually completely removed by the stream in the course of a few week. The underlying auriferous gravels, as they become gradually thawed out and loosened by the sun and the various atmospheric agencies are shovelled into sluice boxes and washed in the ordinary way. When the surface is kept clean thawing proceeds at the rate of from two to four inches a day and bed rock is reached before the season closes.

"On the dry benches in the northern part of the Yukon district, the ground was found not to be frozen in summer, and probably some of the drier and more open tracts in the Klondike district are not permanently frozen.

Poorer gravels.

"On the hill-sides, as well as in the bottoms of many of the valleys, there are large quantities of earth and gravel that are too poor to admit of being worked by the ordinary method of sluicing or rocking now in use, and to yield good results will require to be worked on a larger scale and by more economical methods.

Scarcity of water.

"The clays and gravels when exposed in summer in the creek beds and on the hill-sides, thaw very quickly leaving them loose and friable and in a favourable condition to be acted on by water. The available water in the Klondike creeks is however too limited for work on a large scale and the problem of obtaining a supply from other sources has not yet been solved. The grade of the Klondike River is fairly steep and it is possible that water might be flumed from it. This could only be done at a great cost, as the river would have to be tapped far up. The gravels are, however, exceptionally rich even in many portions of the creeks too lean to pay by present methods of working and would justify a heavy expenditure in their exploitation.

Capital required.

"To install extensive plants either for hydraulicing or sluicing blocks of ground, large sum of money will be needed, and in order to encourage the influx of this capital into the country it will be necessary to offer every facility to investors. It should thus be not only possible but reasonably easy for them to consolidate groups of claims or to obtain blocks of land of sufficient size to make it probable that they would receive a fair return for their investment, especially in the case of lands not sufficiently rich to be profitably worked by hand.

Gradients of streams.

"*Gradients.*—As the valleys are wide and U-shaped, the grades of their beds are not at all steep. The Forks of Bonanza and Eldorado creeks, about 12 miles from Dawson, is about 500 feet above the Yukon River at that place, giving lower Bonanza and the Klondike River combined an average grade for that distance of something over 40 feet to the mile. Bonanza Creek, from the mouth of Cormacks Creek to the Forks, has a drop of about 500 feet, giving a fall of a little less than

100 feet to the mile. The grade of Eldorado Creek is somewhat steeper, the descent from the mouth of Chief Gulch to the Forks, a distance of about four and a-half miles, being about 700 feet, or an average of about 150 feet to the mile.

Proposed reservoirs.

"Above these points, the grades become rapidly steeper and the streams are narrower, so that it might be possible to build dams across them and construct large reservoirs, from which a supply of water could be obtained to serve for washing the lower parts of the hill-sides further down.

The gold of local origin.

"*Source or sources of the placer gold.*—As has been pointed out by Mr. J. E. Spurr of the United States Geological Survey, in the case of the country of Forty-mile Creek and further north and west, the gold in the Klondike has certainly been derived from the rocks of the immediate vicinity, for there is no evidence of the transportation of material of any kind from a distance. The rock underlying the district is a quartzose micaceous and sericitic schist, in which many lenticular stringers of quartz lie parallel to the bedding, and through which some large veins of quartz run in other directions. In a few places dikes of dark-green basic rocks as well, as lighter coloured porphyries cut through the schist, but it is not probable that these intrusives have any influence on its gold-bearing character.

"On Bonanza and Eldorado creeks, one band of the schists is highly graphitic, while near the mouth of Hunker Creek there is a heavy band of granular limestone.

"Granite was reported to occur a short distance up the Klondike but the outcrop was not seen.

Age of auriferous schists.

"The schists are sedimentary or crushed massive volcanic rocks of early Palæozoic, probably Cambrian age, which have been highly altered by dynamic agencies, the quartz veins having doubtless been formed in them while they were undergoing this metamorphism.

"The rocks of this group have been traced northward and westward by the geologists of the United States Geological Survey into the Forty-mile and Sixty-mile district. Southward they have not as yet been exactly correlated with any of the rocks known to occur in Canada, though they may be of the same age as the schists and limestones on Nisling River and along other portions of the Dalton Trail.

Gold associated with quartz.

"That the gold in its original habitat has been associated with quartz there can be no doubt, for many masses of gold-bearing quartz have been found, and many of the nuggets of gold contain particles of quartz. Whether the gold is chiefly derived from the heavy veins or from the narrow stringers has not yet been determined, but it is

probable that in places both are auriferous. We found particles of gold in a thick quartz vein north of Eldorado Creek, but as the abundance or scarcity of the placer gold did not appear to depend on the size or number of these heavy veins, it is probable that the precious metal has been chiefly derived from the narrow stringers or leaves of quartz interbedded in the schist.

"The great ice-sheet of the Glacial period which covered much of British Columbia, did not reach as far north as the Klondike district, so that ever since the land was elevated above the sea, perhaps in the Miocene or Pliocene epoch, it has been cut down continuously by atmospheric and stream agencies forming deep valleys, with intervening rounded hills still covered by a varying thickness of decomposed rock. There is no doubt that much of this decomposed rock, in the Klondike area, contains a small amount of gold, and by constant washing for ages, much of this has become concentrated in the beds of the streams. On Bonanza and Eldorado creeks, and doubtless also on a number of the other creeks that rise in the high land near the Dome, the work of concentration has been greatly expedited by small local glaciers, which, at a period not very remote, have originated at the heads of these creeks, and have filled the bottoms of their valleys through parts at least of their lengths. Thus the Eldorado glacier would appear to have had a greatest thickness of about 200 feet at French Gulch, and to have joined the Bonanza glacier at the Forks, below which both continued on some distance together. The gravel that fills the bottom of the valley from side to side is a typical glacier-wash, having been deposited by the stream which flowed from the face of the glacier. The lower benches on Bonanza Creek were also deposited in a similar way, but the higher so-called benches, have been formed either as lateral moraines along the sides of the glacier, or by streams which flowed between the side of the glacier and the bounding slope of the valley.

District not glaciated.

Small local glaciers.

"The great richness of the Klondike placer ground depends, therefore, first, on the presence of a highly gold-bearing rock, and, secondly, on the occurrence of a set of conditions peculiarly favourable to the concentration of the precious metal.

"*Communication.*—Last summer it was necessary to transport provisions and supplies from Dawson to the various creeks on the backs of men or horses by trails through swamps, and along stony hill-sides which were about as bad as they could be. Good wagon-roads could, however, readily be built from Dawson up the various creeks tributary to the Klondike River and thence possibly across to Dominion Creek, and thus to the tributaries of Indian River. From the Yukon River a good wagon-road could in all probability be easily built from the mouth

Insufficient means of transport.

of Indian River up to the very sources of most of the tributaries. In fact, good and direct roads could easily be built through that whole country, for the hill-slopes are everywhere light and the bogs in the bottoms of the valleys are nowhere very deep, while lakes are conspicuously absent.

Wood supply. "*Fuel.*—The country is more or less thickly wooded with white and black spruce, white and black poplar, and canoe birch. The largest timber is in the bottom of the valleys, some of the white spruce on the flat near the mouth of Bonanza Creek forming a forest of fine tall trees fourteen to eighteen inches in diameter. Excellent timber also extends in places up the sides of the hills to a height of several hundred feet above the level of the Yukon at Dawson, the spruce being mixed with large white poplars. At higher elevations the forest becomes thinner and the trees smaller, until at an elevation of about 2500 feet above Dawson, the timber limit is reached, the higher crests and summits in the vicinity of the Dome being devoid of timber and clothed only with small hardy alpine and arctic plants. If used with reasonable care, there is an abundance of wood in the country to supply the wants of the people for a number of years both in fuel and building timber. The greatest care, however, should be exercised to prevent forest fires which might in a very short time deprive those who are attempting to develop the resources of that country of one of their most valuable assets.

Coal. "Lignitic coal or lignite is reported to have been found on Klondike River about forty miles above Dawson, but no definite information has been obtained about it. It is possible that there may be coal seams here which will furnish a valuable local supply of fuel.

Expenses. "*Cost of living.*—During the past year the expenses of working mines have been abnormally high on account of the scarcity of labour, and the very high prices of machinery and provisions, these prices being due not so much to the inherent difficulty and expense of transporting provisions into the country as to the fact that the means of transport into the country were quite inadequate to supply the people who swarmed into the Yukon district. This summer, however, wages had fallen to about a half of what was paid last winter, and it was found quite possible to purchase provisions at retail prices at the stores, for the maintenance of a party, at less than a dollar a day per man."

BRITISH COLUMBIA.

Mr. R. W. Brock, during the early part of the year, was employed chiefly in work connected with the compilation of the West Kootenay

map. Accompanied by Mr. W. W. Leach as topographical assistant, he left for West Kootenay on May 30th, to continue and extend the field-work necessary for the completion of the map-sheet laid out, which embraces a block of country extending from the 49th parallel northward nearly to the head of Kootenay Lake, bounded on the east by a line east of Kootenay Lake and to the west by a line west of Christina Lake. This map will therefore include the mining centres of Trail Creek, Nelson, Slocan, Ainsworth, Kaslo and several others, besides a portion of the Boundary Creek district. Map.

The portion of the map already completed, has been engraved on copper during the past summer, and when the additions due to last season's work have been made, it may prove to be desirable to print a preliminary edition of the map-sheet, although the completion of its whole area involves much further surveying work. The very rough and mountainous character of the country, renders it exceptionally difficult, and it must be remembered that the whole work of its topographical survey, as well as that of its geological examination, has had to be undertaken by the Geological Survey.

Mr. Brock reports as follows on the work of 1898 :—

"Attention was confined chiefly to that portion of the district which lies between the Columbia River and the Slocan and is bounded by the Nakusp and the Kootenay to the north and south. While the weather was unfavourable for work in this our main field of operation, a transit and micrometer survey was completed of the Arrow Lakes and the Columbia River, from the point, about five miles below Halcyon Hot Springs on Upper Arrow Lake, where the Dominion Lands Survey of the Columbia had been discontinued, to the International boundary at Waneta. In addition to this, a week was spent in the Beaver Mountains, situated between the Salmon, Pend d'Oreille and Beaver rivers, and, after the depth of snow on the mountains generally had rendered ordinary field-work impossible, I visited some of the principal mines in the Slocan district, with the view of collecting a representative suite of specimens of the typical ores of the district. District examined.

"The season was altogether unfavourable for mountain work, and we were, in consequence, unable to finish the Slocan slope of the district. On account of the late spring and the altitude of the mountains, the work was interfered with, first by snow, then by rains until well on in July. About the middle of August the smoke due to forest fires put an end, for the time being, to the topographical work in the mountains. It was then that the survey was made of the Columbia River and the Beaver Mountains. The smoke enveloped the moun-

tains until the latter part of September when it was dispelled by falls of snow.

Method of survey.

"The method adopted in carrying out the topographic work, was that followed in previous seasons, viz., transit triangulation, with sketches, from peak to peak, together with traverses of intervening and connecting trails, ridges and valleys. The framework thus constructed was connected with the work already done, by bearings on fixed points and also by tying in with Robson and with Nakusp Point, the positions of which had been already determined astronomically. The survey of the Columbia furnished additional data for this connection.

Topographical features.

"The character of the country examined is, like that of other portions of the West Kootenay district, mountainous in the extreme. Its special features are the steepness and altitude of its mountains and the narrowness and depth of its valleys. Only in a few places do even the main valleys, such as that of the Columbia and Pass Creek, widen, and for short distances present open expanses or meadows. It consists essentially of a block of mountains, which, rising steeply from the Columbia valley on the one side and abruptly from the Slocan on the other to a height of 7000 or 8000 feet, gradually increase in altitude towards the interior till they culminate in the Valhalla Range, a group of wild and rugged, glacier-bearing peaks.

"In the extreme south, the mountains are massive domes. Throughout all the central part they are lofty precipitous crags, of airy and fantastic form, supporting numerous glaciers and perennial snow-fields. In the north, on parts of Snow and Cariboo creeks, the mountains, while still high and steep, are often drift-covered and grass-grown, giving them a less rugged and more pleasing aspect. This is true particularly of the southern slopes, for, as a rule, throughout the district, the southern side of the mountains are steep, debris-covered slopes while the northern present bold, precipitous faces.

Drainage.

"The main drainage is by the short torrential streams that occupy the narrow deep-cut transverse valleys, heading usually in amphitheatres or cirques carved in the central range of peaks. The actual watershed between the Columbia and Slocan is sinuous, being close to the Slocan valley in the north, but soon sweeping over toward the Columbia and so on southward. It rarely drops below 7000 feet in height. The longest and most important transverse valleys on the Columbia slope, are those of McDonald, Cariboo, Snow and Long creeks in the north, and of Deer and Cayuse creeks and Pass valley in the south. The latter, paralleling the Kootenay and separated from it only by the wall of Sentinel Mountain, affords a very low, easy pass from the Columbia to the Slocan valley

near its debouchment on the Kootenay. Pass Creek, coming in from the north about the middle of this valley, now turns southward to the Columbia. Formerly it appears to have taken the opposite course, discharging into the Slocan.

Longitudinal valleys.

"While transverse valleys predominate, there are within the district two notable longitudinal valleys; one, the southward continuation of the valley occupied successively by Musquito Creek and the Columbia River above Burton City, is drained by Trout Creek, and the other, cut off from this by a spur from the Valhalla Range, but continuing the depression on southward in the same direction, is that of the Little Slocan. This stream drains a considerable area, receiving a large number of the transverse valleys on the Slocan slope in the central and southern portion of the district. Tarns and small lakes are numerous in the upper parts of the streams, being almost invariably found in the cirques at their heads, and occupying shelves of rock near the crests of the mountains. These little lakes, in the higher mountains remain frozen over almost the entire summer. In the Valhalla Range the multitudinous lakelets have the beautiful peacock-blue or green water peculiar to glacier-fed lakes. Lower down in the courses of the streams, lakes may also be found, formed by avalanches or moraines damming their valleys. Lakes of some size occur on Little Slocan, and one or two other streams. The Arrow and Slocan lakes have been described in previous reports of this Survey.

Lakes.

Vegetation.

"The forest growth is similar to that found in other portions of West Kootenay, also described in previous publications.* On the Columbia slope are a number of park-like expanses with a considerable growth of red pine (*Pinus ponderosa*).

Geology.

"With the exception of parts of the Cariboo and Snow Creek basins and a small area in the vicinity of Deer Park, the country examined may be said to be composed of granite. A number of different varieties of granite belonging to several distinct periods are represented.† Owing to the intricate manner in which they cut through each other, to the number of *facies* presented, and to the deformation to which in places they have been subjected, their separation and delimitation is often difficult if not impossible.

Gray granite.

"One of the commonest and most easily recognized rocks is the gray hornblende-biotite-granite, often characterized by large porphyritic crystals of felspar. This is the same granite as that typically devel-

* A list of the principal trees is given in the Summary Report for 1896. Further information may be found in the Annual Report, 1888-89, vol. IV. (N.S.), part B.

† These rocks vary considerably in composition, texture and structure, but for convenience will here be referred to as granites.

oped at Nelson and so many other west Kootenay points. It has already been described as newer than the stratified rocks there and also newer than the porphyrites. While in places the rock is uniform in grain, and phenocrysts are not observable, in others the felspar is porphyritic, sometimes on a very large scale, the crystals being from six to eight inches in length. When such large felspars, in perfect interpenetrating Carlsbad twins, stand chiselled out by surface weathering, this is a striking rock. When mechanically deformed, it becomes a typical augen-gneiss, and when its crushing has proceeded further it becomes a fine-grained, old looking gneiss that shows very little resemblance to the unaltered porphyritic granite. Such a gneiss is to be found near Robson.

Its extent.

"This granite extends from Robson to Cayuse Creek. A spur runs on through Deer Park and beyond, and along the Slocan watershed it extends north of the head of Deer Creek. An exposure of it was also seen on the lake, five miles above Deer Park, and a band several miles wide extends along the Lower Arrow Lake from Long Creek to the north edge of the area of the map-shet. At the head of Snow Creek and in the Valhalla Mountains, some isolated patches were noted.

Younger granite.

"Another rock that is frequently met with is a younger granite, characterized by the colour of its felspars, which are usually pinkish, reddish or brownish. This is also a biotite-hornblende rock that varies considerably in composition and structure. Intimately associated with this granite, so closely as often to be almost undistinguishable from it, is a still younger rock which shows a wider range of differentiation. Followed towards a contact, this rock acquires the structure of a porphyry, and along the border has a compact cryptocrystalline groundmass with phenocrysts of pink felspar embedded in it.

"These 'red granites' are extensively developed along the summit range. They also extend along Lower Arrow Lake from Deer Park to Long Creek. Dykes from them are very numerous in the older rocks.

Acidic granite

"At the head of Snow Creek and in the Valhalla Mountains, is an acidic granite, with felspar usually white or light-pink in colour. Quartz is usually abundant in the rock, while the bisilicates are only sparsely found, though some garnets are developed in it. It is usually fine-grained, non-porphyritic, with frequently-occurring pegmatitic *facies*. It is extensively cut by dykes of a pegmatite that contains muscovite, tourmaline and garnet. The pegmatite extends out from the parent mass and cuts the older rocks in the neighbourhood in the form of dykes. This granite is younger than the gray porphyritic granite. A rock that resembles it and which may prove to be the same, is

found on the Slocan slope, three miles east of the head of Deer Creek. It also contains muscovite-bearing pegmatites, and it is of course also younger than the gray granite.

"The relationship between these and the red granite was not clearly seen. Further study may show them to be closely connected with, if they are not parts of, the same eruption.

"Behind Robson and up Pass Creek, the granites contain bands and lenticular and irregular inclusions of gneiss. This gneiss is a fine-grained, old looking, often rusty rock, with acid and basic bands. The inclusions lie irregularly in the granite, their banding being often discordant with the gneissose structure of the granite. In the basic inclusions dykes of granite and pegmatite are pulled apart, broken and balled, giving it a pseudo-conglomeratic appearance. It is not known whether these gneisses represent inclusions of the old Shuswap gneisses or of the oldest granite of the Kootenay which is so closely associated with the Shuswap series. Detailed study may make it possible to further subdivide the granites of the district. Gneiss.

"All the granites are cut to a greater or less extent by dykes of the basic rock, which constitutes the latest observed eruption of the West Kootenay district.

"In the vicinity of Deer Park, the granites are replaced by sedimentary rocks, and by older and more basic eruptives, which appear to be augite-porphyrites and perhaps other greenstones. These rocks extend more or less continuously along the lake, from five miles up Cayuse Creek to a point about five miles above Deer Park. They are sometimes almost completely cut off by the granites, but re-appear at intervals between the points mentioned. The sedimentary rocks included in this area consist of crystalline limestones, phyllites and allied schists probably equivalent to Dr. Dawson's Nisconlith series (classified as Lowest Cambrian). These rocks are found close to and behind Deer Park. The limestones, which have the greatest areal distribution, extend in a band from two miles up Little Cayuse Creek to the lower Arrow Lake at Little Deer Park. Sedimentary rocks.

"The largest inclusions in the granites of this district, of other igneous and of sedimentary rocks, are on the upper portions of Cariboo, Snow and Trout creeks, behind Burton city. These rocks consist of mica-schists, grey gneisses and limestones, that may be referred to the Shuswap series; of dark argillites and phyllites of the Nisconlith series; and of dark banded calcareous and siliceous rocks similar to the Slocan slates of the Sandon region. These rocks are cut by old eruptives, some of which are altered so as to be only with difficulty dis- Inclusions in granites.

tinguishable from the Shuswap rocks. They are also cut by the granites and by the recent basic dykes. On account of the way in which the granite cuts into them, their actual boundary often cannot be determined. This is especially true of the Shuswap gneisses in the south and west, where they extend as innumerable little patches into the granite of the Valhalla Mountains.

East side of Upper Arrow Lake.

"The rocks on the east shore of Upper Arrow Lake are described by Dr. Dawson in the Annual Report for 1888-89, Vol. IV. (N.S.) p. 36 B. On the west side of the lake from the Halcyon Springs south the rocks are similar. To about opposite Cape Horn, the rocks are the glossy mica-schists, gneisses and interbanded limestones of the Shuswap series. From this point south they are mostly the dark Nisconlith argillites with numerous and large quartz veins. These rocks are much compressed, being in places folded into pitching anticlinoriums and synclinoriums. Some green and grey sheared rocks were also observed which may correspond to the Adams Lake series.

Glacial phenomena.

"In addition to the scoring and polishing of the rocks due to the agency of local glaciers, and the moraines which mark successive stages in the retreat of these toward the higher peaks, evidences of glaciation due to the great Cordilleran glacier are found at various places throughout the entire district. The striking features connected with these are the high altitudes at which they are found, and, notwithstanding the disturbing influences of the Valhalla Mountains and of the adjacent low Columbia and Slocan valleys, their general persistency in direction. The general direction of this striation is about S. 30° E., but local topography may influence it to some extent.

"Terraces of silts and gravels were observed at various places all along the Columbia slope from Burton City to Robson. While a few were seen above 4000 feet, more occurred in the neighbourhood of 3000 feet, and by far the greater number lay between 2500 feet and the present lake-level. One of the best marked and most persistent, which indicates rather a prolonged break in the gradual recession of the waters in which these silts were laid down, is found about five hundred to six hundred feet above the present level of the Arrow Lakes and Columbia or just about the elevation of the old wide valley of the Columbia. The general movements indicated by these and other phenomena, may account for some of the later faulting by which the mineral deposits have been disturbed.

Ore deposits.

"Portions of the district examined have been fairly well prospected, and many claims have been staked. But, although the surface indications in some instances are quite promising, little or no develop-

ment work of such a kind as to prove the extent and value of the ore-bodies, has as yet been carried out in this particular portion of the Kootenay district. The economic minerals have been found in veins in all the older rocks, from the gneisses and schists to the red granite. Wherever observed, the mode of origin of the deposits seems to have been the same. They occur in sheeted zones or bands of fracture in the country-rock, in the neighbourhood of white 'porphyry' dykes, with which they appear to be closely related. They are sometimes found along the edges of these dykes. It is probable that they were formed by hot mineral-bearing solutions which attended the close of that period of volcanic activity that resulted in the injection of the white dykes into the country-rock. These solutions, finding their way along the contacts in some cases, but more usually following the fissured zones in the country-rock as channels, percolated through it, and, meeting with changed conditions of temperature and pressure, deposited their load of vein-matter and metallic sulphides, replacing with this material the original country-rock. From the character of the deposits, it is to be inferred that they would be greatest where the nature of the rock afforded the readiest access to the mineralizing solutions. The lines of fracture being very irregular and very numerous, the mineralizing agent did not confine itself to any one or to the same ones. Sometimes the blocks of rock between fractures were entirely replaced by ore, sometimes they remain as 'horses' in the leads. The ore-deposits are consequently very irregular and cannot be said to have any confining walls; so that if any rule is to be applied to their exploitation, it is to follow ore. Earth-movements subsequent to their formation have caused faults and dislocations. While these are of various kinds, the amount of displacement is usually not great, and a careful study of the ground will generally reveal the direction of the slip. The character of the ore varies somewhat with the locality, but it usually consists of the minerals pyrrhotite, galenite, sphalerite, pyrite and chalcopyrite. In the Burton Camp some fahlore occurs in addition, and, it is stated, some tellurides.

Mode of occurrence.

"At Deer Park, during the season, development work was in progress on the Blue Bird, and on two or three other properties.

Development at Deer Park.

"On the Aaron's Rod, two and a-half miles back from the Needles, Lower Arrow Lake, a tunnel is being driven. At the time of visit it was 390 feet long.

"In the Burton City camp, several properties were active. A compressor was being installed at the Silver Queen in connection with the testing and opening up that property. Work was being continued at the Golden Hope, where a small force has been at work during the past

Burton City camp.

year. The main working is a tunnel 225 feet long. On the Millie Mac a force of men was engaged making preparations for active development.

'Big ledge.' "An extensive deposit of sulphides known as the 'big ledge' occurs six miles back from the Upper Arrow Lake, opposite the Halcyon Springs. As no assay has as yet been made, it is not known if this deposit has an economic value. A tunnel six feet wide and twenty feet long on Walcott and Skea's claim, lay in solid sulphides consisting of pyrite, pyrrhotite, galenite, sphalerite and chalcopyrite. On the surface the ore is weathered to gosson or 'iron-cap' to a depth of three or four feet. As the surface is covered, and time could not be given to it, the extent of the deposit was not ascertained. Nineteen claims, all supposed to cover this lead, have been staked out.

"The main work of the season, as already noted, rendered it impossible to devote time to the examination of the mines actually in operation in different parts of West Kootenay, with the exception of those of the Slocan region, but a few notes on the latter, resulting from personal observations, may be of interest.

Slocan district. "The past year has proved to be a prosperous one in the Slocan district, contrary to expectations in the early part of the season, when the Klondike excitement, together with depressed markets, threatened to retard its development. Increases in the prices of silver and lead had a stimulating effect, so that at the time of my visit, substantial if unostentatious progress was steadily being made. The development work, both in the prospects and mines, has proved very encouraging. That in the lower workings of the large mines has been particularly reassuring to those who entertained misgivings as to the permanency of the Slocan leads, for the depth gained on the Payne, Last Chance and other properties has exposed large bodies of high-grade ore, and has demonstrated the continuancy of the ore-bodies. This permanency was to be expected, such producers as the Ruth, Slocan Star and others, at comparatively low altitudes, showing that mineralization on a grand scale extended to horizons well down toward the bottoms of the valleys. That the majority of the best known mines should be located near the crests of the mountains, is to be accounted for by the fact that prospecting is there remarkably facilitated by the absence of superficial deposits and forest vegetation.

Mines at Sandon. "The Payne has maintained or increased its large and steady shipments of ore, and its payment of excellent dividends. The lowest workings are now 700 or 800 feet below the upper tunnel, and the longest tunnel is about 1200 feet. The Ruth, which passed last year

into the control of an English company, has, under the new management, taken a place second only to the Payne as a producer. The Slocan Star is working steadily, maintaining its reputation as a dividend payer. Concentrating ore was being taken out at the time of my visit, but a large quantity of clean ore was blocked out ready for mining during the winter months, when lack of water makes it advisable to shut down the concentrator.

"At the Last Chance, some shipping was in progress, but until the tramway shall be completed, development work is that which is chiefly receiving attention. Large quantities of high-grade ore are ready to be taken out, and it is expected that as soon as the facilities for shipping are perfected this mine will rank with the heaviest producers.

"On the Noble Five, under the new management, attention has also been turned to development. This appears to be progressing favourably, and it may be expected that regular shipments from this property will soon be resumed. The Wonderful, Sovereign, Treasure Vault, Ajax and numerous other properties in the vicinity of Sandon have also produced more or less ore.

Mines on Howson Creek.

"In the Idaho Basin, the larger mines are working vigorously. The Queen Bess, now owned by the Queen Bess Proprietary Company, England, has become one of the heavy shippers. The Idaho-Alamo group continues to turn out large quantities of ore. Very high grade ore is being mined in the Idaho, some of it containing a large percentage of native silver.

General move in progress.

"Other mines besides these mentioned, in this and other parts of the district, are making favourable progress. The development work on a number of the prospects makes it probable that additions will be made to the list of shipping mines, and a number of new locations of considerable promise are recorded, so that, at present, the mining status of the Slocan is regarded as more satisfactory than at any previous time in its history."

Northern Alberta.

(With adjacent parts of British Columbia.)

Work by Mr. J. McEvoy.

Mr. J. McEvoy was engaged during the early part of the year in the construction of a topographical contoured map of a portion of the West Kootenay district, B.C., from surveys made during the previous summer.

Route through Yellow Head Pass.

Upon his exploration of the past season from Edmonton westward through the Yellow Head Pass to the Fraser and Canoe rivers, he reports as follows :—

Previous explorations.

" In the region surveyed during the last season, explorations had previously been made by Dr. (now Sir James) Hector, in connection with Captain Palliser's exploration of British North America, who, in 1859, travelled from Edmonton westward to the Athabasca River, which he ascended for some distance above Henry house. Several reconnaissance expeditions by the government surveyors engaged in examining lines for the Canadian Pacific Railway, were afterwards made along this route, and a final location survey was completed in 1876.

" Leaving Ottawa on the 24th of May and arriving in Edmonton on the 1st of June, the necessary supplies were obtained and the journey westward commenced on the 7th of June. The party consisted of : Wm. Spreadborough, (who, besides attending to other duties, made a collection of plants) ; with F. A. Jackson and S. Derr, as packers. Besides the above-mentioned, Mr. R. G. Hardisty was engaged to transport the bulk of the supplies as far as Henry house.

Lake St. Ann.

" A wagon-road leads through a good farming country as far as Lake St. Ann, crossing and recrossing the Sturgeon River several times on the way. Lake St. Ann is shallow, about three and a-half miles wide and eight miles long, to the Narrows, north of which it is reported to widen out again to a still larger body. At the Hudson's Bay post there, in charge of Mr. Taylor, to whom I am indebted for courteous assistance, the arrangement of packs was completed and a full complement of horses was secured.

" Leaving Lake St. Ann on the 11th of June and travelling southwestward *via* Island Lake, the Pembina River was reached on the 13th. At Island Lake is Pierre Grey's trading-post, the farthest outlying settlement on the route that is permanently occupied, with the exception of Swift's at Henry house.

Pembina River coal beds.

" The Pembina River is about eighty yards wide, and at the time of our visit was quite shallow and easily fordable. Earlier in the spring or during a rainy season, it is so deep as to necessitate swimming horses. Several outcrops of coal occur on the banks of the river, principally above the crossing. The coal has been on fire here years ago, and the overlying beds of clay and shale have fallen in, giving a very disturbed appearance to the locality. The white clay is partly burned to a pale red terra cotta. Half a mile above the crossing, on the east side, a seam of coal 17 feet 10 inches thick is exposed, of which the upper four feet is impure. On the opposite side there is a seam

13 feet thick, having four small partings of clay and carbonaceous shale, amounting in all to nine inches. Two small seams separated by carbonaceous shale and clay overlie this.

Erosion of Pembina valley.

"The valley of the Pembina is 250 to 300 feet below the level of the surrounding country and gives evidence of a greater amount of erosion than would be expected from the volume of water. A possible explanation of this will be given later, based upon what was seen at the mountains near its source.

Pembina River to McLeod River.

"Beyond the Pembina, the route ascends quickly to the level of the surrounding country, which, away from the immediate vicinity of the streams is flat, and it continues westward, crossing the Lobstick River, a tributary of the Pembina locally known as Buffalo-dung River, at a point where its valley is only fifty feet deep. Further westward, the route crosses a gradually rising country that slopes gently northward toward the Lobstick River. The small tributary streams make very little impression on the surface, and no rock-exposures are to be found, in fact none were seen all the way from the Pembina to the McLeod River. The characteristics of the route are, thick small timber, the greater part of which has been killed by fire, and windfall, frequent bog-holes and deep sticky mud with several bad muskegs. As few persons who travel this way ever cut a stick if they can get around or jump over it, it can readily be understood that, especially in a wet season, the so-called trail is all but impassable. The old trail made in connection with the government railway explorations of 1874-76, is still distinguishable in places but is of little service. The corduroy laid down at that time across the muskegs and swamps is now in such a bad state of preservation as to be unsafe for animals.

"Before reaching the McLeod River, two of its tributaries, Wolf Creek and Moose Creek were crossed. The former is a considerable stream heading with a branch of the Pembina River. Between these two streams the trail runs along a sand-ridge trending N. 65° W.,* nearly two miles in length, bending toward its western end to S. 70° W., with several spurs turning off N. 55° E. The width of the ridge is fifteen to thirty yards, its height five to forty feet and the elevation above sea about 2900 feet.

McLeod River.

Two and a-half miles beyond Moose Creek, the McLeod River was reached and crossed. It is 110 yards wide and at that time (June 19th) not more than two feet deep at the ford; although the volume of water is far greater than that of the Pembina its valley is comparatively shallow, being only 90 to 100 feet deep.

* Bearings refer to the true meridian, but it must be understood that both bearings and distances are here given subject to correction.

"Following the north bank of the McLeod, the Big Eddy is reached in seven miles. Here the river takes a semicircular bend to the south, while the trail, continuing westward, joins it again at White Mud Creek, a distance of ten miles. A large tributary called by the Indians, Stick River, which rises near the base of the mountains, joins the McLeod at the southern point of this bend. From White Mud Creek, the trail follows the river thirteen and a-half miles further, to a point formerly known as Plum Pudding Cache, now called the Leavings. Rock exposures are not frequent on this part of the McLeod, but where seen consist of coarse, gray and yellowish-gray sandstones, clayey sandstones, false-bedded, carbonaceous shale and small seams of lignite. They are of Laramie age and probably represent the lower division of that series.

McLeod-Athabasca watershed.

"At the Leavings the river bends southward, while the trail continuing to the west crosses the watershed to the Athabasca River. This watershed is a slightly rolling country, rising gently to a height of 940 feet above the McLeod or 1340 feet above the Athabasca. In a straight line, the distance between the rivers is only about ten miles. The trail, however, turns south-westward from the summit and reaches the Athabasca at a point twenty miles distant from the Leavings of the McLeod. All this country has been overrun by fire a few years ago and much of the timber destroyed was of merchantable size.

Climate.

"The climate of the country so far passed over, is decidedly wet, but as the bottom of the Athabasca valley is approached evidences of a change become apparent, such as smaller and more scattered timber, steeper slopes on the side-hills and cut-banks of streams, and a marked difference in the vegetation. The difference is more noticeable farther up the river, and is most pronounced from Jasper house to Henry house.

Lower Laramie fossils.

"Near the mouth of the small stream named Sandstone Creek, down which the trail descends to the Athabasca, in an exposure of gray and carbonaceous shales, and gray and yellowish sandstones, some fossils were obtained. Mr. Whiteaves, in a preliminary examination of these, finds that they correspond with the fossils found elsewhere in the Lower Laramie rocks.

"Four miles farther up the Athabasca, at a place known as Ne-kas-pe-kwat (corrupted into Cache Pecotte), a branch route turns northward, crossing the river and leading to the Smoky River. This part of the Athabasca valley is, to a great extent, an open grass country, with some light, second-growth timber. The slope of the south-west side of the valley is very gentle, and at a distance of a mile back the

elevation is not more than a hundred feet above the river. The same characteristics continue up to Prairie Creek, a distance of five miles further. Here the first evidence of the disturbance connected which the uplift of the mountains is seen. Greenish sandstones interbedded with black shales, etc., holding small, irregular seams of lignite, are found, striking N. 80° W., and dipping to north and south at angles of 70° to vertical. These rocks may represent the Pierre shales and Fox Hill sandstones.

Pierre shales and Fox Hill sandstones.

"As yet there is no approach to a mountainous condition, as notwithstanding the evidence of great folding in the rocks, the hills in the vicinity of the river nowhere rise more than 400 or 500 feet.

"Just above the mouth of Prairie Creek, the river bends to the westward for a distance of eight miles, where it issues from Brulé Lake. This lake is an enlargement of the river about seven miles long and half a mile to a mile in width. The trail does not follow this detour of the river, but ascends Prairie Creek nine miles, then turns south-westward across Drystone Creek to Fiddle Creek, which flows into the Athabasca at the head of Brulé Lake.

"As Prairie Creek is ascended, the ridges that run at right angles to its course become more elevated, and between Prairie Creek and Drystone Creek rises the first foot-hill of the Rockies. The limestones make their appearance here to the north-eastward for the first time, in a sharply folded anticline, slightly overturned. On the opposite side of the river, in Bullrush Mountain, the limestones have apparently been similarly folded, but afterwards disturbed and broken by a thrust from the south, resulting in at least two lines of fault. The principal rocks here are fine-grained gray and bluish limestones, and with these are associated thin-bedded yellowish-weathering siliceous and calcareous shales, dark flaggy limestone and carbonaceous shale.

Limestones.

"It would be unadvisable in this preliminary report to make any statements in detail as to the age of these rocks, as the season's work has not yet been plotted, nor have the fossils been critically examined. There is, however, a great thickness of rocks exposed in the Athabasca valley, comprising blue and gray limestones, magnesian limestones, frequently unequally hardened and holding cherty layers, quartzites more or less dolomitic in parts, with some yellow shale and carbonaceous shale. Carboniferous and Devonian beds are represented and also, probably, some Cambrian rocks corresponding to the Castle Mountain Group of Mr. McConnell. The rocks occurring in the first foot-hill mentioned above, very probably represent the Banff Limestones.

Formations represented.

"From this point upward, high, rugged mountains stand up boldly on each side of the valley, with vertical cliffs and steep talus-slopes,

leaving a flat-bottomed valley one to two miles wide through which the Athabasca winds, seldom in one united stream but lost in a net-
Roche Miette. work of sloughs. The most notable feature is Roche Miette, a bare rock-promontory with a vertical face, standing on the east side of the valley just below Jasper Lake. The timber-line is low, trees being seldom found above 6000 and frequently dying out at 5500 feet, the limit in each case being largely determined by the sheltered or exposed nature of the situation. The general aspect of the mountains is rugged and barren, the slopes being too steep in most parts to support a growth of trees.

Lateral valleys in pairs. "The strike of the rocks is from S. 60° E. to S. 70° E., and the confluent streams having the same direction are generally arranged in pairs, each pair occupying one continuous valley, crossing the main valley approximately at right angles. A notable example of this is found in the case of Rocky and Stony rivers (the latter originally Snake Indian River), which join the Athabasca near the site of Jasper house at the foot of Jasper Lake.

Jasper Lake. "Rocky River, where crossed near the mouth, is divided into ten separate channels and was barely fordable at the time. Jasper Lake is about six miles long and a mile in width. Its eastern shore is formed by a narrow sand-ridge, thirty feet high and fifty yards to a quarter of a mile in width. On the other side of the ridge and extending to the base of the hills are two smaller bodies of water known as Fish Lakes. The present form of this ridge is entirely due to the action of the wind, drifting up the fine silty sand from the beach and dropping in on the top. The same action is going on along the banks of the river higher up the valley and was also noticed on the east shore of Brulé Lake.

Sulphuretted water. "Several springs of sulphuretted water occur in this part of the valley, the largest seen being on the east side about three miles above Jasper Lake. A stream of cold bluish-green water, three feet wide and four inches deep, smelling very strongly of sulphuretted hydrogen, comes from under the dolomite rocks, leaving a deposit of native sulphur in its channel.

"A few miles above Jasper Lake, the Athabasca bends slightly towards the east, and continues in that direction to the site of Henry house, receiving the waters of Snaring River from the west on the
Under ground passage of Maligne River. way. At Henry house the Maligne River flows in from the east. It is a swift stream, fordable only at very low water, and possesses no remarkable features for the first mile and a-half above its mouth. It then comes from a narrow winding gorge fifty to a hundred feet deep and fifteen to thirty feet wide. The rocky walls of this chasm have partly

closed over and in places are almost touching, boulders lodged in the crevice preventing them from closing altogether. This is partly due to a fracture in the rocks at one side. On reaching the level of the valley above the gorge, 350 feet above the Athabasca River, it is seen that the volume of the stream is only about one-eighth of that below, and it is evident that the main supply of water comes through underground passages.

Cross the Athabasca.

"Mr. Hardisty set out on his return to Edmonton on the 4th of July with the twelve hired horses. The remainder, with all the outfit, were across the Athabasca on the 5th. The river is swift and narrow at the crossing place, just below the mouth of Maligne River. About half the provisions were stored at Mr. Swift's cabin on the west side, two miles and a half below the crossing, and the westward journey was resumed on the 7th.

Faulted contact with Bow River series.

"Three-quarters of a mile above Henry house, the Devono-Carboniferous limestones are cut off by a fault, and notwithstanding the great thickness of these rocks no trace of them was found on the route west of this. The rocks brought into contact with the limestones by this fault, are hard, fine-grained conglomerates or coarse quartzitic sandstones. Some of these conglomerates hold pebbles up to half an inch in diameter of pinkish, milky, and semi-transparent quartz, the whole very closely resembling the conglomerates of the Bow River series. Associated with these conglomerates and underlying them, a short distance to the south, on the Miette River, are fine-grained conglomerates which have been squeezed out to a schist, with a great development of fine pale mica. Interbedded with these are fine-grained gray and greenish-gray schists with thin slaty cleavage. The course of the Miette River, which comes from the Yellow Head Pass and empties into the Athabasca five miles above the Maligne, follows approximately the summit of a broken, anticlinal fold of these rocks.

Miette River.

"Ascending the Miette River, the trail follows the rocky ridges near the stream and through windfalls of small dead pines for a couple of miles, then descending to the river-flat, it crosses the stream four times in a distance of three miles, in order to avoid steep rocky banks. The animals have to swim at the lower ford, except at low stages of the water. Ten miles up, the river-bottom widens and the stream takes a winding course through marshes and meadows half a mile and more in width. The valley continues of this character to within a mile of the pass, the main water supply having in the meantime been received from the lateral valleys.

Yellow Head Pass.

"Miette River is crossed for the last time at a point, where the channel is blocked by log jams and the stream is divided into several

branches running among the trees. When the last of these branches is crossed it is suddenly realized that the summit of the Yellow Head Pass has been crossed, as at high stages some of the water empties by this branch into the Fraser watershed. The elevation of the summit of the pass is 3733 feet above sea-level, according to the railway survey. It is distant eighteen miles in a straight line from, and is 400 feet above, the Athabasca River.

Valley west of summit.

"From the summit, the route follows the bottom of the valley in a south-westerly direction, inclining gently downward to Yellow Head (or Cow-dung) Lake, distant two miles and a-half and 100 feet below the pass. Yellow Head Lake is a narrow body of water about five miles long and half a mile in width. The route follows the north-west shore, passing through a thick windfall of heavy timber on the way. A small stream, a mile in length, carries the waters of this lake into the Fraser River, which is here a large, rapid, muddy stream unfordable at this season.

Rocks seen in the pass.

"Throughout the pass, in the bottom of the valley, exposures continue of gray, rather fine-grained schistose conglomerate, with greenish-gray smooth schists and blackish argillites, while the mountains which stand on each side of the pass behind intervening foot-hills or ridges, show, overlying these rocks a great thickness of fine-grained gray quartzites, having below them, 150 feet or more of light-gray coarsely crystalline dolomite. A mountain on the north side of the pass was ascended to examine these rocks and to obtain topographical sketches.

Fraser River valley.

"The valley of the Fraser, down which the trail now proceeds, is wide and partly free of timber. The river hugs the base of the steep mountain-side to the south, leaving a gently rising slope on the north, half a mile or more in width. A few miles down, the timber becomes larger and thicker and at a distance of twelve miles from the pass the first of the recently burnt country begins. The burnt forest continues almost without interruption to Tête Jaune Cache, the greater part of it having been set on fire early this season. Fourteen miles from the pass a large stream called Grant Brook flows in from the north. It is about fifty feet wide and very swift. A mountain on the west side of this stream and north of the Fraser was visited, and showed gray quartzites, crystalline dolomite and some white crystalline limestone, with, overlying these, dark-blue flaggy limestones and yellowish and greenish-gray schists. The direction of the Fraser in this part is along the strike of the rocks. Two large tributaries come in from the south besides numerous smaller ones.

"Moose River is three miles below Grant Brook. It is a rapid, muddy stream 150 feet wide, and fordable except at very high water. The head of Moose Lake is two miles and a-quarter below the crossing of Moose River. The lake is eight miles and a-half long, and a mile wide near the east end, narrowing gradually toward the west. Another large tributary from the south flows in near the head of the lake. Much valuable spruce timber has been destroyed by fire in this part of the valley.

Destruction of timber.

"The Fraser River, issuing from Moose Lake, continues its westward course, moving slowly along in a wide stream for two or three miles, when it narrows, and taking a steeper grade, hurries rapidly downward. Fourteen miles below Moose Lake, the first of two large northern tributaries, a mile and a half apart, joins the Fraser. This is a shallow stream 100 feet wide, with a moderate current flowing past the base of Robson Peak, an exceptionally grand mountain standing about five miles north of the Fraser. A rough calculation makes the height of this peak 13,500 feet above sea-level, which shows it to be the highest known point in the Rocky Mountains north of the International boundary. These streams were collectively known as the Grand Forks of the Fraser River. The western tributary, now commonly known as Swift-current River, is an erratic, turbulent stream, fed by glaciers. It may sometimes be forded without difficulty in the morning, and by evening be utterly impassable.

Highest known peak in Rocky Mts.

"A mountain standing between these streams, shows schistose conglomerate interbedded with soft greenish-gray schist, and, near the top, layers of dark, flaggy limestone and gray and black argillite.

"A little above this point, the Fraser River changes its former direction of N. 65° W. to that of S. 60° W., and continues in the last-mentioned direction to Tête Jaune Cache, cutting obliquely across the strike of the rocks. From Swift-current River to the Cache is ten miles, and in the latter part of this distance the valley narrows noticeably, the river being confined by high gravel banks, and near the Cache, by low rocky bluffs.

"At Tête Jaune Cache, the Fraser emerges into the great valley which is the most important feature of the western mountainous country. A good description of this valley, with particular reference to another part of its length, is given by Mr. McConnell in the Annual Report for 1894 (pp. 18-19c). The bottom of the valley is here four to five miles wide and very level. Having a dry climate it is covered with only a light growth of pine trees. So well are its main characteristics preserved throughout, that here there is a striking resemblance to

Great valley at Tête Jaune Cache.

that part of it seen near Donald, on the Canadian Pacific Railway. It deserves a name of more than local descriptive significance.

Cranberry Lake.

"The Fraser now bends to the north-west down this valley, receiving a tributary, the McLennan River, from the south-east. The McLennan takes its rise in a shallow lake in the main valley, called Cranberry Lake, distant fifteen miles from the Fraser and having an altitude of 2622 feet, but acquires most of its water from the adjacent mountains. It is only three-quarters of a mile from Cranberry Lake to the Canoe River, which comes in from the south-west and flows down the main valley in a direction opposite to the Fraser.

Change in rock-series at the great valley.

"Seven mountains in this vicinity were visited, four on the east side and three on the west of the valley. It is evident that the valley not only marks a great division in the topography, but also forms a dividing line of geological importance. On the east side, the first rocks met with are conglomerates, now squeezed so as to assume the outward appearance of coarse mica-schist. These are overlain, near the summits, by undulating folds of black argillite and yellow schists, including beds of dark flaggy limestone, yellow, finely crystalline, dolomitic limestone and talc. The former of these probably correspond with the Bow River series, and the latter with the Castle Mountain group of Cambrian age. The western side is composed entirely of rocks not met with previously on this exploration. They consist of garnetiferous mica-schists and gneisses, with some blackish micaceous schists and light-coloured gneisses that represent a foliated granitoid rock. The garnet-mica-schist is the predominating rock. In some places it is made up almost entirely of mica and garnet. These rocks, although differing somewhat from the Shuswap series as seen further south, are pretty certainly referable to that series. They hold numerous veins of coarse pegmatite, which, besides the ordinary constituents, contain tourmaline, garnet, cyanite, beryl and apatite.

Shuswap series.

Bonanza mica mine.

"On one of these veins the Bonanza mica claim is located, seven miles south of Tête Jaune Cache, 5300 feet above the level of the Fraser River. The vein is about fifteen feet wide, where an opening has been made, dipping S. 45° W. conformably with the country-rock. Its continuation toward the north-west is covered with talus from the mountain, while on the south-west side of the opening the original top of the deposit is seen covered by the mica-schist. At the time of our visit, Messrs. S. Winter and J. F. Smith, with a party of ten men, were engaged in taking out and cutting mica intended for shipment by pack-horses to the nearest railway point. The quartz, felspar and mica are separated into large masses, the crystals of mica being frequently eighteen inches long and eleven inches wide, and are found

in greatest abundance near the hanging wall. It is evident that the mass was cooled at a great depth and very slowly to permit of this amount of segretion. While practically no work has been done with a view of proving the extent of the deposit, it may reasonably be expected, from what actually appears, that a large quantity of mica can be obtained here. The mica is a transparent muscovite with a very light-greenish cast and is otherwise of excellent quality. The probabilities of further important developments appear to be very favourable.

"Another claim, owned by some Edmonton miners, is situated a few miles south-east of the Bonanza. Fifteen miles to the south-east on the mountains, near the head-waters of Canoe River, several claims have also been staked. On one of these some work is reported to have been done, exposing a deposit of marketable mica. It may be expected that further discoveries of valuable mica deposits will be made in these rocks, which are of the same character for a distance of twenty miles at least, and probably much further.

"A great hindrance to the development of this or any other mining industry in this part of the country, is the difficulty of travelling without proper trails. It requires seventeen to twenty days to reach Tête Jaune Cache from Kamloops, a distance of 215 miles, in the present state of the trail. From Edmonton to the Cache, a distance of about 350 miles, requires ordinarily twenty-five days, but in a very favourable season the distance might be covered in twenty days. It will thus be seen that, apart from the question of shipping out the products of the mines, the greater part of the short season available is wasted in travelling to and fro. A moderate sum of money if properly expended on these routes, would put them in a fairly passable condition. Necessity of trails.

"The rocks of the Shuswap series, mentioned above as occupying the south-western side of the great valley, do not carry gold, but on the other side colours can be obtained in most of the tributary streams. On the mountains about seven miles from the Cache, in the rocks before mentioned as probably corresponding to the Castle Mountain group, numerous quartz veins were observed. Where these were noted, the cleavage of the rocks dips south at high angles, while a secondary vertical cleavage or jointage runs north-and-south. The larger and more numerous quartz veins run parallel to this secondary cleavage, and have a thickness of from one to five feet, while smaller lenticular veins follow the principal cleavage. These veins show a good deal of oxidized iron-pyrites and some galena. The galena proved to be argentiferous. Quartz veins. Argentiferous galena.

"Quartz veins are to be seen in many places along the route, all the way from this place to the Athabasca River. On the Miette River, the rocks are frequently marked with a reticulation of small veins of white quartz. Sometimes these reach a width of two feet and over, and claims have been located there from which assays of eight dollars per ton in gold are reported. Colours of gold can be obtained in several places on the Miette River. At the faulted junction of the limestones and conglomerates, near Henry house, galena was noted in a small vein.

Gold on the Miette River.

"On the return journey, some further work was done on the north side of the Fraser valley above Moose Lake, to ascertain the position of a band of rusty quartzite which weathers out to a brilliant red colour. Viewed from a distance, these mountains have a gorgeous appearance of red and yellow, and suggest the name of Rainbow Mountains.

"Returning to Swift's place, near Henry house, on the 1st of September, the provisions that had been stored there two months previously were found all safe, and we were further indebted to Mr. Swift for exchanging a quantity of them for others that were more required. The next two weeks were spent in collecting fossils and in tracing out the complicated faults and folds of the rocks previously mentioned along the Athabasca River.

Jasper Lake to Brazeau River.

"On the 14th of September, the Athabasca was again crossed, and having moved down the river as far as the head of Jasper Lake, the exploration of a route through the mountains to the head of a branch of the Brazeau River, was commenced. The route selected was one that had been travelled by the Indians many years ago, previous to the railway exploration of 1874. Ascending a small stream called Jack Creek, that flows into the Athabasca above Jasper Lake, and travelling in a direction S. 60° E. over three minor summits of 5500 to 6000 feet, the route then turns northward into the valley of Rocky River. It reaches this river at a point distant sixteen miles and a-half from its mouth in a straight line. The valley of the river is remarkably straight, following the strike of the rocks, and is shut in by high wall-like mountains on each side. At a distance of fifteen and a-half miles further up, the river forks, the greater part of the water coming in from the southern branch. Following the other branch, which has a general direction of S. 65° E., the summit is reached in a further distance of thirteen miles, the route, for a great part of the way, being along the stony bed of the stream. The altitude of the summit is about 7500 feet.

"The branch of the Brazeau on the other side, descends rapidly, but without any cañon, and bending northward, at a distance of thirteen

miles from the summit it emerges from the mountains into a plateau country of about 5000 feet elevation. Three miles east of this place, the main branch of the Brazeau, which heads with the Athabasca River near Brazeau Lake, also comes out of the mountains.

Uplift of mountains on Brazeau River.

"The rocks met with on this route are the same as those seen between Jasper house and Brulé Lake. Their attitude at the edge of the mountains, is, however, very different from that on the Athabasca. No folding or crushing is to be seen, but a straight uplift without contortion of the beds and apparently without overthrust, for although the talus from the limestones obscures the line of contact with the Cretaceous sandstones, these rocks are both found in place in the bed of the stream in positions that preclude the possibility of a lateral movement of any extent.

"It was then decided that to return north-westward, near the base of the mountains, and to descend the McLeod River, was likely to yield more new information than could be gained by following the more direct route down the Brazeau and North Saskatchewan rivers. Accordingly, an old Indian trail leading in the required direction was followed. It traverses a level country, having an elevation of 5000 feet above the sea and strongly marked by terraces of round coarse gravel composed of limestone and quartzite materials. A low range of hills eight to ten miles to the north-east, through which the Brazeau River has since cut its way, at one time evidently held in a body of water here. Another branch of the Brazeau, nine miles from the one just left, was crossed, and six miles farther on the most northerly branch of that stream comes from behind a long range of foot-hills having an elevation of about 6500 feet. It seems probable, from the extent of the erosion in the Pembina valley lower down, that, at least part of the drainage from the mountains now emptying into the Brazeau, at one time found its way into the Pembina River which lies a few miles to the north.

Pembina River.

"At this crossing of the Brazeau, there is an exposure of yellowish sandstones and black carbonaceous shales, with several small seams of coal, one of which has a thickness of three feet. The Indian trail forks at this place, one branch descending the river and the other following it up into the foot-hills, so a middle course across country was adopted, and the Pembina River, here a small stream, was shortly reached. Up to this time the country traversed has a dry climate, owing to the effect of the Chinook winds, but now, as the distance from the mountains had been gradually increasing, the effect of a greater amount of moisture was noticeable and muskegs and swamps became numerous. The result of a great fire which overran the country between here and

the Athabasca River has, on the whole, up to the present time at least, been to make travelling less difficult.

"The first rocks met with on the Pembina River were dull olive-green sandstones and shales striking east-and-west, vertical. Further down the river the rock consists entirely of soft slate-gray shales, containing rounded and lenticular nodules of grey ironstone, sometimes cherty. As the river is descended, the dips become undulating and lower, until at nine miles down, the rocks are almost horizontal. These rocks closely correspond with the Pierre division of the Cretaceous.

Pierre shales.

Upper part of McLeod River.

"It is only three miles from here, across low hills, to the source of a stream flowing westward into the main branch of the McLeod, and five miles down this stream the first exposure of yellow sandstones of the Edmonton or Lower Laramie series, was found. The McLeod was reached at a point distant three days' travel from the Leavings. As the river is descended, numerous separate exposures are to be seen in the banks, showing irregular, coarse, yellowish sandstones, interbedded with clayey sandstone and blackish carbonaceous shale. One seam of coal was noted, six inches to a foot in thickness. Other larger seams are reported to occur higher up the river. Some prospecting has been done on the McLeod in which a certain amount of gold was obtained. It is found chiefly in a small seam in the river-gravels principally composed of dark materials derived from the shales.

"The return journey occupied eleven days from the Leavings to Edmonton, which was reached on the 14th of October.

Natural facilities of route.

"The natural facilities of the Yellow Head Pass as a route through the mountains, has been made known by the reports on the railway location line run for the Dominion Government, but perhaps sufficient weight has not been given to the fact that this route is entirely free from snow-slides. The importance of this fact can now be more fully appreciated on account of the great cost of the construction and maintenance of snow-sheds, since experienced in railway work. It may also be worthy of note that this pass affords an easy means of access from the North-west to the great valley previously mentioned, which forming as it does such a good natural highway, should eventually become the chief route for communication between north and south. The advantages of the route for a wagon road are even greater than for a railway, as in making such a road no rock cutting would be necessary.

Glacial drift.

"West of Edmonton, the country is generally deeply drift-covered, showing boulders of Laurentian rocks as well as of gray quartzites from the Rocky Mountains. At Lake St. Ann, besides these drift

materials boulders of yellowish-gray limestone holding Devonian fossils are numerous, with a few of coarse purplish-red quartzite or grit. Laurentian boulders are found to occur westward nearly to the McLeod River, beyond which all the drift material has come from the mountains. The surface deposit is generally a yellowish-white sticky clay, impervious to water, and to this is largely due the extensive muskegs and swamps that characterize the route. The long eskers before mentioned, occurring east of the crossing of the McLeod River, are a notable exception to the general rule. No limestones from the mountains were noted east of the McLeod.

"Along the valley of the Athabasca River in the mountains, exposures of boulder-clay are found in the lateral valleys, mostly composed of local material but containing also many travelled boulders of quartzite. On the east side of the river, above Henry house, a terrace 600 feet above the river is composed of silty calcareous boulder-clay. Traces of this deposit are found along the Miette River, and westward beyond the pass silty terraces, less calcareous in character and for the most part free from boulders, are extensively developed along the Fraser River. The western limit of the silt deposits on the Fraser is a few miles above Moose Lake. White silt deposit.

"On the higher summits of the mountains, no trace of glaciation could be discovered. East of Tête Jaune Cache, at an elevation of about 7300 feet, heavy glaciation was noted running S. 25° W., an occurrence difficult to explain. A mountain north-east of Camp River, about 8300 feet above the sea, has the general smooth aspect of a glaciated summit, but no striæ or travelled boulders could be found. Glacial striæ.

"The distribution of the principal trees is given in the following short notes:—Black and white spruce, poplar and cottonwood are found generally throughout the whole country traversed. Larch (*L. Americana*) extends as far westward as the McLeod River and ascends that river forty miles above the Leavings. It was not seen on the Athabasca or westward. Black pine (*P. Murrayana*) first seen thirty miles west of Edmonton, continues throughout. Douglas fir commences three miles below Jasper house and continues westward. The eastern "balsam" (*Abies balsamea*) was first seen on the Athabasca River, while *A. subalpina* was found generally throughout the mountains. White pine *(P. monticola)* was seen at Moose Lake on the Fraser River. White stemmed pine (*P. albicaulis*) was on most of the high mountains. Cedar and Hemlock (*Tsuga Mertensiana*) came in a few miles below Moose Lake and continue westward. Yew is found on wet mountain sides on the Fraser and Canoe rivers. Engelmann's spruce was found generally throughout the mountains, and another Distribution of trees.

form seen is probably that noted by Prof. Macoun as intermediate between this and the white spruce. Lyell's larch does not occur on the mountains in this district. Canoe-birch was first seen on the Athabasca River and continues westward.

Agricultural and grazing lands.

"One of the important resources of the region explored this season will be its agricultural and grazing lands. Farm settlements are at present to be found as far west of Edmonton as Island Lake near the Pembina River. Beyond that point, with one notable exception, no attempt at cultivation has been made. The exception referred to is a ranch three and a half miles below Henry house on the Athabasca. Mr. Swift has here demonstrated that the country is capable of producing wheat, potatoes, and various kinds of vegetables. On September 1st, he had harvested a crop of two varieties of good hard wheat, and his potatoes were good, both in size and quality. A great part of the bottom land of the Athabasca valley would yield good crops. There is an abundance of good grass all along the route from Edmonton to the pass, more particularly in the vicinity of the streams, and a wide belt of good pasture-land extends along the base of the mountains to the south. The country generally is capable of supporting a large amount of stock. Horses are wintered out successfully on the Athabasca River and at other places.

"In the wide bottom of the great valley passing Tête Jaune Cache, there is some good soil, and it may be safely said that one-fourth or more of its area would make rich farming land. A considerable portion of this is free from timber and covered with luxuriant grass suitable for making hay.

Collection of plants.

"Mr. Wm. Spreadborough, made during the season a collection of the flowering plants which, I am told by Prof. Macoun, includes nearly all the species supposed to grow in the region examined. Several species were found which had not been collected since Drummond's time and two or perhaps three species new to science were secured. One of these, *Viola cyclophylla*, has since been described by Dr. E. L. Greene. In all about 525 species of flowering plants and some cryptogams were collected. The range of several species has been extended, and a number of plants previously known from the lower Columbia, but not found in the southern Rocky Mountains were collected on the Canoe River and on the head-waters of the Fraser River. This is due to the continuity of the great valley, so often referred to in this report, not only affording an easy means for these plants to extend, but also causing a congenial temperate climate to enable them to hold their ground."

ONTARIO.

Work by Mr. W. McInnes.

Mr. W. McInnes, in the early part of 1898, was engaged in plotting and compiling the surveys of the preceding summer and in work upon a general report upon the region covered by the Seine River and Shebandowan map-sheets, already printed. Mr. McInnes left Ottawa on the 13th of June, with instructions to make a geological exploration of the country lying to the north of the Seine River sheet, of the series of geological maps of western Ontario and to the east of the Manitou sheet. This also involved the making of such surveys as were necessary to the compilation of an accurate topographical map of the district. The amount of surveying work which was required was too great to allow of completion of the map-sheet in one season, but about half the area was covered during the summer. Mr. H. L. Smith, who had been nominated to assist Mr. McInnes, accompanied him and satisfactorily performed his duties during the season. On the work accomplished Mr. McInnes makes the following report.

Ignace sheet Rainy River District.

Lake Minnitaki.

"After outfitting at Rat Portage, the season's work was begun at Dinorwic on June 19th. A micrometer survey was started at a point on the south-west arm of Lake Minnitaki about ten miles north of the crossing of Niven's fifth meridian line, and connecting there with last season's surveys. A continuous survey was made of the south shore of the lake to the inflow of English River and of English River with the lake-expansions along its course to Bear Lake, and thence to Ignace station on the Canadian Pacific Railway, by way of Sand Point Lake.

South-westerly bay.

"The shore of Minnitaki throughout the whole extent traversed, lies within the Keewatin system of rocks, though it is nowhere more than three miles to the north of the northern edge of the Laurentian granites and gneisses. All along the shores of the long, narrow, south-westerly bay, from the crossing of Niven's meridian line north-eastwards, the rocks exposed, are in the main massive diorites and diabases with areas of green schist which may probably be considered as crushed and sheared phases of the massive basic rocks. Associated with these basic rocks are areas, more limited in extent, of acid quartz-porphyries and the schists derived from their shearing. Often the quartz-porphyries are still quite massive, and in places they approach very closely ordinary granites. They are seen in places to clearly cut the green schists.

"The strike all along closely follows the general trend of the shore-line, the curve of the latter, from a little east of north to a little north of east, being apparently determined by the strike of the schists. The

next bay, which in direction is closely parallel to that just described and is separated from it by a dividing ridge only half a mile to a mile and a-half in width, shows along its north shore the same set of diorites and green schists, with bands of felspathic schists and quartz-schists similar to those above referred to.

"The south shore of the bay is occupied by massive quartz-diorites and even-grained, hard, grey quartzites in which is developed in many places a rough schistosity striking parallel to the trend of the shore-line. Going southerly from the south shore of the bay and following up-stream a route leading to Kapikwabikok Lake, this band is crossed at about right angles to the strike and is found to give place, at a distance of about three-quarters of a mile from Lake Minnitaki, to basic green chloritic and hornblendic schists and massive diorites, that continue to the northern edge of the Laurentian. On Kapikwabikok and the lake lying between it and Minnitaki, are several small areas of hornblende-granite, biotite-granite and biotite-gneiss, that have the aspect of intrusives in the schists, which they invade in the form of long arms, and blocks of which they inclose. These represent, almost without question, outliers from the main granitic area which comes close to the southern end of the lake, and is at no great distance from the east shores of both Kapikwabikok and the lake to the north of it. Some of the areas may, very probably, be connected with the main mass, but the connection was not established.

Kapikwabikok Lake.

"All along the main south shore of Minnitaki, to within about five miles of the outlet of Twin Lakes, massive felspathic quartzose rocks, probably quartzites, and their derived schists, form the shore, striking nearly east-and-west. For the next five miles, or nearly to Twin Lakes, the more basic schists and massive rocks are seen.

Twin Lakes.

"The greater part of Twin Lakes is occupied by the quartzites, the southern end of the lake extending into the diorites, which here again lie to the south of the more quartzose rocks and between them and the granites. Continuing along the main shore of Minnitaki, the quartzites extend beyond the point where the shore-line bends abruptly to the south, for about a mile down into the southern bay. The remaining shores of this bay lie altogether in the basic division, its extreme southern end reaching down to within a mile and a-half of the northern edge of the granites. The same rocks are found up the English River as far as Otter Lake, where the Laurentian gneisses come in about two miles south of the head of the lake. At the expansion of the river into which Jarvis or Night-owl River flows, the gneisses are within a mile or less of the shore, and at one point, two miles east of the mouth of the river, the schists show

English River.

arms and veins from the granite, cutting them in various directions, but generally along the planes of schistosity. Again, at Flying-loon Lake, another expansion of the river, the main Laurentian area is entered, its northern edge lying two miles from the south-west end of the lake. The rocks in immediate contact with the granite here are coarse, massive diabases. These rocks occupy the whole northern side of the lake, with the exception of a few hundred yards, about midway, where the red, biotite-granite of the south shore cuts into them and forms the immediate shore-line. A small, isolated area of rather coarse red, biotite-granite of even grain, occurs at the fall which forms the outlet of Flying-loon Lake. Southwards along the route from Otter Lake towards Ignace station, obscurely foliated, granitoid gneisses are continuously exposed, striking, wherever the foliation is clear, about east-and-west. In the vicinity of Ignace, and over a large area to the north and north-west of it, the rocks are non-foliated, and the granite consequently furnishes a good building stone, which is being largely used by the Canadian Pacific Railway for the construction of bridge piers and foundations.

Otter Lake to Ignace.

"The English River, at the time of our survey, early in July, was found to be almost at freshet height, so that its ascent was much slower than it would have been at ordinary summer level. A fall, with three short rapids immediately above it, occurs at the mouth of the river, and necessitates a portage of a little over three-quarters of a mile, or, at low water, four short portages. The total rise is here about forty-five feet. The next rapid, past which there is a portage twenty-eight chains long, and which rises about six feet, is only a mile above the first. A quarter of a mile further up-stream, rapids with an ascent of twenty feet, are passed by a portage of sixty-five chains. A mile and a-half of canoe navigation intervenes between this and the next rapids, where there is a rise of about ten feet and a portage of twenty-eight chains. A lake-like expansion of the river here extends westward for two miles and a-half, receiving near its head the waters of Beaver River which drains a lake of considerable size lying to the north-east of Basket Lake and known as Beaver Lake.

Route by English River.

"Swift water with numerous rapids following closely upon one another continues to Flying-loon Lake. In this distance of eight miles there are five short portages with a total rise of about forty-five feet. A rise of about five feet, with a short portage and a stretch of one mile of very rapid water, separates this lake from Jarvis Lake, between which and Otter Lake there is a rise of perhaps six feet. At Otter Lake the river divides into two branches, one draining a short chain of lakes lying to the north-east and forming the route of travel

Two branches of river.

to Sturgeon Lake and all eastern points, and the other, the main English River, coming in from the south. The main river was followed to Bear Lake which is about thirty feet higher than Otter Lake, the principal rise occurring at three short rapids near Bear Lake. The total ascent between Minnitaki Lake and Bear Lake is, therefore, in the neighbourhood of one hundred and sixty feet.

Alternative route from Ignace to Minnitaki.

"Another route from Ignace to Minnitaki Lake, lying south of that above described, was then surveyed. The first lake of any considerable size on this route is that roughly indicated on some maps and called Orang-outang, evidently a mistranslation of the Indian name Mameigwess, meaning a 'wild man' or 'dweller in rocks.' This lake is reached from Sand Point Lake by ascending a smooth-flowing, winding stream of ample volume for loaded canoes. The exposures of rock along the river are of biotite-granite and very obscurely foliated granitoid gneiss. Mameigwess Lake has a coast-line of about thirty-two miles and lies wholly within the gneiss area. Kukukus (Night-owl) Lake, is reached from Mameigwess by a series of five smaller lakes, gneisses only occurring all along the route as well as about the shores of the lake itself. A micrometer survey of the lake gives it a shore-line of fifty-five miles and a total length of a little over thirteen miles. It discharges into English River at Flying-loon Lake by a short river with numerous rapids and a descent of thirty-five feet. Basket Lake and a crooked, narrow lake thirteen and a-half miles long lying just east of it, were also surveyed, together with the river by which they discharge into Kukukus Lake. A few small areas of pine still remain on the shores of the river and lake. The rock exposures show no variation from the granitoid biotite-gneisses, excepting in the replacement of the biotite constituent by hornblende, which occurs in a few places. The very irregular shape of the lake gives it a shore-line disproportionate to its area, the former measuring fifty-six miles and the latter only a little over fifteen square miles.

Beaver Lake.

"Minnitaki Lake was reached by way of Beaver Lake, eight miles long, and several small lakes. The granitoid gneisses continue to within a mile of the east end of Kapikwabikok, the strike of the foliation swinging from north-east on Beaver Lake, to nearly north, parallel to the edge of the area as its western limit is approached.

Route from Little Wabigoon to Ignace.

"A route from Little Wabigoon by the Wabigoon River to the head of Turtle River was then examined, and thence, by a series of lakes and streams the head-water of Turtle River was connected by a micrometer survey with the Canadian Pacific Railway at Ignace Station.

"The route followed, up Snake River through Long Lake and another narrow lake to its head-waters, continued in rocks of Keewatin age from Wabigoni to beyond Bending Lake on Turtle River. The north-eastern edge of this Keewatin belt was fixed at a number of places along the route by offsets through chains of smaller lakes, and proved to be close at hand all along—never at a greater distance than three miles from the main route. This gives to the belt a width varying from twelve miles, at Snake Lake, to eight at Bending Lake. It was found to terminate just beyond Bending Lake, becoming gradually more and more metamorphosed, the diorites and green schists towards the end becoming hornblende-schists and fine hornblendic and micaceous gneisses, having a strong resemblance to the Coutchiching of Rainy Lake and cut in all directions by veins and masses of coarse, white, pegmatite-like, granitoid gneiss. On the western side of Bending Lake, the hornblende-schists are interlaminated with seams of magnetic iron, sometimes as much as a few inches in thickness. These occur in sufficient volume to render compass work about that part of the lake quite impracticable, but they were not seen, in the hurried examination we were able to make, in such quantities as to be of any definite economic importance. On Birch Narrows or Richard Lake on which the extension of this band south-easterly would be exposed, no trace of Keewatin rocks is seen, unless they are represented by the bands of fine black hornblende-gneiss that occur there, in insignificant volume as compared with the coarse, white, biotite-granite and granitoid gneiss and which are contorted and cut by the latter rocks.

Extent of Keewatin.

Iron ore.

"On the route north-eastwards to Ignace, a belt of Keewatin rocks consisting for the most part of highly crystalline hornblende-schists and fine gneisses, is crossed just south of Ogema Lake. It has here a width of from two to three miles only, and represents in all probability an extension of the belt which crosses the railway between Taché and Raleigh. South of the belt, the gneisses have a general east-and-west trend, and north of it a north-easterly foliation.

Keewatin at Ogema Lake.

"In this belt, on an island in the lake south of Ogema Lake, occurs a quartz vein varying in width from over six feet to quite narrow, which has been partially stripped. In places it is well mineralized with pyrrhotite and pyrite with some calcopyrite and is, as far as can be seen from present stripping, very irregular, with spurs running along the foliation of the inclosing hornblende-schists and mica-schists. It is stated that assays have given a certain amount of gold.

Quartz vein.

"For the purpose particularly of fixing the limits of the Keewatin belt crossing the railway east of Taché, surveys were made of lakes lying to the south of the track between Raleigh and Butler stations.

Keewatin belt at Taché.

These lakes were reached by way of Mameigwess, by a route that crosses the railway near the 265th mile-post and follows the Wabigoon River up its principal branch, to a large lake having an elevation of about a hundred feet above the railway, not more than two miles from the track. The whole ascent is practically made in a distance of seven chains, where the river forms a succession of vertical pitches. About the lake hornblende-schists and diorites are well exposed, everywhere much crushed, twisted and invaded by granites, which on both the east and west shores of the lake occur in massive form. A series of small lakes, most of them merely beaver ponds, was followed southerly for about four miles from the south-east bay of the lake, and a very much mixed set of diorites, hornblende-schists, quartz-porphyries and fine gneisses was found to extend for the whole distance. Frequently no sharp line of demarcation could be drawn between the schists, gradually merging into fine gneisses, and the ordinary gneisses of the Laurentian area, a species of contact which seems to characterize the relations of the Laurentian to this Keewatin band all along.

Wabigoon River.

"A track-survey was made of the Wabigoon River, and the western edge of the granite area of Blueberry Lake was better defined. It is along this contact and in a belt of Keewatin adjoining it, that so many promising properties have been taken up during the past year. To assist the development of these, a road has been cut out from the Canadian Pacific Railway into the centre of the mining district, locally known as the New Klondike.

Auriferous quartz veins.

"Work, at the time of my visit, was being done on two properties, numbered 416 HN. and 419 HN. respectively. On the first, held by a Winnipeg company, a shaft of eighty-feet has been sunk, but was full of water, and preparations for pumping it out were then in hand. The main vein at the outcrop varies in width from eighteen inches to less than a foot. It was found to hold a course of N. 64 E. (mag.) for about three hundred feet, where a sudden bend easterly, almost at right angles, was accompanied by the development of a mass of quartz forty or fifty feet in diameter, with the outer wall underlying at a very appreciable angle towards the original vein. At a distance of sixty feet the vein resumes its original direction and size and has been stripped for a further distance of five hundred feet. Beyond this, Mr. Thos. Hogan, who is engaged in its development, states that he has traced it across the two succeeding locations. The vein occurs in a quartzite-like rock which merges into a quartz-porphyry, which is itself probably intrusive in the crushed diorites that form the prevailing country-rock. The vein is generally well-defined, with good walls, and carries zinc-blende in notable quantity with iron-

pyrites and chalcopyrite, and shows some free gold. A spur offsetting to the south-east forms a narrow vein which is also fairly well mineralized. A good, general average gold-content, is claimed for the main vein.

"At 419 HN., sinking was being pushed forward in a shaft that had then reached a depth of 115 feet. The vein, which was being developed by an English company, was small, running from a foot to only a few inches, and had been traced on the surface for only a short distance. The values were high enough, however, to warrant its development, in the hope that it might strengthen in depth. After losing the vein at eighty feet, the shaft was continued downwards and the vein, or a vein, was again picked up, which, at 115 feet showed six inches to ten inches of quartz across the shaft. Like 419 HN., the quartz carries iron- and copper-pyrites and zinc-blende, with a considerable amount of visible free gold. The containing country-rock is here a green schist, evidently derived by shearing from a diorite or diabase,

"Work, in the way of stripping, test pits, etc., has been done on a number of properties in the neighbourhood, that lie in a contact zone of the Keewatin with an intrusive granite area. Spurs of the granite invade the green schists in many places, and it is not improbable that some at least of the quartz-porphyries are phases of the granitic intrusive, although generally they seem to represent the later extravasations from the magma which supplied the basic diorites at an earlier stage.

Rocks seen along railway.

"The remainder of the season was spent in making an examination of the section afforded by the exposures and cuttings along the line of the Canadian Pacific Railway, which traverses the area of the sheet from north-west to south-east. The western end of the section shows the lacustrine, stratified, silty clays extending easterly along the track to between Dyment and Taché stations, or to an elevation of a little over 1250 feet. Occasional exposures of Keewatin schists are to be seen outcropping here and there through the drift to within about half a mile of Taché, where the north-easterly corner of the granite area of Blueberry Lake crosses the track and extends along it for about two miles. Beyond, and extending eastward for six miles, or to just beyond Raleigh, is another belt of Keewatin, made up for the most part of hornblende-schist and very fine gneiss.

Stratified silts.

Gold locations near Raleigh.

"Near the contact of these rocks and the granite, a number of locations have been taken up, and on one at least some preliminary work has been done in stripping and sinking a few test-pits. The country-rock here is a hornblende-granite that incloses blocks and

extended, broken bands of diorite. It shows often an obscure foliation striking about N. 55° W. The quartz occurs as a series of lenses of very irregular shapes and sizes, along a line running about N. 20° E., and probably representing a line of fracture. The mode of occurrence of the quartz is extremely irregular. It varies from stringers and small lenses one foot in diameter, to masses fifteen to thirty feet across, often with their longer diameters parallel to the foliation of the rock and nearly at right angles to the line of outcrop of the quartz. Following the line of outcrop, the quartz can be traced, not continuously, but in exposures occurring at close intervals, for a distance of about fifteen chains.

"The quartz is not highly mineralized, showing, as far as noted, only a little iron-pyrites. Samples taken from the surface and representing as nearly as possible the average quartz are being analyzed in the laboratory of the Survey.

Granitoid gneiss.

"After crossing the Keewatin belt above mentioned, the remainder of the section to English River lies entirely in the granitoid gneisses striking generally but a few degrees either way from east-and-west.

Silts.

The white, silty clay of the Wabigoon area does not again appear. Cuttings through drift are, however, numerous, showing with but a few exceptions unstratified material, varying from a clay inclosing large angular boulders through coarse gravel to sand. All seem to be glacial in origin and they are seldom even modified by subsequent water action. Glacial striæ, averaging about S. 30° W. in direction, are seen at many points."

Work by Mr. D.B.Dowling.

Mr. Dowling was employed during the early part of the year in compiling certain facts relative to the orography of the Arctic Islands and the northern part of the continent for mapping purposes. He also completed a draft report on the Cambro-Silurian rocks of the Lake Winnipeg Basin, which had been delayed pending the examination of the fossils collected there, undertaken by Mr. Whiteaves. He also prepared the manuscript of the Lake Winnipeg map-sheet for the engraver.

Lake Nipigon.

As it appeared desirable that the geological examination and survey of Lake Nipigon, already partially accomplished by Dr. Bell in 1869 and 1871, supplemented in 1894 by a traverse of the shores by Messrs. McInnes and Dowling, should be completed for publication, Mr. Dowling was requested to undertake this work. The survey made in 1894 consisted of a traverse with transit and micrometer around the shore-line, while many large islands and two large bays had not been visited. Arrangements were made with the Hudson's Bay Com-

pany whereby the use of one of their large sailing-boats was secured, and a cedar canoe was shipped to Nipigon Station by rail. On the work Mr. Dowling reports as follows :—

"Leaving Ottawa on the 16th of July, I proceeded to Nipigon station, near the outlet of the Nipigon River, where four men were hired. Two of these, Indians from Lake Nipigon, had brought a boat over from the Company's trading post for our use. This had been left near the outlet, and the men coming down by canoe arrived before the party had been completed. With a good load of provisions in the canoes we reached the lake on the 24th of July, and the survey of the islands was commenced the next morning. The order in which they were visited was in a general way from south to north-west and then north and eastward till all were surveyed, or, in the case of small ones, fixed by cross bearings. Several elevated points on the mainland and islands afforded good views, and were occupied as transit stations, from which a series of angles on the positions of islands were read and sketches made. Thus at Gros Cap on St. Paul Island, our station was at an elevation of 300 feet, and we had a view to near the north end of the lake. Our station on the south-east end of Grand Island was at an elevation of over 200 feet, while that on the Outer Barn was at 450 feet, affording a view in which the whole width of the lake was seen and angles read on elevated points up to forty miles away. Other stations at lesser elevations furnished a network of triangles covering the width of the lake, so that a connection across was made at several points. Ombabika Bay, across the mouth of which we passed in 1894, was traversed by transit and micrometer during this season, as also Pijikawabikong Bay at the south-east corner of the lake. Several streams entering the lake, mainly on the east side, were ascended, and estimated traverses of their courses were made. From Ombabika Bay, Little Jack-fish River was traversed for fifteen miles. The Vermilion River, emptying into Humbolt Bay, was examined for a similar distance, and the Sturgeon River, near Poplar Point, was ascended to a point about twenty miles from the lake. Two routes being known to our men, we left the river at the first long portage, and by a chain of lakes to the south, followed parallel to the river for nearly ten miles, then, returning to it again we ascended as before. On the return journey the whole of the river so avoided was traversed.

Triangulation surveys of islands.

Surveys of streams.

"Smaller streams were found flowing from the east, but as they are little travelled by the Indians short excursions only were made up these.

"The survey of Nipigon River made in 1894, did not include the upper part, or that above Lake Hannah, the short route to the lake *via* the Flat-rock Portage having been followed. This gap was therefore filled by our surveys made at the close of this season. A map of the lake and river can now be compiled. The need of a good geographical chart of the river may be inferred from the fact that over four hundred and fifty sportsmen visited this river during the fishing season from June to the middle of September.

Rocks of the islands.

"The rocks of the islands in the central portion of the lake are all formed of trap—the 'crowning overflow' of the Nipigon formation, while a few at the north extreme and near the eastern shore, as in Ombabika Bay and Humboldt Bay, are of gneiss and dark-green schists referable to the Archæan. Little arable land is to be found on any of them, as the covering of drift is very thin and consists mainly of boulders, while the surface of such as are formed of trap is very irregular being generally a mass of broken fragments.

Shakespeare Island.

"Several of the islands are of considerable extent. Shakespeare Island, east of the entrance to McIntyre Bay, is roughly rectangular in outline, six miles long from north to south,, and five miles broad, but from the eastern side, a group of islands appears to extend this, five miles in a south-east direction. Several high hills form prominent landmarks, the most conspicuous being Paupuskeese Mountain, an isolated mass of trap near the west end of the island. A high ridge at the north-east corner is also prominent, as well as Hat Mountain on one of the islands of the group to the east.

Grand Island.

"Grand Island, near the western shore, is roughly triangular in shape with a length of about ten miles. The coast-line measures over twenty-seven miles. The main body of the island is high, having a general elevation of over two hundred feet above the lake.

"Stretching northward, and separated by narrow channels, are several large islands reaching to near the north end of the lake. These, with the addition of Murchison Island, a large high island near the east shore, constitute the main body of the islands of the northern part, though numerous others of smaller size are scattered about in an irregular manner. The whole group occupies an elliptical area inclosing a rather shallow basin in the centre of the lake. Between these islands and the eastern shore, a very deep channel is found, evidently formed by the denudation of the trap and underlying sediments down to the original floor, and as the Archæan rocks are found along the eastern margin of the lake overlaid by heavy beds of trap, the slope of the original basin must here have been very steep.

"Livingstone Point, on which a heavy bed of trap still rests, shows the upper surface to dip very sharply to the west. The inner end of the trap hill reaches to a height of about six hundred feet, while the western end is only about two hundred feet in elevation. The inner side of the ridge inclosing Ombabika Bay is also much higher than that facing the lake. The inland extensions of these ridges about the northern part of the lake are eroded away, and the Archæan rocks succeed them to the east, but toward the south-east the limit of the trap is apparently at a greater distance from the lake, and could not be ascertained without many traverses across country eastward. Eastern edge of trap.

"The topography is without doubt greatly influenced by the erosion of the great mass of trap that may be said to have filled the basin. The exposures all along the lake, show the mass to have been very much broken by vertical fissures, so that most of the cliffs are subject to frequent falls of rock; but a series of greater fissures would appear to have also been formed upon the cooling of the mass of molten trap. These no doubt surrounded, in an irregular manner, local centres of greater thickness, and were enlarged by the subsequent sinking of parts of the basin owing to the displacement of such a large mass of erupted material from below. That these great lines of fissure extended along the eastern side of the basin, is shown by the existing traces in the mass of trap confining the southern end of the lake, the outlet by the river being roughly along a great fault or break forming a cañon, the eastern side of which is almost precipitous, and rises to nearly six hundred feet—the western side very much lower and decreasing in height to the northward. Other great faults no doubt run northward between the islands and the ridges on the east shore. Faults.

"The denudation of the rocks along minor lines of fracture is well exhibited in Pijitawabikon Bay, a long, narrow break in the high plateau, branching out at its head into irregular, small, deep gullies, in which are insignificant streams.

"Many of the high ridges appear to be of the nature of immense dykes, and it is found that at several points the trap has broken up through the limestones and underlying sediments, displacing and disturbing them laterally, as at Cook Point, or filling gaps or breaks in the Archæan, as was noted near the mouth of Little Black River, and at the long portage on Sturgeon River. Great dykes.

"It was found, by ascending several streams from the north and east shores, that a terrace of sand, about one hundred feet above the lake, through which the streams have cut deep valleys is here developed. The upward extension of the terrace, limited in width by the slope of Sand terraces.

the underlying rocks, was found on the Jackfish River to be nearly ten miles, and on Vermilion River and other rivers farther south along the east shore, was considerably less. The White-sand River, on the west side of the lake, also flows through sand terraces, and a lower one is found spread out over the low country from this river to Mount St. John.

"Vermilion River and Sturgeon River, on the eastern shore, also show deposits of stratified sand, from an elevation of nearly one hundred feet down to near the lake-level.

"The underlying rocks are seen on these streams only at the various rapids and falls. On Little Jackfish River, greenish gneisses and schists, similar to those of the Couchiching series, are met with, and on the Vermilion River, which enters Humboldt Bay, schists and greenstones of the Huronian, form a band running east-north-east from the head of the bay. At the first rapid and on the island at the mouth of the stream, the contact between these dark rocks and the gneisses is found. It is of the nature of a zone of intrusive granite in which contorted stringers of both rocks are found, the general strike of both gneiss and schist being nearly parallel, running about ten degrees north of east.

Huronian rocks.

"The Sturgeon River, for twenty miles, or as far as traversed from the lake, occupies a depression in rocks of the Huronian, running very closely along the strike, so that no great width of beds is seen; but besides the greenstones and schists so common to this formation, beds of coarse conglomerate occur on the lake route above the long portage. A high ridge of trap starting from Mungo Park Point on the lake, north of the mouth of the river, runs in a direct line south of east and crosses the valley of the river at the long portage.

"An abrupt break of half a mile in width, allows the passage of the stream, and through this the river pours over many small falls and rapids, past which a portage of a mile is made, the fall in that distance being over fifty feet. The rocks above and below being of Huronian greenstones, this ridge appears to be of the nature of a great dyke, as all the exposures on the stream in the gap are of the dark brown trap. A number of mining claims were staked out at the mouth of the river some years ago, but no paying ores appear to have been found. Ore from a band containing disseminated pyrites was shipped out, but appears to have been of little value. The stream has been prospected but without very much success. Specimens of the ores from the mouth of the river, as well as a pyritous rock from the Steep-rock Fall near Crooked Lake, were secured. Gold was reported as discovered west of Nipigon River in the vicinity of the western part of Purdom

Economic minerals.

township. The sample that was shown me consisted of a small piece of quartz in which several particles of gold were plainly visible. As the locality was not yet staked out it was kept secret.

"During the course of the work, twenty-five photographs of lake features and rock structure were taken and a series of rock specimens was collected.

"Our surveying operations terminated on Sept. 21st at Camp Victoria, and we then proceeded to Nipigon, where the men were paid off and the canoe and camp furniture were stored. Ottawa was reached on Sept. 26th."

Work by Dr. R. Bell.

Dr. R. Bell devoted time during the winter of 1897-98 to writing a report for issue with the French River sheet of the Ontario series of maps; also to geological and topographical compilation connected with other maps on the north shore of Lake Huron. The discovery of gold at Michipicoten having drawn a good deal of attention to that district, Dr. Bell was requested to undertake a further geological examination of it, his preliminary report upon which is as follows:—

Michipicoten district.

"The field-work of the season of 1898 occupied about four months. I left Ottawa on the 5th of July and returned on the 8th of November. The greater part of this time was spent in the Michipicoten gold district, which lies at the north-eastern angle of Lake Superior, but having completed the principal field-work there early in October, the remainder of that month was devoted to making a survey of the whole course of the White River or eastern branch of the Missisagui (or Missisauga) and an exploration of the country about its source, in order to complete for publication the northern part of map-sheet 129. I have to thank Messrs Eddy and Jordon for facilitating this work.

Party.

"In performing the work in the Michipicoten district, my party consisted of two assistants, Mr J. M. Bell and Mr Howells Frechette, and from five to seven bush- and canoe-men as required; but while engaged in the White River work during the remainder of the season, I was accompanied by only two canoe-men. I may here express my entire satisfaction with the efficient manner in which every member of my party performed his duty.

Position of gold discoveries.

"It was the discovery of gold near Michipicoten in 1897 that rendered it desirable to have a more exact and complete survey of the surrounding district than had hitherto been made. The most important section of the gold-bearing area of this region lies within the western half of map-sheet 143, of the Ontario series, the remainder of the

auriferous tract extending northward into the ground covered by sheet 156, of which both the topography and geology are sufficiently well shown on my map of the basin of Moose River published in 1881.

Michipicoten mining division.

"Following the discovery of gold at Wawa Lake, near Michipicoten, a large tract around the north-east angle of Lake Superior was proclaimed as a gold district by the government of the province of Ontario in 1897. This district is described in 'an Order in Council approved by His Honour the Lieutenant-Governor the ninth day of September A. D. 1897', as the 'tract limited upon the east side by the meridian of the east end of Dog Lake or say eighty-four degrees west from Greenwich, on the south side by the latitude of Cape Gargantua, say forty-seven degrees thirty-six minutes, on the north side by the latitude of forty-eight degrees thirty minutes, and between the westerly ends of these lines of latitude where they touch Lake Superior, by the shore-line of said lake, containing about five thousand square miles, be declared a Mining Division and that the name thereof be the Michipicoten Mining Division.'

Previous work.

"I had incidentally done more or less topographical and geological work in this region in the years 1875, '76, '77 and '81, which, with the results of the present season's operations will enable me now to compile a map of it showing both the geography and the geology with considerable accuracy of detail.

Difficulties encountered.

"The district is not an easy one to survey and map, because of its primitive condition and other circumstances. There are only a few canoe-routes within its limits, and these are difficult on account of the numerous portages, as well as the broken and rapid character of the streams, due to the general slope of the whole country towards Lake Superior. No roads or surveyed lines exist, while the hilly nature of the district and the almost impracticable character of much of the bush, render 'traversing' in the woods a very arduous undertaking. In spite of these obstacles, however, I succeeded in obtaining all the

Surveys made.

data required for the construction of a map. Within these limits we made micrometer surveys of the coast of Lake Superior to the western and southern margins of the sheet, and also of all the streams and inland lakes where canoes could be employed. Sketch-surveys were made of the smaller streams and of the lakes inaccessible to canoes, while various trails and all the old tote-roads which had been used in the construction of the Canadian Pacific Railway, were carefully located on the map by pacing and taking compass bearings of every change in their course. Finally, in order to ascertain the geology in sections where no prominent topographical features were known to exist, we made numerous traverses through the bush, some

of them being of considerable length. Our difficulties were increased by continued wet weather, the season having been the most rainy one for the last thirty years. The insect pests, which are always a serious obstacle to all kinds of work in the woods during the summer season, were this year unusually troublesome, especially the mosquitoes, black flies and sandflies. Insect pests.

"As many observations for latitude were obtained as the weather permitted me to take. A considerable number of photographs were secured, and barometric readings were everywhere recorded in order to ascertain the elevations of mountains, hills and terraces, as well as of lakes, waterfalls and river-stretches. The temperature of the water was noted every day as an indication of climate. Notes were constantly made as to glaciation and surface geology, which are always interesting and often important subjects. Particular attention was paid to the nature and the mode of occurrence of the gold-bearing veins of the district. The principal discoveries were visited and fair samples for assay were broken by myself from the veinstones *in situ*. Observations were always noted as to the distribution and the local characters of the forest trees. But as I had made large collections of plants in this district in previous years and had also made somewhat extensive collections of insects of the orders Coleoptera and Lepidoptera, I did nothing further in these lines during the past season. Observations and photographs. Specimens collected.

"It would have facilitated my geological work very much if accurate surveys had previously been made of the principal topographical features of the district, because the time I was obliged to devote to this work necessarily occupied a large proportion of the season. Want of topographical surveys.

"A considerable proportion of this district is occupied by two belts of Huronian rocks, lying at right angles to one another; the larger one, which for convenience we may designate the Michipicoten belt, running north-eastward, and the smaller, which may be called the Cap Choyé belt, south-eastward from Michipicoten Bay. A narrow interval of granite at Burnt Point, separates these at the shore of Lake Superior; but inland, the extension of this granite occupies the whole of the triangular space between the two belts and the eastern boundary of the sheet. The larger belt is bounded on its north-western or outer side by the older Laurentian gneisses, and the smaller one on its south-western side by both granites and gneisses. Huronian belts.

"The former has an average breadth of about fifteen miles, and it extends from Michipicoten Bay to a short distance beyond the line of the Canadian Pacific Railway at Missinabie station, a distance of forty-six miles. On the shore of Lake Superior it reaches westward Michipicoten belt.

from the mouth of Michipicoten River to Dog River, a distance of ten miles, and southward from the former river to Burnt Point Harbour, a distance of ten miles also. Near the mouth of Michipicoten it throws off two narrow spurs to the eastward, each of which runs into the granite area a distance of about ten miles. Without a map to accompany the description it is difficult to convey an accurate conception of the form of this belt or triangle. It may, however, be said that its north-westerly boundary runs as a curving line north-easterly from the vicinity of the mouth of Dog River on Lake Superior to the Magpie River, which it intersects at about eleven miles in a straight line below the crossing of the Canadian Pacific Railway. The south-easterly boundary, after giving off the two spurs already mentioned, follows a north-easterly course to the outlet of Mattagaming Lake (often erroneously called Dog Lake).

Rocks of this belt.

"The rocks of the Michipicoten belt consist mainly of slaty and amorphous greenstones with occasional massive crystalline varieties. There are also smaller proportions of hornblende-schists and mica-schists, greywackes, argillites and clay-slates, siliceous, felsitic and other crystalline schists, quartz-porphyries, conglomerates or agglomerates, breccias, dolomites, etc., in still smaller amounts. An isolated area of red granite about two miles in length occurs on the west side of the Magpie River just above the second portage from its mouth.

Outlines of Michipicoten belt.

"The following is a more detailed description of the Michipicoten belt:—Beginning at its southern extremity, the line of contact between the granite on the east and the Huronian schists and other rocks on the west, runs northward from Burnt Point Harbour with an eastward curve to the Michipicoten River, which it strikes about two miles from the mouth. The boundary next runs south-eastward along the southern side of the spur of Huronian rocks above mentioned. The north-eastern side of this spur, which runs south-east, crosses the Michipicoten River just above the foot of Long Portage. From this point upward along the river, the rocks, as far as the junction of the Sequamka, are mostly gray granites of various shades and textures, while those south of the mouth of the river are mostly red granites.

First spur.

Second spur.

"The second of the narrow Huronian spurs already mentioned, crosses the Michipicoten River at the mouth of the Sequamka River. This stream was surveyed by micrometer to the edge of the sheet, and the rocks observed upon it consisted entirely of gneiss, the strike of which varied from W.N.W. to W.S.W. Gneiss occurs again at Cat portage on the Michipicoten about a mile above the Sequamka, and

also in the hills to the north-west of the outlet of Whitefish Lake, striking east-and-west in both localities.

Rocks on Whitefish Lake.

"Around the shores of Whitefish Lake, at Pigeon portage and about the southern part of Manitouwick Lake, the rocks are mostly gray granite. On other parts of the latter lake, gneiss, greenstone and green schists as well as granites are found. Near the south-western extremity of the main body of this lake, a hill of gray granite on the north-west side is faced by a large dyke of diorite, which forms a bluff 250 feet high. The dyke may be 300 or 400 feet in width, and it runs about south-west and north-east. Its existence may have had some connection with the geological history of the lake, which also runs in the same direction. The diorite is lighter in colour and coarser in texture in the centre of the dyke than towards the sides.

Manitouwick to Wawa.

"The canoe-route from Manitouwick to Wawa (properly Wawagonk), which I also surveyed by the micrometer, follows a chain of small lakes and streams, lying in a tolerably direct course. Several excursions were also made from the line of this route into the country on either side, for the purpose of ascertaining the character and extent of the rock-formations. With the exception of a hill of gray gneiss 300 feet high on the north-west side of the route, the only rocks seen between Manitouwick and Hawk lakes consisted of red and gray granites, which continue to the second pond south-west of the latter. From this pond to Wawa Lake, there is a variety of green and grayish crystalline schists and greenstones, agglomerates, greywackes, etc.

Wawa Lake.

"Around Wawa Lake and thence to the mouth of the Michipicoten, slaty and massive diorites prevail. In the hills overlooking the northern side of Wawa Lake near its north-eastern extremity, a massive looking white-weathering rock is very conspicuous owing to the woods having been mostly burnt off. It consists of a compact light-reddish felsite with a decided conchoidal fracture and showing lines of lamination parallel to the general strike of the other rocks in the neighbourhood. The white crust, due to weathering, which generally characterizes felsites is here very marked.

Wawa to Grasett.

"The tote-road from the north-east end of Wawa Lake to Grasett station on the Canadian Pacific Railway, which was in use during the construction of the line, was surveyed by pacing and bearings all the way to the northern edge of our map. It crosses the Magpie River about eight miles within the sheet. The rocks observed along this road are all Huronian and consist of massive and schistose greenstones, a variety of schists some containing much free silica, gray micaceous schists, solid and schistose graywackes passing into gneiss and felsitic schists of various colours.

Magpie River. "On the Magpie River, between its mouth and the northern margin of the sheet, the rocks noted were massive diorites, both crystalline and micro-crystalline, slaty diorite, chloritic, micaceous and hornblendic schists, soft, light-greenish-gray schists with calcspar, sericite, glistening gray schist, volcanic breccia and graywacke schist-conglomerate, besides the small area of red granite already mentioned.

Cap Choyé belt. "A cross-section of the smaller or Cap Choyé belt, at right angles to its strike, occupies the coast of Lake Superior from Old Woman River to the bay on the south side of Cap Choyé. This belt runs inland in an east-southeasterly direction and has an average width, as ascertained by different traverses, of eight or nine miles, or about two-thirds that of the Michipicoten belt. Its boundaries appear to be nearly parallel to one another. The rocks of this belt consist principally of schistose greenstones, siliceous and coarse argillaceous schists, together with smaller proportions of other crystalline schists similar to those which have been mentioned as occurring in the Michipicoten belt. A patch of red granite within this belt was observed on the shore of Lake Superior. The existence of these Huronian rocks in this section of the coast is shown on my map of 1881, already referred to, but it was only during last summer that we proved them to form a great belt running across the sheet. This fact is an important addition to our knowledge of the geology of this district, as these rocks will probably prove auriferous like those of the Michipicoten belt. A good many years ago, a quartz vein, said to be large and well charged with copper-pyrites was found and opened by a Mr. T. Fréchette, about fourteen miles east of Gargantua Harbour. We were unable to rediscover this vein, but we came upon the prospecting camp in its vicinity and obtained some samples of the ore which are rich in copper and may contain gold as well. I was credibly informed that another copper vein had been discovered in the course of this belt further east, or at a place lying to the northward of the mouth of Agawa River.

Economic minerals. "The economic minerals of the Michipicoten mining district hitherto discovered, consist of iron, copper, and gold ores, and granite suitable for monuments and construction.

Iron. "*Iron.*—A large deposit of iron ore occurs on the shore of Lake Superior at Little Gros Cap, near the mouth of Michipicoten River, and an attempt was made to mine and export it about twenty-five years ago. As the locality is fully described in my report for 1876, nothing further need be said in regard to it.

Copper. "*Copper.*—Thirty years ago, indications of copper were discovered at several places around Wawa Lake, and a Mr. J. T. Johnson of Detroit purchased from the Government a number of large locations

surrounding the north-eastern half of the lake. Some prospecting was done on one of these, near the centre of the south side of the lake, and, I was informed by a man who had been engaged in the work, that a promising vein of quartz with copper-pyrites had been found. Some of the ore may still be seen lying about at the site of the buildings which were erected at the time the prospecting was going on, but as the location is now overgrown by a dense thicket of brush-wood and young trees, we were unable to find the old workings. The occurrence of copper-pyrites at two localities in the Gargantua Huronian belt has been referred to in describing these rocks.

"*Gold.*—In the Michipicoten district, the precious metal occurs in the form of finely disseminated free gold in quartz veins. The principal discoveries so far have been made around Wawa Lake and all the way across the Huronian belt between this sheet of water and the foot of the Long Portage on Michipicoten River. The associated rocks are the schistose greenstones and greywackes with crystalline diorite or diabase occasionally in the vicinity. The veins in this tract are numerous and often of a good workable size—say from four to six feet in width. Their prevailing course approximates to a northerly direction. The quartz is of a hyaline variety and contains only very small quantities of associated minerals, comprising copper-pyrites and iron-pyrites with a little calcareous spar. Gold.

"So far, the work done can only be called prospecting. Numerous prospecting pits have been opened and at the Jubilee mine a shaft had been sunk to a depth of sixty feet on the underlie of the vein. As yet nothing can be said with certainty as to the richness of the ore, as no commercial tests have been made and the reported assays cannot always be relied upon. In some cases specks of gold in the quartz can be seen by the naked eye or with the aid of a magnifier. Average samples were collected by me for assay from the principal 'prospects.' Prospecting work.

"On the south side of Michipicoten River and thence to Burnt Point, several quartz veins have been discovered and mining claims located, but I was only able to visit one of these.

"The sands and gravels of the valleys of the Michipicoten and Magpie rivers, having been derived largely from the disintegration and glacial crushing of the Huronian rocks of the vicinity, in which no doubt great numbers of small as well as some large quartz veins existed, contain a notable proportion of quartz vein-matter. It is said that the more quartzose of these gravels and sands have yielded gold on assay, and, in consequence of such reports, many sand claims were started and registered in the books of the local inspector of mines, but I have no reliable data as to the proportion of gold which Alluvial claims.

may have been detected. No attempt has been made to work any of these claims."

Work by Mr. A. E. Barlow.

The greater part of the winter of 1897-98 was spent by Mr. A. E. Barlow in working up the various surveys made during the preceding season in connection with the Haliburton map-sheet, (No. 118) while progress was made in the collection and compilation of material necessary for this map. A part of his time was likewise devoted to a study of the geological results obtained during the progress of the field-work, as well as to the examination of the large number of rock-specimens obtained. The report in connection with the exploration and surveys of the area covered by the Nipissing and Temiscamingue sheets was completed and is now in the press.

The geological investigations carried on for several seasons past in Central Ontario by Dr. F. D. Adams and Mr. Barlow in collaboration, were continued during the past summer. These gentlemen were assisted, particularly in regard to the necessary measurements and topographical surveys, by Mr. J. Keele, Mr. G. W. Ross, jr., and Mr. F. G. Stevens.

Field-work by Messrs. Barlow and Adams.

The close association in which Messrs. Adams and Barlow have worked in the field, renders it appropriate that their progress report upon the work should be made jointly. In the following pages the observations of both gentlemen are therefore combined:—

"The work was pushed forward as rapidly as possible, but the geological boundaries are so intricate and the relations so critical and difficult, that part at least of another season will be required before a final report can be written. It was found necessary, in order that the structure of the district might be thoroughly worked out, to include in the area of survey a portion of the map-sheet to the south (No. 113) comprising parts of the townships of Burleigh, Methuen, Lake, Tudor and Grimsthorpe.

Topographical surveys.

"Re-surveys were made, by Mr. Barlow, of Loon Lake in Chandos township, Paudash Lake in Cardiff, Eel Lake on the boundary between Anstruther and Cardiff, and Bass Lake on the boundary between Limerick and Tudor. Mr. Keele made a survey of the Deer River from the outlet on Loon Lake, in Chandos, to Whetstone Lake, in the township of Lake, showing this crooked stream in detail, in a manner not attempted on the township plans.

"Besides this Mr. Keele made micrometer surveys of a group of lakes situated in the northern portion of Burleigh and the southern parts of Cavendish and Anstruther, including Long, Cox, Cold, Gold, Gull, Catchacoma, Bottle and Sucker lakes.

"Mr. Barlow's work, comprised the area composed chiefly of the granitic and dioritic gneisses, in the north-eastern part of the map from Egan Estate to Brudenell corner; while, in the southern part of the sheet, he worked chiefly in the district to the east of the Hastings road. Dr. Adams, with Whitney as a base, worked in the north-western part of the sheet, exploring and mapping geologically the townships to the west and south-west of Egan Estate station on the Ottawa Arnprior and Parry Sound Railway. Dr. Adams left Montreal for the field on June the 20th and returned on September 12th, while Mr. Barlow was engaged in field-work from June 25th to October 1st. Area examined by Mr. Barlow.

"The great tract of country contained in the northern and north-western part of the map-sheet, exhibits a very typical development of the granites and gneisses of the Laurentian. The latter usually dip at low angles and are in some places quite flat, the strike running in great sweeping curves, often of considerable complexity. Three small outliers of the Grenville series were noticed on the shores of Barrys Bay of Lake Kaminiskeg, while two others occur between Hopeville and Emmett post-office in the south-western part of Hagarty township. In the vicinity of Rockingham and between this village and Brudenell corner, there is a large development of crystalline limestones belonging to the Grenville series and similar rocks may be encountered at frequent intervals between this place and Rochefort P.O., in the south-eastern corner of Hagarty. The Grenville series likewise occupies small patches in Monteagle and Carlow townships, but by far the greater part of these townships is underlain by the more massive granite and gneiss. A large irruptive mass, composed chiefly of granite, diorite and gabbro, covers the southern portions of Mayo and Dungannon and the northern parts of Cashel and Limerick, thence extending westward into the north-eastern corner of Wollaston. To the north, in the townships of Dungannon and Mayo, a large area of limestones and amphibolites occurs, cut through by a mass of intrusive material of both acid and basic facies. These rocks were formerly classified as belonging to the Hastings series, but certain portions present the highly metamorphosed character of the Grenville series. Similar rocks, some even in a less altered condition, are present to the south of these huge batholitic masses, covering the southern parts of the townships of Limerick and Cashel in the south-east corner of the sheet. At several places, notably in the vicinity of Gilmour station on the Central Ontario Railway and between this place and St. Ola station, detailed studies were made of the occurrence of certain 'conglomerates,' and the conclusions reached would seem to indicate that, in many instances at least, such rocks in these regions are not true conglomerates, but are Fundamental gneisses. Outliers of Grenville series. Irruptive mass. Examination of conglomerates.

of the nature of autoclastic rocks or dynamic breccias. These pseudo-conglomerates as here represented, would appear, in fact, to have been formed by the rending apart of certain of the more brittle bands, while the inclosing limestone or schistose matrix has yielded somewhat readily to deformation. The subject is of rather exceptional scientific interest and a paper by Mr. Barlow, covering the observations made, has lately been presented at the meeting of the Geological Society of America.*

Area examined by Dr. Adams.

"Dr. Adams, having completed his work on the north-west corner of the sheet on July 25th, left Whitney on that date and went south through the townships of Airy, Sabine, Nightingale, Bruton, Harcourt and Herschell to Baptiste Lake. Along this line an excellent opportunity was afforded for the study of the relations of the Fundamental gneiss to the great limestone-bearing formation known as the Grenville series, which appears in force on Baptiste Lake. On several lots on ranges IV. and V. of Bruton, a granular, white felspar rock was found, identical in appearance, and probably in composition, with the albite rock found associated with the nepheline-syenite in the township of Dungannon and elsewhere in the district about Bancroft, and which is there a differentiation product of the nepheline-syenite magma. No nepheline, however, could be detected in this Bruton rock. The first occurrences of limestone were found on the last range of the township of Harcourt. The occurrences of this rock, however, are small and disconnected, until the first ranges of this township are reached, when the limestones and the rocks of the Grenville series are seen almost continuously along the line of the Irondale, Bancroft and Ottawa Railway.

Felspar rock.

Limestone.

Intrusive contacts.

"The study of this region, showed conclusively that the contact between the Fundamental gneisses and the Grenville series is an intrusive one, and that the rocks of the last-mentioned series, have slowly sagged down into, or have been gradually uplifted by an underlying floor or batholite of granitic material. The chief developments of the Grenville series, run in great curves around these batholites, and in contact with granite material its rocks become broken into many discontinuous patches, usually manintaining the strike of the adjacent part of the formation from which they have been detached; showing that the rending action of the granite has been a slow and gradual one, and not of the nature of a violent intrusion.

Detailed work on Grenville series.

"The month of August and the early part of September were occupied in making a detailed study of one of the most complicated portions of

*Published in Ottawa Naturalist, vol. XII, No. 11, Feb., 1899, pp. 205-217, Plates VI-IX.

the whole district, comprising the township of Monmouth and portions of Dudley, Cardiff, Chandos, Burleigh and Methuen. In Monmouth there is one of the best developments of the Grenville series in the whole area, while, in the other townships, there are in addition excellent exposures of the Fundamental gneisses with great granite intrusions, as well as occurrences which have been referred to the Hastings series, the geology of the district being of the most intricate character.

Its results.

"The study of the Grenville series in Monmouth, showed beyond a doubt, that this series is a sedimentary one. It includes a great development of bedded white quartzites, evidently altered sandstones. The associated limestones also, that occur in heavy bands, and, as everywhere else in the Grenville series are in the form of white crystalline marbles, were in a few plans along the line of the Irondale, Bancroft and Ottawa Railway, seen to hold little dark strings suggestive of remnants of the original limestone in a less altered condition. On this account, a careful search was made, which resulted in the discovery of two localites in which the limestone was almost unaltered, being very fine in grain and blue in colour, and bearing a strong resemblance to the limestones of more recent formations. In such cases the blue limestone is interstratified with the ordinary white coarse-grained marble of the Grenville series and passes into it, there being evidently portions of the limestones which have escaped metamorphism. These occurrences serve to dispose of any lingering doubts concerning the sedimentary origin of the limestone in question. The localities where these unaltered limestones are best seen are, lot 27 of range XIV. of Monmouth and lot 28 of range XI. of the same township.

Unaltered limestones.

"The relations of the Grenville and Hastings series in this district were made the subject of careful study, and much additional evidence bearing on this disputed question was collected during the summer.

Nepheline-syenite.

"Several new occurrences of nepheline-syenite were discovered during the past season, in the district examined. The most noteworthy is that which was found in the form of a wide band running through the township of Monmouth. It is first seen near Wilberforce, and thence runs in a south-west direction, parallel to the I. B. & O. Railway, as far as lot 13 of range IX., where it bends back upon itself, and, passing a little to the west of Hotspur P.O., runs in a north-east direction for four miles. This band has been traced continuously for a distance of ten miles. It wraps around and forms a border to a large granite intrusion, often pegmatitic in character. To all appearance it is a differentiation-product of the granite magma. In fact, nearly all the occurrences of nepheline-syenite that have been found in the present sheet (No. 118) bear a similar relation to granite masses. Not to mention

Its relation to granite magma.

the occurrences in the Bancroft district, described in a former report, there may be cited as example, an occurrence discovered last year on lot 26 of Faraday, on the line between ranges A and B. This occurrence, which is at least one hundred yards wide and holds sodalite, lies on the margin of the great mass of granite forming the northern half of the township of Faraday and between it and a great development of crystalline limestone in the western portion of the township. Another similar occurrence of nepheline-syenite was found on lot 15 of range I, of the township of Harcourt, and is well exposed in a cutting on the I. B. & O. Railway. It again occurs at the contact of the great mass of granitic rocks occupying the northern part of the township of Cardiff and the crystalline limestones of the Grenville series which sweep around it.

Further occurrences of nepheline-syenite.

"Still another great development of nepheline-syenite intimately associated with granite, is that composing the Blue Mountains, a long range of hills running north-east and south-west through ranges VI. to XII. of the township of Methuen. These rise from a great granite plain, and the petrographical associations are of extreme interest but require further study before they can be clearly made out.

"In addition to the band of nephline-syenite above described, from Monmouth, there is also in the same township an isolated area of considerable size situated on lots 9, 10 and 11 of ranges VII. and VIII. where it breaks through the limestone of the Grenville series.

Association with corundum.

"The occurrence of nepheline-syenite in Methuen, referred to above, is of especial interest from an economic standpoint on account of the occurrence of considerable deposits of both muscovite and corundum in the pegmatite veins and coarse segregations occurring in it or in its immediate vicinity. In fact, corundum has been found so generally in connection with the nepheline-syenites occurring in the north-eastern portions of the sheet, that all the areas of this rock above mentioned are worthy of being very carefully searched for this mineral.

Economic minerals.

"A large number of mineral deposits occurring in the district examined were carefully investigated. These consisted of deposits of graphite, apatite, mica, corundum, iron-pyrites, molybdenite, etc.

Mica.

"The only deposit of mica that was being worked in the district examined, is situated on lot 7 of range XXII. of Cardiff, by the side of the I. B. & O. Railway track. This deposit is owned by Messrs. Best and Membry. A pit twenty feet square and eighteen feet deep had been made, and a considerable amount of mica, in sizes up to two feet by two feet and a half, had been extracted. The mica is dark in colour, and occurs in a mass of the granular green pyroxenite, so frequently found, as in this case, associated with the limestones of the

Grenville series. Similar dark-coloured mica, in large sheets, has been discovered on lots 30 and 31 of range XIII. of Cardiff, as well as amber mica of good quality, but of smaller sizes, on lot 31 of range XII. of the same township. The mica deposits of Methuen, mentioned above, are, however, no longer worked. Work on the corundum deposits had also been suspended at the time these were visited.

Molybdenite.

"Fine specimens of molybdenite are to be obtained on range I. of the township of Harcourt, at a point which is probably situated on lot 3. The country-rock is a granular green pyroxenite, which has been produced by the complete alteration of an isolated mass of limestone inclosed in the Fundamental gneiss. This pyroxenite is traversed by little strings of pyrite and molybdenite, associated in places with pyrrhotite, tourmaline, sphene and other minerals. A pit about fifteen feet deep, has been put down on the deposit by Mr. Gordon, of Toronto, and a considerable amount of pyrite, said to contain gold, has been raised, as well as a small amount of molybdenite.

Quartz veins.

"Samples of quartz collected from the Higman mine, on lot 9, con. VII. of Limerick, assayed in the laboratory of the Survey, proved to contain no gold, and only 0·175 of an ounce of silver to the ton of 2000 lbs.

"Other samples collected from large irregular masses of quartz cutting crystalline limestone on lot 31, con. VI. of Cashel, were found to carry neither gold nor silver."

QUEBEC.

Work by Dr. R. W. Ells.

The winter of 1897-98 was spent by Dr. R. W. Ells in plotting and compiling the notes of field-work of the preceding season, and in laying down the geological lines on map-sheets Nos. 119 and 120. Considerable time was also devoted to work upon a proposed special map of the Ottawa district. Dr. Ells' field-work, during the summer, was carried on partly in Ontario but chiefly in Quebec. Surveys and examinations were made within the area of map-sheets 119 and 120, now in course of compilation, for the purpose of completing the necessary information for these sheets. Dr. Ells was also requested to undertake the preparation of a general explanatory report to accompany the Three Rivers sheet, or north-west sheet of the series of four which has generally been referred to as the "Eastern Townships," series. This involved the correlation of much work previously done by other members of the staff, and necessitated some further surveys and examinations for this purpose. The map-sheet is now in the

engraver's hands for completion. On his field-work, Dr. Ells reports as follows:—

Various surveys.

"Several weeks of May and June were spent in completing the examination of certain areas, lying to the south of the Bonnechère and Madawaska rivers in Ontario, and in correcting the surveys of the townships of Hull, Eardley and Onslow, in Quebec. On

Work in St. Maurice district.

the 28th of June, I set out for the St. Maurice district, in order to complete if possible, the series of surveys which had been partly made in that area several years before by Messrs. Adams, McConnell, Giroux, Ord and Low, in connection with the geology of the north-west map-sheet of the 'Eastern Townships' series, the report on which, owing to various causes, had not been prepared for publication. A report on a portion of this area, embracing the south-west corner of the sheet, had, however, been published in 1895 by Dr. Adams, in connection with his report on the anorthosite masses of that district.

"In carrying out this scheme of work, after several days spent in the vicinity of Joliette, St. Gabriel de Brandon and the country to the north and east of that place, I left for the village of St. Michel des Saints, about sixty-five miles north. This place is situated on the upper part of the Matawin River, which is the principal tributary of the St. Maurice from the west.

Ascent of Post River.

"Here men were engaged, and early in July I began the ascent of the Post River which was followed up to its head in Lake Clear. Thence, by a portage of half a mile, the waters of Vermilion River were reached, and these were followed north to a further distance of twelve miles through a chain of lakes. The country in this direction was found to be generally nearly level, characterized by great areas of sand and gravel with but few rock-exposures. Clear Lake, at the head of the Post, is of large size, with generally sandy shores; the only rocks seen being grayish and reddish banded gneiss.

Rocks near Post River.

"Along the Post River also the shores show comparatively few rock-exposures, and these are of the upper or grayish, often rusty, gneiss series. About two miles below Clear Lake, a small band of crystalline limestone shows in the stream, and some scattered blocks extend for several miles below this place. On a small lake to the east (Jerome Lake), reached by a portage which is about one mile north of the forks of the Long Lake River, the gneiss, which is of the usual gray and reddish variety, and is cut by red granites, contains a broad belt of almost pure quartz. This band is white, with a breadth of at least fifty feet, and its lower portion, near the contact with the red granite, carries a quantity of black and broken crystals of mica. Masses of

clear red felspar are distributed through the quartz. The mica is of no economic importance, although spoken of as a 'mine' by the hunters.

Long Lake River.

"Returning down the Post, the west branch, known as Long Lake River, was ascended to Lake Croche, the stream being in places very rough and the portages bad. From Lake Croche a portage of nearly a mile leads to Long Lake, and from the head of this lake, Lake Travers, the source of this stream, is reached. On Lake Croche, crystalline limestone occurs at several places along the east shore, but the prevailing rock is a reddish granite-gneiss, foliated, coarse-grained and rough-weathering. Along the stream below this lake large areas of reddish augen-gneiss with a well-defined foliation were seen.

Lake Travers.

"On the long stretch between this lake and the head of Lake Travers, much of the rock seen is a foliated red granite; but several outcrops along the upper portion of the route are of reddish-gray and gray garnetiferous mica-gneiss. Glacial striæ were noted at several points with a course of S. 10° W. About Lake Travers masses of red foliated gneiss occur. From the head of this lake a portage of three-fourths of a mile leads to Lake Sassiakinagog on the upper waters of the Manuan River where also grayish mica-gneiss, with black hornblende bands, appears, with a strike a few degrees east of north.

Sassiakinagog Lake.

"Sassiakinagog Lake is eighty feet lower than Lake Travers. It is a large sheet of water with long arm-like bays. The prevailing rock is grayish and reddish-gray gneiss, but there is also a large development of grayish quartzite like that seen along certain parts of the Lower Ottawa. This rock extends along the north shore of the lake for several miles, and though several blocks of crystalline limestone were seen, no ledges of this rock were noted. Much of the shore is, however, low and without rock-exposures.

Thence to River Milieu.

"Following Pasquatazebe Creek from the south-west end of this lake, we reached the height-of-land between the Manuan and the Matawin at the head of the north-east branch of the Milieu. The country along this stretch is generally low and the shores of the creek are swampy, only one outcrop of rusty quartzose gneiss being seen. The lake shores along the upper part, however, show many large boulders of reddish gneiss and granite.

River Milieu.

"The Milieu flows, for most of its course, between low and sandy or bouldery banks, the upper portion of the valley is swampy and the stream is choked with thick alders. Heavy rapids are frequent and are often caused by boulders, of large size, but rock-ledges are not very numerous. Where seen these ledges are of gneiss of the usual Grenville type, sometimes with areas of gray quartzite. Though no

limestone was seen along the stream, several outcrops of this rock are found both to the east and west of this river, at a distance of ten to twelve miles from its mouth. These outcrops may be the extension of certain bands seen along, or in the vicinity of, the Matawin, below the village of St. Michel, and which there have a strike to the west of north, in the same association with rusty gneiss so frequent in the Grenville district. Along the lower part of this stream, not far from the limestone bands, there are several deposits of mica which in former years were mined to a slight extent, but have long been abandoned. Apatite also occurs with the mica, the containing rock being a greenish pyroxenite, as is the case in the Ottawa district. The lower part of this stream, flows through banks of sand for several miles till it enters the Matawin about eight miles below the village of St. Michel.

Upper Matawin.

"The south branch of the Matawin or Cypress River was next ascended, to the head of Cypress Lake. This lake is about six miles in length and is bordered by high hills and ridges on the south and west, which separate its waters from those of L'Ouareau River and from the head of the L'Assomption River. Portages extend from the south end of this lake to both these places. The character of country in this direction is very much like that seen about Trembling Lake on the Rouge River. The rocks around Cypress Lake are for the most part grayish and reddish-gray gneiss, often garnetiferous, having a strike of N. 65° W. with a dip to the south-west. In places the gneiss is quite rusty, and quartzite also occurs, but no limestone was seen in this direction. A portage from the north-west angle of the lake leads across to Devil Lake on Devil River, which flows into the Rouge.

North-west branch of Matawin.

"The upper or north-west branch of the Matawin, above the Cypress branch, is formed by the confluence of two streams, each of which extends for about thirty miles northward, flowing generally through low and often swampy country. They are said by the hunters to show solid rock, the banks consisting for the most part of sand and gravel, with stretches of beaver-meadows, and they were therefore not followed. Descending the river again to St. Michel, traverses were made to lakes Trefle and Proteau and to the chain of lakes along the south-east border of the township of Provost. The same kind of grayish, often garnetiferous and quartzose gneiss, was observed on all these, and bands of impure limestone were noted on several of them. Mountain masses apparently of reddish foliated granite are seen in parts of this area. The gneiss strikes generally to the north-west and the dip is usually to the south-west. The rocks are in places much disturbed near the granite masses.

"Surveys were made of the roads in the vicinity of the Matawin, both to the east and west of St. Michel, after which I began the descent of the Matawin to the St. Maurice. In this traverse an examination was made, for the sake of comparison, of the rocks along the lower part of the Eagle River, on the north side, and further down, of the Antikagamak Lake and of Lake Wapizagonk on the headwaters of the Shawenigan River. Descend the Matawin.

"Returning to the Matawin, we descended that river to the head of the Cinq Rapids, from which point a portage-route of about three miles leads across to the Cinq lakes. The Matawin below this point is very rough, with heavy rapids, so that it is very rarely traversed. This part was, however, surveyed by Mr. Ord in 1880, so that our section along this river is complete.

"The portage to the lower Cinq Lake is over a ridge of grayish, sometimes garnetiferous gneiss. Along the lake, good exposures are seen near its lower end and in the east bay. The rocks are grayish gneiss with a very low dip to the east, the angles being rarely more than five degrees. Several low undulations are seen and bands of a coarser red gneiss, as well as of black hornblende, appear on the east bay. This chain of lakes was followed south to its head, and a portage made to the head of the chain of the Fishing lakes, whence a route extends out to the St. Maurice at the village of Grandes Piles. These lakes are leased by the Laurentian Fishing Club, by which good portage-routes have been opened to a number of the surrounding lakes. In all these, however, there appears the same character in the rock-exposures. They are all gneiss of the upper or Grenville series, with occasional areas of granite. The dips are everywhere at low angles, but several anticlines traverse the district. Cinq Lake. Fishing lakes.

"Throughout all this Matawin country, with the exception of the small settlement near St. Michel, there is no means of communication except by canoe. The whole country is one unbroken wilderness, abounding in deer, caribou, moose and bears. Beavers are still numerous in most of the streams and the traces of their presence may be frequently seen in the shape of houses and dams. The whole district is densely wooded, though most of the growth is small, owing to a fire some years ago that swept off much of the timber along the course of the river for many miles. Character of the country.

"The geology of portions of this district, both to the north and south of the Matawin, had already been examined by Messrs. Giroux and Adams, and also in 1880 by Mr. Ord. On reaching Grandes Piles, it was my intention to make an examination of that part of the St. Geology.

Maurice extending thence up to the mouth of the Vermilion River, to see how far the gneisses of the Grenville series there run, but a severe attack of lumbago, contracted while descending the lower part of the Matawin, rendered further exploration in this direction impossible. The examination of the area to the east of the St. Maurice had, for the same reason, to be abandoned, but as this portion had been traversed by Mr. A. P. Low, in 1891, this will not be necessary, as his notes on this district are so full that the geological structure of the area can be readily understood.

Surveys made in the autumn.

"Returning to Ottawa, the remainder of the season in the field was devoted to the completion of the surveys in the townships west of the Gatineau, and along the north side of the Ottawa River. In this connection a further examination was made of the geology of Calumet Island, where important deposits of blende and galena have been mined for several years, and where a new deposit of nickeliferous pyrrhotite has been recently discovered.

"Further examinations were also made in the area to the south of the Rideau River, in Gloucester township, and a well-defined line of fault separating the Calciferous limestone from the Utica shales was located on lot 14, range IV. of that township. The beds of the former are there tilted up to an angle of 65° and certain portions of the strata in the vicinity are cleaved at right angles to the bedding.

"The surveys in the townships of Nepean, North Gower, Goulbourn and Marlborough were also carried on sufficiently to ascertain the geological structure of this area, and to connect the work of the previous season with the former surveys in the immediate vicinity of Ottawa. Several faults were found in this district, separating the Calciferous from the Trenton and Black River formations.

Results obtained in St. Maurice district.

"The results of the examinations in the St. Maurice district may be briefly summed up, preliminary to the general report on the area now being prepared. In character, the gneisses, quartzites and limestones are similar to those of the Ottawa district, and it would therefore appear that all the rocks from the Palæozoic of the St. Lawrence basin, northward for some distance beyond the northern limit of the map-sheet, belong to the Grenville series rather than to what has been called the Fundamental gneiss. With these, however, are associated masses of newer intrusive rocks, such as anorthosites, granites, syenite and augen-gneiss, some of which constitute areas of large extent and can be depicted on the map. In other cases such are the difficulties of access that the outlining of these masses must be largely conjectural.

"The crystalline limestones have but a small development and occur at widely separated localities. Bands cannot be traced continuously from point to point for any considerable distance, as the outcrops are sometimes abruptly cut off by intrusions, or thin out of themselves. In places their tracing is prevented by the great expanse of sand and gravel drift. Certain of these reported bands of limestone can scarcely be regarded as other than calcite masses, which are a part of the pyroxene rock with which they are associated; and in this case are not an integral part of the gneiss and quartzite series. Those noted along the upper portion of the Matawin are, however, like the Grenville limestones. The largest development is in the township of Polette near the St. Maurice, where there is a reported breadth of from 200 to 400 yards, extending for several miles along the strike. East of this river true limestones are rarely seen, though the gneisses are of the same general character as in the area to the west of the river. Crystalline limestones.

"The garnetiferous gneiss has a wide distribution. It can be recognized at all points in the area of the north-west map-sheet. It is associated with grayish and reddish-gray gneiss, and often with schistose bands, as is the case with the bands to the south of the Ottawa, in Renfrew county. The rocks lie in a series of low anticlines, the dips being generally from five to twenty degrees, though sometimes, in consequence of breaks or faults they become vertical. Owing, however, to the mantle of drift, these anticlines cannot be definitely traced for long distances. The banding of the gneiss, as in the Ottawa district, is north, varying a few degrees on either side. Garnetiferous gneiss.

"Economic minerals are apparently rare in this district, with the exception of the deposits of bog-iron ore, which are found at many widely separated points. The distribution of the principal deposits has already been noted in the summary report of Mr. Low for 1891. Along the upper part of the Matawin small quantities of mica and apatite are seen, but the quality and quantity are not such as at present to render their mining profitable. These deposits have been described in the summary report of Mr. Giroux for 1891-92. Economic minerals. Iron ores.

"Small quartz veins are seen at many points in the gray gneiss and are supposed by the settlers to indicate gold. In all the cases examined, the only mineral seen was iron-pyrites, which is sometimes found in small quantity. On the upper part of the L'Assomption River, near the forks, bands of serpentine are associated with crystalline limestone, and these sometimes carry small veins of chrysotile, similar to those seen along the lower Ottawa. From the narrowness of the veins exhibited Quartz veins. Chrysotile.

as well as from the inaccessibility of the area where these occur, the economic importance of these deposits doubtful.

Limestone. "Near St. Michel, some of the limestone bands are locally utilized for lime-burning. A deposit of ochre on the lower part of the Milieu, at the last rapid before reaching the Matawin, appears to be of good quality, but is too far from means of transport to be worked except

Garnets. for local purposes. The garnets in some of the gneiss bands in this area are remarkable, both for the large size of the crystals, some of these being fully an inch in diameter, and for their abundance.

"The general geological features of the greater portion of this area have already been described in the summary reports of Messrs. Low, Giroux and Adams and need not be further referred to in this place.

Mica. "In the area along the lower Gatineau, mica mining has again been resumed. In the township of Wright, the mine opened some years ago by the Rev. Father Guay, of Gracefield, on lot 15, range II., which was closed for some time, has been reopened, and large quantities of mica of good quality are now being extracted. The pit in September, was down to a depth of forty-five feet, and the crystals were very abundant. They were distributed through a mass of grayish and pinkish calcite in a pyroxene rock which cuts the gray gneiss. About three and a half tons of mica per week were being taken out at the date of my visit.

"Along the river between the Pickanock and Aylwin, several other deposits of this mineral are now being worked. These are all in pyroxene-rock and the prospects are good for favourable returns, though the colour of the mica is in most cases very dark. There is a large development of pyroxene along the Gatineau in this area and mica deposits are numerous.

Mining at Calumet Island. "The most important mining developments along the lower Ottawa, at present, are on Calumet Island. Here the old workings on the Lawn property, near the east end of the island, on blende and galena deposits, have been extended, and development work is now carried on over three lots on range IV. The containing rocks are largely dioritic, with some reddish granite, and these masses are intrusive through the gray gneiss and limestones. These latter are well exposed along the Roche Fendu channel of the Ottawa on the south

Lead and zinc. side of this island. The principal workings at present are on what is known as the Bowie property, where a large open-cut has been made on an ore-body in the diorite, that carries both blende and galena. The ore-body is of considerable extent, but is pockety in its character, and no well-defined hanging or foot walls were seen, though the mass sends off spurs into the enclosing diorite. Over 1000 tons

of ore was mined at this place during the past summer, and the ore finds a ready sale in the European market. On the west part of the area a shaft has been sunk to a depth of nearly 130 feet, in order to cross-cut and intersect several masses of ore that appear at the surface in this vicinity, but work on this location was suspended during the season in order to fill orders from the Bowie pit. There is evidently a large quantity of mixed blende and galena ores in the intrusive rocks of this district, but in none of the openings examined was any well-defined vein structure noted, the ore everywhere appearing rather in pockety masses, though some of these are of large extent.

Nickeliferous pyrrhotite.

"About three miles to the north-west of this mining area, on lots 11 and 12, range IX., another interesting deposit of mineral has recently been opened on the property of Mr. E. P. Cowan. The ore here is different from that on the eastern end of the island, being mostly a pyrrhotite, which carries both nickel and cobalt. The associated rocks are diorites that cut a series of gray and rusty gneisses and crystalline limestones. A large knoll of the diorite rises to the south of the ore-bed, which has a thickness of about twelve feet, and between it and the diorite mass is a band of crystalline limestone. The ore itself is associated with another band of diorite that apparently traverses gray gneiss, the latter being seen beneath or to the north of the ore deposit. On the river a short distance to the south of this mine, the formation is mostly a crystalline limestone, and the intrusions of diorite and granite in this rock can be readily seen. The bed of pyrrhotite at the Cowan mine dips to the south at an angle of about 50°. A shaft has been sunk to a depth of about forty feet and cross-cuts has been made to test the thickness of the deposit.

"Between this place and the Lawn property, there are several points at which mineral indications have been noted, but little attempt has as yet been made to ascertain their value.

Mica.

"Mining for mica is also being carried on along the north side of the Ottawa between Bryson and Coulonge, to the north of Calumet Island, where several deposits of this mineral have been discovered. The work on these, however, is so far largely preliminary, and nothing definite as to the value of the properties can be here stated. In this area most of the mica is of the dark-coloured variety.

"The season's work extended from May 16th to Oct. 1st."

Work of Prof. J. A. Dresser.

Professor J. A. Dresser of St. Francis College, Richmond, Que., having offered to undertake a detailed investigation of Shefford Mountain, with a view to the presentation of a report on the petrography of the mountain to the Geological Survey, has, during the past summer,

been accorded some slight assistance in the prosecution of this work. Prof. Dresser had previously familiarized himself with the general features of the rocks of Shefford Mountain, and it appears probable that his further examinations will enable this isolated mountain mass to be described as a useful type, illustrating the structure and composition of other similar elevations of the St. Lawrence plain in Quebec. Professor Dresser contributes the following notes on the progress of his examination :—

Structure of Shefford Mountain.

"From a review of the work now done, it is clear that Shefford Mountain, as has long been known, is chiefly an igneous mass of later age than the surrounding sediments, which are much disturbed and altered at the contact. The latest of these sediments is the Farnham black slates (D 3a, G.S.C. map of 1896).

"The mountain itself and most of the later dykes in it, share in the general foliation of the region, viz. : that of the Appalachian system.

Relation of stratified to intrusive rocks.

"The evidence is also very strong, if not conclusive, that the mountain is an uncovered laccolite, rather than a volcanic neck. The sedimentary rocks dip away from the igneous on all sides at high angles, showing an arching rather than a breaking-through of the sedimentary rocks.

"Patches of stratified rock frequently overlie the igneous rocks. Such are lithologically similar to the other sedimentary rocks of the district. One of these is an area of slate, at least a quarter of a mile in extent and probably a hundred feet in thickness, and overlies a part of the two latest rocks in the mountain. It forms a sort of cap on the highest peak of the mountain, is altered at its contact with the underlying igneous rocks, and is cut by dykes from each of them. Also, on the leeward side of the course of the chief glaciation, the sedimentary strata still stand leaning against the igneous rock to a height of 1000 feet (by aneroid) above the base of the mountain and about 200 feet lower than the overlying slate just mentioned.

Denudation.

"The amount of the denudation of the sedimentary rocks over the surrounding plain, must have been very great, at least 1000 to 1200 feet of their thickness having been removed. A small lake, half way up the north-west side of the mountain is of glacial origin.

Various igneous rocks.

"The igneous rocks are of at least three different ages of intrusion, besides later dykes of two or else three different ages :—

1. A rock of the gabbro family.
2. A syenite, having varying characteristics.
3. A kind of porphyrite.

"The relative ages of these rocks can be clearly seen at numerous contacts which are well exposed. Also, large numbers of dykes of each of the later rocks are found cutting the preceding one or ones.

"There is also a mica-syenite which is cut by Nos. 2 and 3, but I did not ascertain its relation to No. 1. It may form a fourth number of the series.

"No tufaceous or amygdaloidal rocks could be found.

"None of those rocks show any near relation to a collection made on Mt. Orford two years ago between Eastman and Miletta, a section mentioned by Dr. Ells.

"The later dykes which cut both mountains may be more alike. Those in Shefford Mountain appear to be two kinds. They seem to correspond more or less closely to the dykes of Lake Champlain described by Prof. Kemp and others in publications of the United States Geological Survey."

Work by Mr. R. Chalmers in Quebec.

During the winter of 1897-98 Mr. R. Chalmers was engaged in completing for publication a general report, embracing the detailed work of three seasons, on the surface geology and auriferous deposits of south-eastern Quebec. This report is now in press and will shortly be issued, accompanied by a map showing the gold-bearing belts of the region.

On field-work carried on in Quebec, Mr. Chalmers reports as follows:—

Examination of landslip in Portneuf.

"In accordance with your instructions I left Ottawa on the 6th of June and proceeded to the county of Portneuf, in the province of Quebec, to examine and report on a very remarkable landslide which had occurred there during the previous month. Mr. J. Keele, of the Geological Survey, was sent with me to photograph some features of this landslide, and a survey of the pit or chasm caused by it was also made.

"The landslide referred to took place in the parish of St. Thuribe, on the east bank of River Blanche, a tributary of the Ste. Anne, at a point about three miles north of the village of St. Casimir. We reached the spot on the 7th of June and set about collecting all the information we could concerning the catastrophe. Mr. Keele made a paced survey of the area of the landslide and took more than a dozen photographs at points selected by me. The depth of the pit below the general surface of the terrace in which the *débâcle* occurred was likewise measured and the gradient of the bottom approximately ascertained by aneroid readings taken at different points. Mr. Keele returned to Ottawa on the 10th of June,

while I remained a day or two longer to examine some features of the locality and also to visit the scene of another remarkable landslide which occurred on the Ste. Anne River, north of St. Albans, about seven miles above St. Thuribe, on the 27th of April, 1894. After this I proceeded to Quebec.

Character of the landslip.

"The River Blanche landslide, according to the reports of the farmers and others living in the vicinity who witnessed it, took place on the morning of the 7th of May, 1898, between half-past five and nine o'clock. These people, as they arose and looked out were terror-stricken to behold the earth moving from under them, not *en masse*, but piece by piece, and floating off in a stream of semi-liquid mud towards a gap in the river's bank through which it passed into the valley of the Blanche. The river-valley is here bordered by terraces of Leda clay and Saxicava sand, which, previous to the landslide, stood from twenty-five to thirty-five or forty feet above the river-bed. In about three hours or three hours and a-half, a portion of the terrace eighty-six acres in extent and from eighteen to twenty-five feet in depth was thus broken down and the larger part of it swept through the narrow opening referred to into the valley, filling it up nearly to the level of the bottom of the pit from which the material came. It seemed as if there had been a reservoir of soft clay here in a flowing state, which, breaking through the border of the basin enclosing it at the point of least resistance discharged into the valley of River Blanche in the manner described, carrying with it, for greater or less distances, the upper and more coherent clay in masses of various shapes and dimensions. These masses appeared to have split off vertically from the walls of the pit as the lower part slid away from beneath, and frequently exhibited a columnar structure. The larger, which were irregularly pyramidal in form, occasionally became stranded, and presented abraded and striated sides from the passage of other clay blocks. In these stranded masses the strata were observed to be still in a horizontal attitude. The smaller masses were borne into the valley by the torrent of mud. The number of clay blocks, great and small, irregularly distributed in the pit, gave it the appearance of a wilderness of mounds, cones and pyramids; while the quantity of material (chiefly Leda clay) discharged into the valley of the Blanche was found to occupy it for a distance of nearly two miles to a depth varying from ten to twenty-five feet.

Its effects.

"In the destruction caused by the landslide one child, a little daughter of Phileas Douville, lost her life, portions of two farms were ruined, two dwelling-houses, a school-house, two barns and a number of outbuildings were buried in the *débris*, and a large number of logs that lay in the Blanche were covered up by the clay and sand.

"As this singular phenomenon has been personally investigated and described in detail by Dr. G. M. Dawson in a paper read before the Geological Society of America, at the meeting held in New York, on December 28th to 30th, 1898, it is unnecessary for me to say anything further concerning it here.

Landslip at St. Albans.

"The landslide that occurred near St. Albans, four years previously, was somewhat different from that of River Blanche. At the first-mentioned place, the clay and sand moved directly off the west bank of the Ste. Anne into the valley and diverted the river from its former course. The length of this slide was about three miles and a-half, the width about one mile, and the depth ranged from ten feet in some places at the upper part to two hundred and fifty feet along the river. Soon after it took place Messrs. P. S. Archibald and W. B. Mackenzie, of the Intercolonial Railway Engineers' Office, Moncton, N.B., visited the locality, and made a survey of it. Mr. Archibald very kindly sent me copies of his plans, and a brief report of his observations. Mgr. Laflamme, of Laval University, Quebec, also made a survey and detailed examination of this landslide and read a paper concerning it before the Royal Society of Canada, illustrated by a map and diagrams*.

Observations by Sir W. E. Logan.

"This catastrophic and apparently little known form of denudation has called attention to the fact that the landslides above described are not altogether new in the St. Lawrence valley. A pit produced by one of these was noted by Dr. Dawson, immediately to the north of that of St. Thuribe, the approximate area of which is given on the plan of that landslide. Sir W. E. Logan also recorded the occurrence of one which took place on the bank of Maskinongé River on the 4th of April, 1840, in a paper read before the Geological Society of London†. It seems that a mass of sand and clay covering an area of about eighty-four acres was moved to a depth of nearly thirty feet, piece by piece endwise, through a narrow opening into the river-valley there also in about three hours. From Logan's survey of this slide, during the autumn after it occurred, and his description in the paper cited, it must have resembled that of River Blanche very closely.

Heights of terraces.

"After the investigation of the landslides at River Blanche and St. Albans, I proceeded to the south side of the St. Lawrence valley to level the Pleistocene shore-lines there, commencing at Lévis and vicinity and going westward. The elevations of these had previously been ascertained approximately by aneroid; but it was considered desirable that at certain points, where they were well-defined, levellings with a

* Trans. Royal Society of Canada. Vol. XII., 1894. Sec. IV. pp. 63-70.

† Proceedings of the Geol. Soc. of London. Vol. III, 1838-1842, pp. 767-69.

spirit-level from the nearest railway stations should be undertaken. Work of this kind was begun at St. Anselme Mountain, fifteen miles south-east of Lévis, and continued westward as far as Shefford Mountain at West Shefford station, Canadian Pacific Railway, interrupted a good deal, however, towards the end of June by wet weather. A few days were then spent at Dudswell in a re-examination of the gold-bearing rocks of that place and in securing samples for an assay and mill test.

HUDSON BAY.

Work by Mr, A. P. Low.

After the first pages of this report were ready for press, a letter was received from Mr. A. P. Low announcing his safe arrival at Great Whale River, giving the main results of his explorations during the past summer and outlining his plans for the coming season. It is thus possible to include the essential parts of this interesting communication, from which it appears that Mr. Low has been able to make very important additions to our geographical and geological knowledge of the east coast of Hudson Bay. Mr. Low writes as follows :—

Difficulties encountered.

"I am happy to state that my party have been in good health and that we have had a successful season, although not doing as much work as I had intended, owing to the continuous bad weather during September, when we had a succession of gales from all points of the compass.

Shoal coast.

Another cause of delay was the unexpectedly shallow water found everywhere along the coast from within a few miles of Cape Wolstenholme to Portland Promontory. This stretch of coast resembles that of the east coast of James Bay, being very low, almost flat and fringed with small islands, with shallow water and a very uneven bottom extending several miles off shore. The islands and shoals are largely formed of boulders (morainic material) which appear to have been shoved up into sharp lumps by the grounding of heavy ice in the shallow water. We ran aground several times even when sailing slowly with a good look-out, and it was only good luck that prevented serious consequences on two occasions, when we were aground for several hours and only got clear by removing the cargo and ballast, as the tide rises so little that it is practically useless to depend upon it to float the yacht.

Consequent delays.

Owing to the above causes we did not reach Portland Promontory until the 9th of September, when I considered it too late in the season to attempt the exploration of the outer islands, and in this I was right, as the weather continued very stormy for the next three weeks, and it is doubtful if we would ever have arrived here had we gone to the northern islands,

which I have since learned are nearly all low and largely formed of drift material, without harbours and surrounded by shallow water and shoals, resembling the coast to the northward. Instead of going to the islands we continued the log-survey down the coast to Great Whale River, and, as you may see from the accompanying reduction of the survey, have made some additions to the previous track-survey of this part of the coast.

Work begun at Cape Wolstenholme.

"As I wrote you, Capt. Gray of the *Erik* thought it better to land us near Cape Wolstenholme rather than at Port Laperriere, and as the conditions were favourable I agreed with him, so, on the morning of August 1st the *Erik* came to anchor near the head of a small bay just east of Cape Wolstenholme and remained there until evening, allowing us to rig and load the yacht, which had been put overboard the previous evening and towed behind the steamer. The following day, while the men were completing the rigging, etc., Young and I were engaged in making observations for latitude and longitude, and also in examining the country and rocks in the vicinity. The coast about here is high, rising abruptly from 800 to 1000 feet above the sea and then more gradually inland to a general elevation of about 1500 feet, being on top a succession of low, rounded, glaciated hills. Terraces occur on the flanks of the hills more than 700 feet above the present sea-level. There were considerable patches of snow everywhere, but most of it was old, as the spring had been early and hot, and so nearly all the previous winter's snow had already melted. While climbing the hills I shot two barren-ground caribou, thus giving us a supply of fresh meet to begin with. These animals are very numerous about here and along the coast for about fifty miles to the southward of Cape Wolstenholme, and we frequently saw small herds along the land-wash as we passed in the yacht. Beyond this they are not common along the coast, but occur plentifully some miles inland all the way southward to the wooded country near the Nastapoka River. The Eskimo leave the coast early in August, going inland to kill deer for food and winter clothing, and remain in the interior until December, when they slowly make their way southward to Great Whale River, trapping foxes as they move along.

High land near the cape.

Caribou.

Round the cape.

"On the 3rd of August, we sailed past Cape Wolstenholme, but only got to a small cove about four miles beyond, owing to light winds. The channel between the mainland and the eastern Digges Island is less than two miles wide; the tide sets strongly through it, and there was considerable loose ice floating about when we passed".

Character of the point.

"Wolstenholme terminates in a small point about 200 feet high, immediately backed by jagged perpendicular cliffs composed largely of

rusty-weathering dark mica-gneiss, on edge. The cliffs are about 1000 feet high, and are full of crevices where the murre (Brunnick's guillemot) breed in tens of thousands; each bird lays a single egg on a narrow ledge, over which it straddles, and we could approach within ten feet without disturbing them. The noise of the birds' wings when a gun was fired was like heavy thunder, and the first time I fired I dodged behind a mass of rock, thinking that the report had dislodged a large piece of the cliff above. These birds also breed in great numbers on Digges, but were not seen to the southward; I think that they do not leave Hudson Bay, for the Eskimo say great numbers pass the winter in the open water outside the outer islands.

Guillemots.

"The perpendicular strata of dark, schistose mica-gneiss (Grenville series) often contain much disseminated pyrite, and some beds are graphitic, but there is no limestone. These rocks are cut by masses of pink and red mica-gneiss and mica-hornblende-gneiss which is intruded into the darker gneisses.

Eskimos.

The next two days were quite calm and we remained at anchor, making excursions inland and examining the brooks for possible traces of gold, but without success. While here we were visited by seven Eskimos in kayaks and I engaged one as guide to the first river to the southward. They are encamped in the same place, Nuyuk, where Dr. Bell visited them, some fifteen miles west of Wolstenholme.

"On the 5th we picked up our guide and made about five miles more, when the ice gradually closed and forced us into a little cove where we remained ice-bound until the 8th, when the wind set the ice off the coast and we had no more bother with it, the last being seen on the 10th.

Lower land to the south.

"The coast where we were ice-bound is much lower than about Wolstenholme, the cliffs have totally disappeared, and the land rises gently from the shore into rounded hills (200–500 feet) composed largely of drift, with rock showing only on the summits and points. Beyond this, to within a few miles of Cape Smith, the coast and country in rear are very low with few rock-exposures; these being nearly all granitic gneiss with broken bands of schistose mica-gneiss and of altered basic irruptives. At Cape Smith and along the north side of Mosquito Bay, a range of high hills reaches the coast from the north-east. These hills on the coast vary from 500 to 800 feet, but inland rise above 1000 feet.

Trap hills

They are formed of trap, usually fine-grained and frequently having large cavities filled with calcite and quartz, and sometimes short irregular veins of these minerals. In places the rock is a fine-textured

green diabase, weathering to a rusty-brown. It is nearly everywhere jointed in such a manner as to give the mass a rough basaltic structure, by dividing it into rude, irregular prisms, which are inclined at all angles to the horizontal. In many places the outsides of these prisms are altered to a depth from one to three inches into a dark-green crystalline mineral like hornblende. Along certain lines, especially near a contact with the granite, which is of later date, a schistose structure is developed in the trap. This has flattened and lengthened the prisms, drawing them out into bands and producing schist like Huronian schists, with the dark and light bands formed from the altered outsides and cores respectively of the prisms; while other quartzose bands, holding calcite, are formed from the masses of those minerals already mentioned. I saw this change in all stages in several places on the coast, and it seems to me probable that many of the light and dark banded Huronian schists found so commonly throughout Canada have a like origin and are not true pyroclastic rocks.

Metamorphism of trap.

The hilly country does not extend further than the north side of Mosquito Bay, to the southward of which the coast again becomes very low and is fringed with many islands to Portland Promontory, where highlands again occur. From Portland Promontory to Great Whale River, the coast is bold and rocky, rising in rather sharp irregular hills from 500 to 1200 feet high. These are formed largely of red granitic gneiss, holding numerous large fragments of light-gray quartzose mica-gneiss. The rocks of the coast between Mosquito Bay and Portland Promontory, are also largely granites, holding, in places, broken bands and masses of rusty-weathering and very quartzose mica-gneisses; and along with these in several place, notably near Thompson Harbour, Puvungituk River and Portland Promontory, large masses of dark and banded basic schists (altered traps), gabbro and diabase.

Low country south of Mosquito Bay.

"The unaltered clastic rocks and traps are first seen on the outer islands at Portland Promontory, where the inner islands are formed largely of the same rocks metamorphosed and jumbled up by the intrusion of granite. The Hopewell and Manitounuck Islands are capped with trap, while the Nastapoka chain is without trap and its rocks are probably higher in the series than those of the islands north and south of it. The unaltered rocks occur on the mainland about five miles south of the Nastapoka River and continue to within five miles of Great Whale River. Along Manitounuck Sound, there is an unconformity, or rather, the lower beds are wanting, limestones resting upon the granites; but in several places I found masses of arkose, coarse sandstone and silicious limestone enclosed in and un-

Unaltered rocks first seen.

Junction with granites.

doubtedly older than the granite. These included rocks belong to the lower members of the unaltered series as shown in my section at Castle Peninsula, Richmond Gulf, and consequently, as on Ungava Bay, the so-called Cambrian is older than the granite rocks here and to the northward. * * *

Great deposits of iron ores.

On all the islands of the Nastapoka chain, I found great thicknesses of magnetite and magnetite-hæmatite ores, associated with jasper and similar to those discovered on the Hamilton and Ungava rivers. In places, beds of rich ore were seen more than 40 feet in thickness and the amount of iron here is incalculable. There is also a good deal of silicious ankerite, which, as stated in Dr. Bell's report, contains large percentages of manganese. The magnetite occurs in thinner bands along with ankerite in the Hopewell Islands, but on the Manitounuck Islands there is very little ore. In the areas of altered traps and other schistose basic rocks to the northward of Portland Promontory, pyrite and pyrrhotite are common, the latter ore in large masses occasionally. These masses of pyrrhotite may contain gold or nickel, as they usually occur close to large granite intrusions.

Other minerals.

"Quartz veins are also often numerous in these localities, and may prove a source of gold, although I saw no free gold in any of them during my hurried examinations.

Glaciation.

"These are the principal points of interest in relation to the geology of the region, and it remains only to state that the country was entirely glaciated, with the ice-flow everywhere outwards to the sea, or a little to the north of west. The drift brought down by the glacier-ice forms a great part of the shoals and islands extending for several miles off the coast, and from information obtained from the Eskimos, it would appear that a line of morainic islands extend southward from the neighbourhood of Portland Promontory nearly to Nastapoka River. These islands lie forty or fifty miles off the coast, and may be similar to those of James Bay.

Terraces.

"The post-glacial, or later glacial subsidence along the coast, exceeded 700 feet, and, consequently, a large amount of the present northern land was then under water, leaving the highlands of Cape Wolstenholme and Cape Smith as strings of islands. In a number of places I saw fine examples of striæ produced by floating ice, differing from glacier striæ, in seldom being more than a few feet long, generally curved, and crossing one another at various angles.

Rivers.

"Owing to the want of a guide along this low and broken coast, it was only with considerable difficulty that we found the mouths of any of the rivers, and thus we missed those of the Koghaluk, Puvungituk

and Tuchuchutuk, although we tried to find that of the first-named, and entered bays that must have been close to it on both sides. The Eskimos say the Koghaluk is the largest river on the coast. If it is greater than the Sorehead, it is indeed a large river, as the latter is much larger than Great Whale River. The other rivers are not large or important.

"Considerable attention was given by me to the fisheries of the bay and the following notes on these may be of value. Fisheries.

"I carefully enquired about the common salmon from the Eskimos at Cape Wolstenholme and others to the southward. None of them had ever seen this fish, and, consequently, it may be taken that it does not enter the strait much further than the west shore of Ungava Bay. Salmon.

"Hearne s salmon is probably the most important food fish of Hudson Bay. It is very plentiful along the northern coast from Cape Wolstenholme to Cape Jones, and is especially abundant in the mouths of the northern rivers, where with our small nets we several times took more than thirty fish in a night. They vary in weight from three to fifteen pounds, a good average being six pounds. I have no doubt that this fish would be very valuable if the bay were accessible by railway, as it is not only very plentiful but is much superior in flavour and colour to the lake-trout. Hearne's salmon.

"Sea-trout are common along the coast, especially to the southward of Cape Jones, where they are caught in nets in shallow water between the islands, along with small whitefish. Both species enter the rivers in September and ascend them to deposit their eggs. The trout rarely weigh five pounds and do not average three pounds. Trout.

"As previously stated in my reports, whitefish are caught along with the trout in James Bay and are common along the coast to Hudson Strait. In the northern part, they are larger than in James Bay and were nearly always taken in our nets with Hearne's salmon, when they weighed from three pounds to six pounds. Whitefish.

"I am now certain that cod is not only found in Hudson Bay but that it remains in these waters throughout the year, as I have learned that the Eskimos, along the coast between Great Whale River and Portland Promontory, and those living on the outer islands, make a practice of catching these fish through the ice throughout the winter. The Eskimos of Wolstenholme knew the cod, but rarely fished for them. Those at Mosquito Bay often caught them on hooks, and while anchored at Cape Smith we caught two fish about thirty inches long which my men (Nova Scotia fishermen) pronounced true cod. Cod.

"The shallow water and sandy bottom off the coast to the northward of Portland Promontory are not favourable for cod, but the deeper water and rocky bottoms along-shore to the southward of that place and as far as Cape Jones, together with the rocky inner and outer islands and banks, are ideal places for cod, and they are commonly taken by the Eskimos in these places.

Bait.

"There is a good supply of bait, or food, for the cod, in the caplin, which are often thrown up along the coast. We also took 'lance' in the dredge, together with many sea-urchins, star-fish, crabs, etc., in fact everything that is found on the Labrador coast, except the squid.

Importance of fishery not known.

"Although I do not know the extent of the fishing grounds or abundance of the cod in Hudson Bay, and had no means of determining these points, our boat being too small for fishery work, I think that the knowledge of their presence in considerable numbers throughout the year, points to a practically inland fishery, and is of so great value that these facts should be brought to the attention of the proper authorities, so that an early and complete investigation may be made, with a suitable vessel, of this perhaps important fishery. There is no reason why, in the deeper waters of the bay, halibut may not also be found, although I can hear nothing of this fish from the Eskimos.

"Herring is unknown to the Eskimos, and consequently may be assumed not to occur in Hudson Bay. The only other salt water fishes are two species of sculpin, and small lump-fish, etc., of no economic value.

Seals.

"I do not think that the seal fishery of Hudson Bay will be of commercial importance, although there are plenty of seals along the coast; for, as they never congregate in large numbers to pup, like the harp and hood seals off Newfoundland, the killing of these animals will be left, as at present, to the Eskimos.

Walrus.

"The walrus is not now very abundant, and ivory sufficient for shoeing dog-sleds is difficult to obtain for the Eskimos. I learn that on the outer islands of the North Belchers there are a few 'rookeries' where small herds of walrus remain during the summer, and where they are seldom disturbed by the natives. I hope to know personally about these next summer.

White whale.

"The white whale or 'porpoise' frequents the mouths of the large northern rivers in considerable numbers, and there might, for a time, be carried on profitable fisheries for these animals; but the experience of the Hudson's Bay Co. and others is against a permanent, successful porpoise fishery, as after a few captures they will not enter the rivers.

"Bone whales are practically unknown to the Eskimos of this coast, and what whalebone they may have has been obtained from Eskimos to the northward of Hudson Strait.

"The Eskimos report that the rivers and numerous large lakes of the barren grounds contain quantities of brook-trout and lake-trout, arctic salmon-trout and whitefish. Fresh-water fish.

"Mr. Young has made a large and nearly complete collection of plants. We have also a number of butterflies and other insects, as well as some marine animals obtained by dredging. Meteorological observations have been regularly kept since August 1st, including the surface temperature of the water. Collections.

"We arrived at Great Whale River post on the 25th of September, and were kindly received by Mr. Gillies who placed two rooms in his house at our disposal, and furnished quarters for the men in the servants' house. Mr. Gillies is also assisting us in procuring dogs, guides, etc., for our spring work. Proceedings at Great Whale River.

"Our first care on arriving was the proper housing of the yacht in winter quarters, and we soon had her dismantled and hauled out alongside the Company's craft on a low bank about half a mile above the post. The men were then set to work to make two sleds, before cold weather, and when these were finished, they spent the remainder of October in chopping fire-wood. Early in November I sent Lantz and Ford a few miles to the southward to hunt, as fresh meat is a very scarce article here, and we live largely on salt and tinned meat owing to the scarcity of ptarmigan, hares or deer. Mr. Young has been busy plotting his surveys of the past season, keeping weather observations and other work incidental to the trip. I have developed all the photographs taken and they have turned out satisfactorily on the whole, being better than those of any other season. * * *

"I will now try to give you a short sketch of my present plans in regard to future work. It was intended that the party in the spring should go inland from here and explore the country to the eastward. With such an object in view I wrote to Mr. Gillies to provide Indians along our possible route with nets, so that they might lay up stores of fish for our use as dog-food and also kill deer for the same purpose. The Indians would not take the nets and said that the deer also could not be depended on; consequently, I have no dog-food inland, and cannot, therefore, make any extended stay in that part of the country. Plans for further work.

"As this must be abandoned, I have, after consulting Mr. Gillies and the Eskimos, determined to divide the party, sending Mr. Original plans modified.

Young to the Belcher Islands and going myself northward along the coast some distance past the mouth of the Nastapoka River and then inland about 100 miles to a very large lake, called Eskimo Seal Lake, to explore the country about there on the edge of the barren-grounds. On both these trips seals can be obtained to feed the dogs, while on the coast, and inland, the Eskimo say that sufficient caribou may be killed to keep the dogs going. We shall probably start about March 1st, as previous to that date the short days and extreme cold make dog travelling very slow and disagreeable, and the amount of work done would be inconsiderable and very expensive. The mail packet also does not arrive here until the end of February, and as that will be our first news from home since leaving, eight months before, we naturally want our letters before going off. I expect to be absent until early in April, and Young will probably be away about the same time.

Exploration of Great Whale River.

"On our return, when the travelling on the crust ought to be good, I propose taking the united party inland up this river, and we may be able to go a considerable distance up the main river and perhaps to cross to Little Whale River and descend it to the coast, but this will depend on the information which I may get from Indians expected here after New Year. Travelling on snow and ice is practically over by the 15th of May, and we will then turn our attention to outfitting the yacht for next summer's work. The ice usually leaves the river about the last of May, but it is always two weeks later before the coast is clear of ice, and often the ice does not go sufficiently for boat work until much later. If the season is at all favourable, I propose to go northward along the coast to Richmond Gulf, and then to sail out to the North Belchers and make a survey of them and of the outer islands of the South Belchers, which cannot be reached by Young in the winter owing to the ice not setting fast. We will probably finish with the islands late in July, when we will return here and then proceed southward, carrying on the log-survey. On arriving at Paint Hills and Cape Hope, as extended an examination of the Huronian rocks as possible will be made, and we will leave in time to arrive at Moose early in September, so as to be able to send out specimens, etc., by the Hudson's Bay Co.'s ship, and also to escape the heavy gales always due in the first half of that month.

Work after opening of navigation.

"If the ice hangs heavily on this coast until July, I do not think it advisable to try to explore the outer islands in our lightly-built craft, and so, instead of waiting longer for it to clear, we will leave early in July for the southward, where the time may be profitably spent on the Huronian areas. These are my intentions at present, but plans

may have to be changed in consequence of various circumstances—for one thing, there may be no dogs, as a large number died last winter and the disease may come again. In this case I will go inland without them as we did on the Hamilton River.

"Before closing I wish to state that Mr. Young and the other members of my party have been most diligent and efficient in the discharge of their duties."

NEW BRUNSWICK.

The following account is given by Mr. Chalmers of his field-work in, New Brunswick, in the later part of the summer :—

Work in New Brunswick by Mr. Chalmers.

"On the 29th of June, I left Ottawa for New Brunswick, to resume the survey and examination of the surface geology of that province, especially of the quarter-sheet map No. 1, N.W., which includes the principal part of York, and smaller portions of Sunbury and Carleton counties. The survey of the area embraced in this sheet was begun in 1893 and continued in 1894, and it was now proposed to complete it. Mr. W. J. Wilson, of the Geological Survey, joined me early in August, and the remaining summer months were spent in this work, namely, in mapping the superficial formations and forest-covered areas, measuring the heights of the hills, lakes, etc., by aneroid or spirit-level, and in studying the different kinds of superficial formations which characterize the district.

Valley of St. John River.

"The surface geology of this portion of the province, although affording nothing new, was found nevertheless to possess many interesting details. From the extent of country cleared of forest, better facilities are afforded for examining its surface deposits than in most other parts of the province. The most striking natural feature of western New Brunswick is the valley of the St. John River. This and some of the valleys of the larger tributaries, trench this otherwise plateau-like district in such a manner that, except in the Carboniferous area, few horizontal or base-levelled surfaces are to be seen. Evidences of dislocations and uplifts, with probably correlative subsidences, and in some instances apparent tilting of blocks of the land, within times geologically recent, appear to be found. These changes have in some instances affected the present drainage lines and have obliterated old ones. Numerous facts in regard to subærial denudation, the origin of lake-basins, the transportation and disposition of the materials constituting terraces, kames and other forms in which the thick beds of sand and gravel found here occur, were observed. These terraces and kanes are especially noteworthy on

the west side of the St. John, though the valleys of the Keswick and Nackawicac on the east side, exhibit thick beds of modified gravel and sand much denuded. Well developed terraces in the tidal part of the St. John, show former water-lines considerably higher than the river-floods of the present day reach; but whether these are of fresh water or marine origin has not yet been fully determined.

Lakes.

"Many beautiful lakes are found scattered over the areas of pre-Carboniferous and granite rocks in western New Brunswick, that diversify the scenery and give a pleasing effect to the landscape. Usually the larger lakes occur in groups, as, for example, the Cheputnecticook, Eel and Magaguadavic lakes. The basins of several former lakes were also found, notably at Brockaway settlement in the Magaguadavic valley, at Canterbury station and in other places.

The Grand Falls.

"As much interest attaches to the Grand Falls of the St. John, and as some uncertainty exists in regard to the measurements of the height above sea-level formerly made, it was thought advisable, when we were in the vicinity, to connect the upper and lower basins, so-called, with the height of the Canadian Pacific Railway station there by a series of levellings. Two or three days were spent in this work, and from the measurements effected, the upper basin was found to be 417 feet above mean tide-level, and the lower basin 300 feet, according to the September height of the river, the season of the year when it is generally lowest.

Height of river above the falls.

"In the North-east Boundary Survey, under the direction of Major J. D. Graham, one of the United States commissioners, to whom was assigned the survey of the line from Passamaquoddy Bay to the highlands that divide the waters which flow into the Atlantic Ocean from those flowing into the St. Lawrence, 'a line of levels, with two spirit-levels checking each other, was carried from mean tide at Calais, Maine, to the monument at the source of the St. Croix River. Thence it was run along the true meridian to the intersection with the River St. John, the surface of which at this point was found to be 419·2 feet above the level of mean tide at Calais. The basin of the river immediately above the Grand Falls may be stated as of the same height, in round numbers, (although two miles and a-half further down stream) as there is very little current between these two points.'

"It thus appears that the elevation of the upper basin of the Grand Falls, as based on the Canadian Pacific Railway levels, is very nearly the same as that obtained by Major Graham, the difference not being greater than may be due to the seasonal fluctuations of the river's level.

"The British Commissioners on the North-east Boundary Survey, Messrs. Featherstonhaugh and Mudge, from an elaborate series of barometric levellings based on the tidal portion of the St. John River, arrived at different results, finding the height of the upper basin of the Grand Falls to be only 296·75 feet above the sea. And from this point as a base, Mr. Wightman measured the altitudes of a number of mountains and lakes between the Upper St. John and the Baie des Chaleurs with the barometer. A list of these is given in Hind's Preliminary Report,* but it is believed they are all too low.

Search for datum points.

"In seeking base-levels from which to measure altitudes with our aneroids, we had sometimes to make use of the tidal portion of the St. John River between Indiantown and the head of the tide above Fredericton, and the actual height of its surface with reference to high-tide or mean-tide in the Bay of Fundy, therefore, became an important question. Attempts were made to ascertain this by levelling from the Canadian Pacific Railway to certain points; but the results thus far obtained are incomplete owing to causes unnecessary to detail. Nevertheless, they serve to show that the level of this portion of the river is remarkably inconstant, rising and falling with the non-tidal portion above tide-head, and that it is but little affected by the tides. At the lowest stages of the river in autumn and mid-winter, there seems to be a hydrographic depression there at high-tides in the Bay of Fundy, the surface being then below that level. Owing to the narrowness of the St. John at the falls near the mouth, only a limited quantity of sea water can flow in at high-tides; consequently the interior basin, or depression referred to, is raised only a few inches (about sixteen inches at Indiantown and five at Fredericton†) before the ebb sets in. But the reason why this portion of the river falls below the level of high-tides seems to lie mainly in the fact that there is a greater outflow than inflow at these tidal falls. For example, the flow inward commences about two hours and a-half before high-tides, and continues two hours and a-half after. The time for vessels to go through the falls is given in the almanacs as follows:—'The falls are level, or it is still water at about three hours and a-half on the flood, and at about two and a-half on the ebb. Much depends on the floods in the St. John River, and the time of high-water, or full sea, which is often hastened by high southerly winds.' ‡Between every two successive high-tides, therefore, the flow outwards lasts fully seven hours, while

Tidal slopes on St. John River.

*A Preliminary Report on the Geology of New Brunswick, etc. By H. Y. Hind, M.A., 1865, pp. 22-32.

†Tidal Phenomena of the St. John River. Bull. Nat. Hist. Soc. of N.B. No. XV, 1897. Prof. A. Wilmer Duff, M.A.

‡I am indebted to Mr. S. W. Kain, of St. John, for information on this question.

the inflow continues only about five hours. At neap-tides the inflow is still less and the outflow correspondingly greater. This discharge from the tidal basin of the St. John, unless compensated by an equal or greater inflow from the non-tidal part above, brings about a general lowering, during the seasons mentioned, to a level below that of high-tides in the Bay of Fundy. The height and attitude of the water-surface in this portion of the river, it thus appears, are dependent upon several interrelated and complex conditions. Generally speaking, it may be stated that it oscillates between the high-tide and mean-tide levels of the Bay of Fundy. At the railway bridge, Fredericton, the autumn level of the St. John at high-tide was found to be one foot nine inches (1·77 ft.) lower than that of the same tide in St. John Harbour, the distance between these two points being eighty-five miles. At Westfield Beach, twelve miles from St. John, it was found to be approximately six feet and a-half (6·60 feet) lower. These figures are subject to correction, the levels used being those of the Canadian Pacific Railway. They indicate, however, a gentle incline in the surface of the St. John at and below Fredericton, but how far down river has not been ascertained.

Complex relations.

Character of surface of country.

"The agricultural condition of the country is of much interest and a number of excellent farming tracts are included within the limits of the map-sheet referred to. The valley of the St. John is especially noteworthy in this regard, a considerable width of alluvial soil being found on each side of the river. Good tracts of arable uplands were also noted in York and Carleton counties, and many of the farmers are in prosperous circumstances. A large extent of the country embraced in this sheet is still forest-clad, though portions of it have been swept by conflagrations. Lumbering is, however, still an important industry, and wherever these fires have not destroyed the woods entirely, the younger or second growth of trees is rapidly taking the place of those cut away in the ordinary lumbering operations. It is observed, however, that the spruce logs are becoming somewhat smaller than formerly; but the conservative regulations adopted by the provincial government relative thereto, will, doubtless, afford such protection to the younger forest growth as to ensure its yield for commercial purposes for generations to come.

Discovery of Silurian fossils.

"Before closing work for the season, Mr. Wilson, while engaged in mapping some forest areas and surface deposits along the St. Andrews and Woodstock branch of the Canadian Pacific Railway, was fortunate enough to discover fossils about six miles from Canterbury station, in the belt of rocks lying north-west of the granite area in western York. I thought it best while we were in the vicinity to make a

collection, and accordingly a few days were spent in doing so. The fossils when submitted to Dr. H. M. Ami, were pronounced by him to be Silurian, though the rocks in which they occur have hitherto been classified as Cambro-Silurian.

"The rocks in which the fossils were found consist of partially altered, gray slates, with certain shaly bands, and dip N. 20° W. 80°. A wide belt of somewhat similar strata, closely conformable, and in nearly vertical attitude, is exposed in cuttings along the railway-track here. About half a mile south-east of the fossil bed a reverse dip comes in, and dark pyritous, highly altered bands are interstratified with the gray slaty rocks. No fossils were detected in these.

Distortion of fossils.

"The fossils seem to have been subjected to great stresses, many of them being flattened and stretched out or otherwise distorted in a remarkable manner, showing the effects of the pressure more than the rocks containing them do. It was observed, however, that the slaty cleavage and bedding approximately coincide, and the question arose whether it is not to this fact that the extremely distorted condition of the fossils is due—that is, to the fact that the shearing and lines of flow have been always at right angles to each other. Further investigation is, however, required to elucidate this question.

"Following is a preliminary list of the fossils as determined by Dr. Ami:—

Forms determined.

"Crinoidal columns and fragments belonging to at least two distinct species. *Orthis* (*Rhipidomella*), sp., compare *Rhipidomella oblata*, Hall from the Lower Helderberg of New York State and Canada. *Orthis*, sp. indt. smaller than preceding but with coarser and less numerous costæ. *Leptæna rhomboidalis*, Wilckens, *Strophomena* or *Streptorhynchus*, species undetermined. *Spirifer*, sp., two distinct forms at least present. *Pterinea textilis*, var., an example showing characteristic sculpture of this uppermost Silurian species.

"The season's work closed on the 25th of October.

"In the New Brunswick work Mr. Wilson gave me important and valuable assistance, some portions of it having been carried on independently by him."

Work by Prof. L. W. Bailey.

Professor L. W. Bailey was again employed in field-work in New Brunswick. Some of the observations made have been incorporated in his report on the mineral resources of the province, shortly to be issued, other data obtained will be reserved for a later report on cer-

tain features in the geology of New Brunswick. The following is Professor Bailey's account of his operations during the summer :—

"According to your instructions received in June last, these investigations were mainly directed to two objects, viz. : (1) the obtaining of any additional data which might be available, bearing upon the question of the mineral resources of the province, and, (2) the more definite determination, if possible, of the age and relations of the great bands of slaty rocks that traverse the central portions of New Brunswick on either side of the central granite belt.

Further investigation of minerals.

"(1.) The information of an economic character thus obtained, being supplementary to that collected in the previous year, a report upon which has already been submitted, it has been thought well to take advantage of a delay in the printing of the latter to incorporate therein all additional matter available, as has now been done. This matter relates more particularly to the gypsum deposits of Albert county, various quarries of building-stone, the Albert shales, clays for brick-making, sands, mineral paints, etc. The report referred to, as thus amended, is now passing through the press.

New facts relating to coal deposits.

"In connection with this branch of inquiry, considerable attention was devoted to the consideration of the occurrence of coal in New Brunswick, increased interest in this direction having been awakened through the results of borings undertaken at various points. Among these that of Dunsinane, in Kings county, is especially interesting as revealing a thickness of the coal-formation at this point, (over 1300 feet,) which was entirely unsuspected and which makes it possible, at least, that the hitherto accepted view that the coal-formation of New Brunswick is very shallow may be erroneous. As bearing further upon this subject, visits were made to various parts of the Carboniferous area, especially about Moncton, Buctouche, Chatham, Caraquette and the Miramichi River, with a view to obtaining new data for a general discussion of the whole subject. As this discussion was too lengthy for incorporation in the report mentioned above and will be based to some extent upon a critical examination of the cores from borings, not yet available, it is proposed that it shall form a portion of a separate report, in connection with the discussion of the topic next to be referred to.

Examination of slate belt.

"(2.) In the study of the slates and associated rocks of central New Brunswick the discovery of fossils was considered to be of primary importance. Hence a large amount of time was devoted to this object, an amount, unfortunately, quite out of proportion to the results. In particular, it was hoped that something might be obtained by a systematic search along those portions of the North-west and South-

west Miramichi rivers and of the Nashwaak River that are bordered by these rocks ; but on reaching these streams at the points to be studied, the extremely low state of the water was found to be such as to make their navigation wholly impracticable. Resort was then had to the St. John River and its numerous minor tributaries in York and Carleton counties, the fossiliferous beds of the Beccaguimic River being first examined, and a study then made of the fine section, exclusive of the granite almost continuous for forty miles, between the last-named stream and Fredericton. No remains of distinctly organic origin were found ; but the discovery on the main river, above the mouth of the Shesgomoc Stream, of calcareous strata, which, though metamorphosed and non-fossiliferous, cannot well be other than the equivalents of the fossil-bearing limestones of the Beccaguimic, will serve to make much clearer the geology of this part of the province and to give a wider basis for the discussion of the age of its contained formations.

"The discussion in question will form a second division of the next report, and will include the results of the study of the Beccaguimic fossils, already forwarded to the office of the survey. Further details to be given.

"The time devoted to the above work was three months."

Nova Scotia.

Mr. H. Fletcher was engaged during the winter of 1897-98 in plotting the surveys made in Cumberland county referred to in the Summary Report for 1897, (pp. 99 to 100,) and in revising those made by his assistant, Mr. M. H. McLeod, in connection with the preparation of several sheets of the geological map of Nova Scotia. He also made sections based upon a re-examination of the upper portion of Logan's section from Shulie to Two Rivers for comparison with the rocks of the south side of the basin. Work by Mr. H. Fletcher.

On the 16th of June, he left Ottawa for field-work in Nova Scotia, and did not return to Ottawa until January 8th, 1899. On this work he reports as follows :—

"I was again assisted by Mr. McLeod, who was detailed to make the surveys necessary to complete map-sheets 59 and 60. The rocks examined by him are chiefly those which overlie the Coal Measures, and would thus, according to Dr. Selwyn's classification of 1881, be called Permian or Upper Carboniferous. They have been mapped as Permo-Carboniferous by Dr. Ells, who has included with them most of the rocks at one time called Triassic in Prince Edward Island. They are spread out in a syncline, the axis of which extends almost due west from the mouth of French River, and which has been already Field-work by Mr. McLeod.

described as crossing Tatamagouche River and River John. From Malagash Point an anticline, running parallel, brings rocks of the Carboniferous limestone series from beneath the former—both series resting unconformably upon the igneous and metamorphic rocks of the New Annan and Baxter mountains, Tatamagouche Mountain and other portions of the Cobequid Hills, the contact being in places complicated by faults.

Springhill coal-field.

" My own work was confined principally to the district adjacent to the Springhill coal-field, and to a closer study of the faults and folds affecting the Coal Measures there, in which I was again efficiently assisted by Mr. G. W. McCarthy, who was with me by the kind permission of Mr. J. R. Cowans, and traced, by means of bore-holes and trial-pits, the lowest seams worked at Springhill mines to a distance of more than two miles and a-half beyond the point to which they were proved by the late Mr. Scott Barlow and Mr. John Anderson.* I have also to thank Messrs. George Hall, Ben. Parsons, John Murray, C. Hargreaves, Arthur Alloway, Harvey Howard, William Conway, and other officials of the Cumberland Railway and Coal Company, and the owners of the land on which this work was done, among others, Messrs. Wesley Herrit, Fred Jones, Alfred Smith, Rufus and Levi Gilroy, Thomas Boss and Mrs. Stephen Herrit.

" The details are not of such a nature that they can at once be presented, but the general results may be briefly stated.

" So much has been already written about the Springhill coal-field, that reference need be made only to modifications resulting from an extension of the underground workings and the proving of the outcrops of the coal-seams to the south-eastward.

Seams worked.

" The three seams at present mined at Springhill are called, in descending order, the North Slope or Thirteen Foot seam of Barlow's reports† the East Slope seam and the West Slope, Eleven-foot or Black seam. The workings of the Syndicate or South Slope are on the North seam,‡ those of the Aberdeen or No. 5 Slope, on the West seam. The North Slope has been sunk past the 3200-foot level, without diminution, I am informed, in the size and quality of the coal, while the 1900-foot level has been extended to a point about seven chains across the Athol road, thirty-nine chains west of Miller's corner, far beyond the fault once supposed to determine the western boundary of the coal-field, which may indicate that the overlap of the upper rocks is here upon the Productive Measures rather than upon

*Reports of Progress, Geol. Surv. Can., 1873-74 p. 156 and 1875-76 p. 346.

†Report of Progress, Geol. Surv. Can., 1873-74, p. 154.

‡Trans. Can. Soc. of Civil Engineers, vol. II., p. 404.

the Millstone Grit. The continuation of this slope, a line of surface-pits in that direction, or the tracing of some of the uppermost seams will solve this doubt.

"The great fault running south from Stewart meadow, with which this is connected on the map of 1885, seems not to pass the railway from 'the Lower Carboniferous outlier,' but instead to turn nearly at right angles to the eastward towards Saltsprings and perhaps to join the Black River fault. The fault, stated by Dr. Ells, on the authority of a former manager, to terminate the coals against the limestone, was subsequently shown to be of minor importance, by the connection of the underground workings on the West Slope seam with those of the Aberdeen Slope, which were continued far past it; the coal at the face being still, it is said, seven feet thick and of good quality. The extension of the lower levels in this direction is likely to prove this corner of the field, while a tunnel, now being driven across the strata from the West Slope seam, will test the underlying seams, some of which have been to a small extent worked. Faults.

"The 2600-foot level, already driven 2700 feet south-westward from the North Slope, follows a small fault or roll, which is perhaps a prolongation of that which skirts Coalmine Brook for a quarter of a mile the present crossing of the railway to Parrsborough.*

"About fifty feet to the eastward of the last pit mentioned by Mr. Barlow, on the West Slope seam,† another was sunk eighteen feet, to the seam, which below that point showed the following section:— Seams traced.

	Ft.	In.
Top coal	2	2
Shaly coal and black shale	0	6
Coal	0	9
Shale	0	1
Coal, in part soft and shaly	2	10
Stone, mixed with coal	1	0
Under water and not well seen	3	0
	10	4

"It does not appear that either the top or bottom was exposed in this pit. From it the coal was closely traced to the Herrit road, on the east side of which a bore-hole passed through fourteen feet and a-half of coal and shale; while, about three chains to the southward, a seam was found in the proper relative position for the East Slope seam.

* Annual Report, Geol. Surv. Can., vol. I (N.S.), p. 31, line 24.

† Report of Progress, Geol. Surv. Can., 1875-76, p. 346.

Jones Brook.

"On Jones Brook, about a quarter of a mile further east, these two seams were again found the uppermost containing about eight feet three inches of excellent coal, with two partings of shale each about three inches thick, while the coal in the thick lower seam appears to have improved.

Hill's pits.

"Half a mile east of the Herrit road, pits were sunk in 1865 by an American company, which is stated to have expended $20,000 in testing their claims and to have succeeded in proving at least two workable seams of coal of good thickness. These belong also to the Springhill series, as inferred by Messrs. Woodhouse and Jeffcock in their report, and are no doubt identical with the above. Both were bored through by us, and a considerable thickness of strata was also tested both above and below, after which the lowermost seam was traced to the eastward, and proved to be that opened at McCarthy's slope, near the point at which (Report for 1873-74, page 159) two seams were said to have been found by Mr. Probert. The uppermost seam was not, however, opened by us hereabout. A gray, massive sandstone, containing concretions of coherent, calcareous, brown-weathering, ringing, fine sandstone, that lies between the two seams, appears in blocks associated with drift coal at a large spring a quarter of a mile east of McCarthy's slope, or more than a mile from the Herrit road, indicating no doubt the proximity of the coal, which was not, however, tested.

McCarthy's slope.

Smith Brook.

"An outcrop of this sandstone, about half a mile further to the eastward, led to the discovery of coal on the north side of Smith Brook, where the upper part of the lower seam was pierced in a bore-hole as follows:—

	Ft.	In.
Surface	8	0
Gray sandy shale	3	0
Gray argillaceous shale, with harder layers	5	0
Coal with thin partings	3	3
Shale or slaty coal	0	3
Good coal	1	8
Shale	0	2
Good coal	1	5
Gray shale	0	4
Good coal	3	1
Greenish coherent underclay		
	26	2

"In an adjoining hill the pavement of an overlying seam was exposed, which may represent the East Slope seam, but was not tested.

"The next openings lie nearly half a mile to the south-eastward, along the north bank of Sugarwood Brook, a tributary of the South Branch of Black River. Here the first bore-hole passed through about eighteen feet of coal, with several thin partings of shale, while further down the brook the following section was cut through and bored :— Sugarwood Brook sections.

	Ft.	In.
Gray sandy shale	1	8
Coal, with two small partings	1	7
Clay	0	4
Coal and coaly shale	1	1
(This upper portion of the seam does not appear in the borings to the westward.)		
Soft clay	0	4
Bluish-gray argillaceous shale	3	10
Coal	0	7
Dark argillaceous shale with *Stigmaria*	1	0
Coal	0	1
Coaly shale and coal	0	5
Good coal	1	9
Gray shale	0	8
(The above section is exposed in a pit. The following strata were bored through.)		
Coal	1	5
Shale	0	11
Coal	3	9
Gray shale	2	1
Coal	2	1
Shale	1	4
Soft coal	2	7
Dark-gray soft underclay	3	0
	30	6

Sections in adjacent pits.

"In the immediate vicinity of the foregoing sections, a great difference is found in the strata overlying the top coal. In three adjacent pits, only a few feet apart, the section is as follows:

No. 1.

	Ft.	In.
Gray shaly sandstone with concretions.	13	0
Gray conglomerate and coarse grit	6	0
Gray flaggy sandstone	3	2
Gray pea- and nut-conglomerate, containing large pieces of greenish argillaceous shale and fragments of coal	3	0
Broken rock, perhaps conglomerate but doubtful, possibly crushed down over the coal	3	6

No. 2.

Greenish-gray very fine sandstone in thick beds	10	6
Gray or dark argillaceous shale	3	4
Greenish-gray or drab very fine sandstone or arenaceous shale	1	2
Gray and yellowish argillaceous shale	0	9
(The above section is that in the pit. It is continued by boring as follows.)		
Coal	1	6
Shale	0	2
Coal	1	8
Dark shale	1	7
Coal	0	4
Dark shale	0	8
Coal	0	7
Shale	0	3
Coal	0	6
Shale	0	11
Coal	1	7

No. 3.

Gray banded sandstone	2	3
Dark-gray coarse grit and conglomerate	2	3
Gray and dark-gray coherent sandstone with *Calamites*	1	6
Gray pea-conglomerate	2	8
Gray, thick-bedded, striped sandstone full of carbonized plants	3	9
Dark-brownish and gray, coaly, crumbling, fine grit.	1	0
Gray argillaceous shale	0	9
Coal	—	—

"In pit No. 2 the upper part of the coal seam appears to be wanting.

"In a fourth pit the rock was greatly broken and the top of the coal was again wanting. This irregularity and replacement of the finer rocks above the coal, in so short a distance, suggests a possible overlap or unconformity. But where this might have been determined, the coal-seam meets a fault, running south-westerly along Sugarwood Brook, by which it is thrown about 350 feet to the north-eastward. Its crop was again traced about 270 feet, to another small fault, at which the thrust seems to be to the south-westward. At a distance of about 600 feet south-east of the brook the following section was obtained by boring: Section in fourth pit.

Section determined by boring.

	Ft.	In.
Sand and clay	4	0
Drift coal, not found to the dip	3	2
Gray argillaceous shale	0	10
Conglomerate	1	10
Gray sandstone of fine grindstone grit	2	10
Dark blackish argillaceous shale	0	5
Light-gray soft argillaceous shale	3	3
Good coal	1	6
Dark shale	0	3
Coal	0	5
Shale	0	3
Coal	0	4
Shale	0	7
Coal. (This may be the top coal of the foregoing section)	0	5
Soft shale	0	8
Gray argillaceous shale	2	5
Coal	0	3
Black shale and coal in thin layers	2	0
Good coal	0	9
Shale	2	8
Good coal	4	6
Shale	0	5
Good coal	1	9
Shale	0	6
Coal and coaly shale	1	7
Shale	0	6
Coal with three one-inch hard bands	2	4
Shale	0	6
Good coal	1	6
Shale	1	3
Coal	3	4
Gray shale, somewhat hard, with a little coal	1	0
	48	0

Sections only approximate.

"These sections, cut by a hand-drill, must be taken as merely approximate and subject to correction, but they serve to show the general structure of the seam. Some good layers of coal were exposed at various points by shallow pits. The season was too wet for sinking a shaft necessary to prove the whole thickness of this seam, and, the ground becoming covered with snow, work had to be discontinued before the seam was found further to the south-east. Had it been possible to prove about 2100 feet south of the above bore-hole, the relation of the thick coal seam to a conglomerate (shown on Mr. Barlow's map of 1874 as running from a point near the fork of the roads at Tom Boss' south-westerly down the Maccan River with a north-westerly dip), might have been made plain. This conglomerate I am at present disposed to regard as above the workable coals.

Coal beneath the west slope seam.

"A bore-hole near the head of Sugarwood Brook, cut a twelve-foot seam of coal and shale in alternate layers, which probably underlies the foregoing; while about 850 feet down-stream from the last opening on the latter, nine feet and a-half of similar alternations, probably overlie; neither seam being workable. In the main South Branch of Black River, half a mile above the bridge at Tom Boss', a small seam of coal with a very low south-westerly dip seems to overlie all the foregoing. All the rocks of this vicinity are nearly horizontal,

Claremont anticline.

"From the above description of the trend of the coals at the Herrit road, it may be inferred that an anticline passes near this point, a prolongation of that of Claremont toward Mapleton. Some work was done where this line crosses the Leamington and Old Mountain roads, but more will be required before the precise relation of Barlow's highest coal-seam, traced by him to the Athol road past the furthest underground levels, to the small coals of Harrison Brook, the Old Mountain road and the deep bore-hole at Mapleton can be defined.

Rocks above and below Coal Measures.

"The rocks overlying and underlying the Coal Measures between Thompson and Westchester, and towards Rodney and Southampton, have also been, to some extent, studied, in an attempt to harmonize the various views held in regard to the different groups of rocks, the similarity of which in mineral composition and fossil contents has led to their being often confounded. Some attention was also paid to tracing the Black River fault,* well seen in the river at Keiver's bridge, about a mile further down stream, and at the mouth of Johnston Brook.

Examinations made with Dr. Ami.

"Two or three days were spent with Dr. Ami at Harrington and Moose rivers, examining the rocks compared with the Devonian of

* Report of Progress, Geol. Surv. Can., 1873–74, p. 168.

New Brunswick by Dr. Ells*, which Dr. Ami, on the evidence of the fossils, now correlates with the Riversdale and Horton series, and calls Carboniferous. It must, however, be remembered, that the Horton has been stated by Sir J. W. Dawson to be equivalent to several groups that by some geologists are regarded as Devonian.

Economic minerals.

"In the course of last season I visited several places in which mining developments of supposed economic importance had been made.

Coal near Amherst.

"At one of these, in Lowe Brook, about a mile above the pumping station, some two miles from Amherst towards Salem, a seam of coal, six to eight inches thick, in three layers and for the most part good, was uncovered among gray and drab argillaceous shales and sandstones containing fossil fern-fronds two inches long.

Manganese.

"The manganese deposit in the same neighbourhood was again worked last season, and a small quantity of good ore was extracted.†

"In November, I examined a portion of the line of the railway now under construction from Windsor to Truro, along which petroleum was reported to have been found. On the part constructed between Windsor and Mosherville, only a few masses of marl, gypsum and limestone were encountered, the cuttings showing chiefly masses of sand, clay and gravel with boulders.

Whycocomagh iron ores.

"In October, by your instructions, I went with Mr. C. A. Meissner, manager of the Londonderry iron mines, to Whycocomagh, to note the developments made by him on the iron ore of the brook that flows through the Indian Reserve. The associated rocks of this district are described in the Report for 1882-84, pages 34 H and 91 H. The present workings lie about half a mile above those formerly opened, and the ore may follow the course of the stream, as indicated by a band of quartzite. A tunnel driven into the west bank, high above the stream, cut quartz and quartzite, succeeded by about seven feet of hard red hæmatite and rock in layers of from two to four inches in thickness, after which comes nine feet of ore, partly specular iron and partly hæmatite, with an occasional admixture of fine-grained magnetite. The average of this nine-foot band is said to be fifty per cent of metallic iron. It contains about five-tenths per cent of phosphorus, ten to fourteen per cent of silica, and a variable quantity of sulphur. In the front of the vein a good deal of pyrite was found, while the back part which contains the solid ore has little sulphur. Another tunnel, eighty feet below the first, went through twenty feet of limestone, dark-green slaty rock eighty feet, then ten feet of dark quartzite; but, at last accounts had not cut the ore.

*Annual Reports Geol. Surv. Can., (N. S.), vol. I., p. 51 E, and vol. V, p. 69 P.
†Summary Report, Geol. Surv. Can., 1897, p. 101.

Search for gold.

"Other openings have been made in this mountain which exposed iron ores more or less promising. At the same time a visit was made to the pits, sluices, etc., on the brook at the head of Whycocomagh Bay, where search had been made for gold, and where a tunnel, 130 feet long, had been driven from the brook through the pre-Cambrian rocks. All work had been discontinued before the date of my visit.

Mines at Cheticamp.

"The Cheticamp Gold Mining Company began active operations on the 28th of April last, on a mixture of sulphides, principally galena in large lenticular masses, in the pre-Cambrian slates of Faribault Brook. A good road has been built from the settlement, nearly three miles distant, to the deposit. Shafts have been begun and a considerable quantity of ore has been extracted. A concentrating plant capable of treating fifty tons of ore a day, a forge, workshop, boarding-house and two or three miners' houses are being erected. At the time of my visit about fifty men were employed, and the company is said to have expended $30,000.

Loch Lomond.

"On January the 4th, 1899, I visited, with Mr. J. A. Gillies, M.P., a deposit of galena and chalcopyrite found to contain silver and gold, in rocks of the same age about a quarter of a mile east of the middle lake at Loch Lomond, in Richmond county. The ore is in a quartz vein four feet and a-half thick, exposed in a pit fourteen feet deep and twelve long, and said to have been cut at some distance both ways from the pit. The vein is of some promise, but too little work has been done to determine its value.

Coal of Cochran Lake.

"A small quantity of good coal was taken by Mr. E. W. Moseley, from a shaft eighteen feet deep to the top of the seam, about 500 feet to the eastward of the pits sunk by his father, the late E. T. Moseley, of Sydney, south of Cochran Lake.* An attempt made to open this seam in the neighbourhood of Loon Lake was frustrated by quicksand found to a depth of twenty-seven feet in the pit."

Work by Mr. E. R. Faribault.

The greater part of last winter's office work was devoted by Mr. E. R. Faribault to the completion of the large scale plans of the gold-mining districts surveyed the previous summer in the county of Guysborough and in the eastern part of the county of Halifax, and described in last year's Summary Report. Ten of these plans were prepared for the engraver and their reproduction attended to. The plans of Goldenville, Salmon River, Moose River and Mooseland were printed on the scale of 250 feet to one inch and those of Oldham, Caribou, Killag, Fifteen-mile Stream, Forest Hill and Upper Seal Harbour on the scale

Plans of gold districts published.

* Summary Report, Geol. Surv. Can., 1897, p. 102[a]

of 500 feet to one inch. Some time was also occupied in the study of the geological structure of these districts, in order to define the richest auriferous zones and the relation of these to the different parts of the anticlinal folds, and to determine their extension beyond the present developments to greater depths.

Progress of map-sheets.

Some progress was also made in compiling the one-mile to an inch map-sheets of the country lying immediately north-east of Halifax, completing for publication the Shubenacadie sheet (No. 56) and the Lawrencetown sheet (No. 53.) The first black proof of the former sheet has been received from the engraver and corrected, and the latter sheet is now ready to be engraved. The first black proofs of the Eastville sheet (No. 48) and Upper Musquodoboit sheet (No. 49) have also been received and corrected, and the Moose River sheet (No. 50) has been printed.

Progress was also made in collecting notes to complete the general report on the gold fields of eastern Nova Scotia.

Field-work in 1898.

On the work accomplished in the field during the past summer, Mr. Faribault reports as follows:—

"In compliance with your letter of instructions, I left Ottawa on the 11th of June to complete the mapping and study of the structural geology of the gold-bearing belt lying to the east of Halifax, in order to prepare for publication the map-sheets covering that area, and to make special plans of the principal gold districts not already surveyed in that region.

Assistants.

"I was again assisted in the field, during the season, by Messrs. A. Cameron and J. McG. Cruickshank, who have been my assistants continuously since 1885 and 1887, respectively. I have to thank many gentlemen for information, assistance and hospitality, and I wish to mention especially Messrs. Edwin Gilpin, Inspector of Mines, and T. R. Gue of Halifax, A. A. Hayward and D. C. Wilson of Waverley, G. J. Partington and John H. Anderson of Musquodoboit Harbour, and J. H. Townsend and John Murphy of Tangier.

Re-examination of country east and north of Halifax.

"Doubtful points to the east and north of Halifax, have been re-examined and some of the anticlinal folds and boundaries of the black slate belts have been located with more accuracy, in order to determine the most important faults.

"The Montague anticline was traced westward to Brady's farm on the Waverley road, to the west of which it is cut by an important fault running north through the Waverley chain of lakes. The fault has shoved the Montague anticline 7000 feet to the north, two-thirds of the way up the west side of Lake Charles, where it was located and

traced westward about Taylor's Lake and to Navy Island in Bedford Basin, where it appears to form a broad dome with an east and a west pitch, characteristic of a gold-district. Rich float quartz was discovered last year along this anticline in the cuttings of the Dartmouth Railway Branch, north of Burnside, and a large block of areas has been taken up under lease or prospecting licenses.

Gold at Burnside on dome of Montague anticline.

Faults.

"An important fault has been located at the head of Porters Lake, and traced north-east through Dollar Lake; and another parallel fault was determined one mile south-east of Oldham and traced to Soldier Lake.

Auriferous veins at Karney Lake.

"An anticlinal fold runs N. 28° W. (*mag.*) along the middle of Karney Lake and forms a broad elliptical dome extending north from the outlet of the lake to the Hammond Plains road. Several corrugated interbedded veins have been observed along this belt and gold is reported to have been found on the east side of the lake.

Auriferous veins on domes of the Horne settlement anticline.

"A dome with all the characteristics of a gold district was also located on the Horne settlement anticline, crossing the middle of Shubenacadie Grand Lake. The eastern end of the dome crosses the south-east shore of the lake half a mile north of the outlet, where a belt of auriferous veins has been prospected on the north dip. Further investigations should be made here, south of the old works and nearer the anticline. The west end of this dome skirts the north-west shore of the lake as far west as Rocky Brook, where auriferous drift is reported to have been found up the Rocky and King's Meadow brooks; thence it was traced along Sandy Lake and as far west as Joe. Shannaman's farm on the Beaver Bank road. No exposure was found at Indian Point on the Shubenacadie Grand Lake, but the centre of the dome certainly comes near this point, which should be a good field for prospecting. Another dome was located further west on this anticline, along the south shore of Pockwock Lake where quartz was observed at several places. The rocks are greatly altered here by the eastern end of the main granite area forming the backbone of the western part of the province, and only a few exposures of rock could be observed, not sufficient to make out the structure of the dome.

Gold-districts surveyed.

"Special detailed surveys were made, and plans partly completed, of the gold-districts of Waverley, Montague, Lawrencetown, Lake Catcha, Tangier and Cow Bay in the county of Halifax.

Waverley gold-district.

"*Waverley Gold District.*—Three weeks were spent surveying this interesting and important district and a plan on the scale of 250 feet to one inch was plotted in the field. The auriferous quartz veins, which have been worked from time to time since the first discovery of

gold in 1861, are all interbedded between layers of 'whin' and slate on the crown of a huge anticlinal fold. The general course of the fold is N. 80° E. (*mag.*),* and its axis pitches westward at an angle varying from 10° to 35° from the horizon, while one leg dips south, angle 25° ,and the other north, angle 70°. Extensive denudation has worn away and truncated this enormous fold to a depth of over 12,000 feet, exposing a horizontal section of strata and intercalated auriferous veins which were formed 7000 feet below the base of the black slate group. The veins conforming with the strata, their outcrops have also a semi-elliptical shape, pointing westward and dipping north, west and south, like the saddle of the fold.

Faults.

"The fault referred to above as following the Waverley chain of lakes, has greatly disturbed this anticlinal fold. The main dislocation runs up Lake William and Lake Thomas and passes immediately west of the short run uniting these two lakes. It causes a horizontal displacement of some 800 feet to the south on the east side of the fault. The west fault runs up by the railway station and through Muddy Pond, and has been ascertained by Mr. A. A. Hayward, in the underground developments of the Lake View Mine, to give a shove of 118 feet to the south on the east side, and to dip east at an angle of 40°. Another line of disturbance was also located by surface trenching on the same property at the south-west cove of Lake Thomas, but the displacement does not appear to be extensive.

Pay-zone 600 feet wide.

"The high dip of the north side of the fold being more favourable to the formation of large and permanent auriferous veins than the low dip of the south side, all the most valuable veins are found on that side. As far as present operations indicate, the pay-zone attains its maximum development immediately north of the anticline on the West Waverley and Lake View properties, where it is over 600 feet wide, and has been worked for a length of 7000 feet. Several leads have been operated along this pay-zone, to depths varying between 200 and 350 feet, on the above properties, and most of them have given good returns to that depth, while a few, especially the most northerly, were found to decrease in size and value. A shaft sunk 628 feet on the dip of the Dominion lead, showed the vein to decrease from fifteen inches on the surface to a mere film of quartz with small lenticular pockets at the depth of 500 feet. A close study of the structure of the anticlinal fold shows that this diminution of the veins in size and value in depth is attained when the northern limit of the pay-zone is reached. In this district, the axis-plane of the fold forms the southern

Workable portions of veins limited to the pay-zone.

Axis-plane forms the southern limit of the pay-zone.

* The magnetic variation in this part of Nova Scotia is about 21° 30′ E.

limit of the pay-zone and it dips south at an angle of 69° from the horizon, while the interbedded veins dip to the north at an angle averaging 70°, giving a diverging angle of 41° between the two planes; so that a cross-cut driven south from the bottom of the 628-foot shaft on the Dominion lead would reach the anticlinal axis at some 650 feet and should develop a large belt of veins in the auriferous zone, many of which do not crop at the surface. A cross-tunnel driven south from the 360-foot shaft on No. 6 lead, on the Lake View property, would likewise develop a belt of auriferous veins in the richest part of the pay-zone. On the West Waverley property, at the depth of 225 feet, a cross-tunnel was driven south 641 feet from the Brody lead to the anticline, cutting ten leads, two of which do not crop at the present surface.

Developments.

"A considerable length of this auriferous-zone is still undeveloped, between the Lake View mine and the Laidlaw Hill property at the east end of the district, the disturbed condition of the strata having hindered, to some degree, any important operations.

Rich "Barrel-quartz" vein worked on anticlinal dome.

"A valuable and interesting 'barrel-quartz' vein, was worked extensively some years ago around the crown of the anticlinal dome on Laidlaw Hill. It was operated as deep as could possibly be expected from individual effort and gave very good returns. A company has lately consolidated these small properties, has driven a tunnel 670 feet long from the level of Lake Charles, cutting the barrel-quartz vein at the apex of the saddle, along which levels have been driven around the dome, 434 feet on its north dip and 238 feet on its south dip. The present developments prove the auriferous value of the vein to that level and for some distance lower, and show that the pay-zone at the extreme east end of the district is confined to the arch-core of the fold, upon which other auriferous veins certainly occur to much greater depth.

Arch-core of fold should be developed.

Yield.

"The total yield of the Waverley gold-district, taken from Dr. Gilpin's report on the 'Ores of Nova Scotia' published this year by the Department of Mines of the province, is, up to date, 61,308 ounces, from 122,346 tons of quartz, valued at $1,200,000, or an average of $9.81 per ton.

Montague gold-district.

"*Montague Gold District.*—Two weeks were spent in a survey of this important district, and a plan on the scale of 250 feet to an inch was partly completed in the field. All the veins operated in the district follow the stratification in the same manner as at Waverley, and are situated along an anticlinal fold that runs N. 78° E., and pitches east at an angle of 8°, on area 781 of the original block, and to the west at a very low angle, at the north end of area 951 in the same block,

forming a long and narrow elliptical dome. The strata lie at a low angle for some distance on both sides of the saddle, the dip increasing gradually till it meets the perpendicular 1000 feet south of the axis, and reaches 70° at a distance of 1250 feet to the north of it, the axis-plane of the fold dipping north at an angle of about 80°.

Pay-zone 500 feet south of axis.

"As far as present developments indicate, all the more important veins are found on the south dip, where they form, at the middle of the district, a pay-zone about 600 feet wide, the northern limit of which is about 500 feet south of the axis. The plan of the district is not sufficiently completed yet to report conclusively on it. A few words, however, may be said of the important pay-streaks which have been worked so extensively on the Lawson lead to a depth of 313 feet, on the Annand lead 250 feet with a trial shaft 400 feet deep, on the Twin lead 150 feet, and on the Rose lead to a depth of 270 feet with a shaft 388 feet deep. These rich pay-streaks are situated along an imaginary line running almost parallel with the anticlinal axis and they are characterized by enlargements and enrichments of the veins dipping to the west at low angles. Although there is reason to believe that the limit of the pay-zone has not been reached on the above mentioned leads, at the depths to which they have been worked, it is probable that in some of them the limit of the high-grade ore is near at hand. For the zone of rich streaks appears to be narrow, and as it is parallel with the axis-plane, it dips to the north at an angle of 80°, whereas the dip of the veins is to the south, angle about 80°, so that the two planes would give a diverging angle of 20°, and so limiting the length of the pay-streaks on individual veins. Thus, to keep in the pay-zone it becomes necessary to cross-cut north when the limit of the pay-streaks has been reached, and new veins will in this way be developed which might be barren or wanting on the surface.

Richest pay-streaks limited within a narrow zone.

Developments on the Golden Group and Symonds-Kaye properties.

"The Golden Group Company, has lately acquired the Lawson, DeWolf and Rose properties; the plant and mill have been remodelled to handle with economy large quantities of ore; and, if the developments are carried on in the direction outlined above and the auriferous zone is systematically blocked out, there is every reason to believe that the large returns obtained in former years will again be realized, and a new system will be inaugurated which may do much to solve the problem of deep and permanent gold mining in Nova Scotia.

"Important leads are also being operated on the old Symonds-Kaye property at the south-west end of the district, which is characterized by angular veins intersecting the interstratified veins and giving rise to rich pay-chutes at their junctions. The undeveloped ground on the

northern part of this property and immediately west of the Lawson, is certainly promising and should be prospected.

"A few veins have been opened on the north side of the anticline, but developments have not yet been sufficient to locate the pay-zone; the field is, however, promising.

Faults.

"No fault of any importance has disturbed the structure of the fold. One cutting the strata at right angle on the south dip, opposite the middle of the dome, gives a maximum displacement of forty feet, measured horizontally at the Lawson lead, and a few parallel slide-faults have been met with in the workings of the Skerry, Rose and other leads. Their outcrops almost coincide with that of the strata and they dip south at low angles, the top part having moved upward and northward.

Yield.

"The total yield of the district to date is 39,071 ounces, valued at $742,349, from 22,652 tons of quartz, or an average of $32.77 per ton, the highest average of any district in the province.

Lawrencetown gold-district.

"*Lawrencetown Gold District.*—Two weeks were employed surveying this district and a plan on the scale of 500 feet to one inch was partly completed in the field. All the auriferous quartz veins developed some years ago but not worked lately, belong, as in the above two districts, to the interbedded class and are included in an area nearly half a mile wide and over one mile long. The remarkable width of auriferous ground, is due to the presence of two anticlinal folds, converging as they approach this district from the east. The immense strain and pressure accompanying the meeting of these two folds have developed, as at the Moose River district, fissures along the bedding planes which have eventually been filled by segregation, producing the auriferous veins which have been brought to view afterwards by extensive denudation and are now being worked.

Auriferous ground of remarkable width.

Two anticlinal folds.

"The anticlinal folds have a general east-and-west course and are 1800 feet apart at the foot of Echo Lake. The most northerly crosses the lake 1600 feet north of the Mill stream outlet and the other crosses that stream 200 feet below the outlet. The syncline between these two anticlines runs down Echo River to the dam, coalescing towards the west with the southern anticline and terminating on the Shanghai property. All the openings on the east bank of Partridge River are situated on the opposite sides of this syncline, while on the Shanghai property they are on the north limb of the syncline, with the exception of those at the western end of the Bennett lead, which are on the south dip of the southern anticline. The operations along this double fold have established the presence of

a rich pay-zone, which will certainly prove valuable when systematically developed with a proper knowledge of the structure of the strata. As depth is attained on the Wadlow belt, cross-cutting north will have to be done, to keep to the north of the synclinal trough and new veins will then be developed in a promising part of the pay-zone. Developments of rich narrow pay-zone on Shanghai property.

"Several veins have also been worked for a distance of 2000 feet to the south of the double fold, some of which have given streaks of very high-grade ore; but none of them have been worked to any depth.

"A few small veins have also been tested on the north side of the north anticline, but heavy drift has prevented prospecting along this promising axis.

"One main fault has been located running down Partridge River in a south-east direction to the Lawrencetown Lake, with a horizontal shove to the south of some 200 feet, on the east side of the line; and two other right-hand faults were established to the west, parallel with it, with displacements of about 90 and 17 feet respectively. Faults.

"*Lake Catcha Gold District.*—Two weeks were devoted to a detailed survey of this district, discovered some twenty years ago, and a plan on the scale of 250 feet to an inch is in progress. All the more important veins operated belong to the interbedded class of fissure-veins and are situated on the north side of a broad anticlinal fold. The general course of the fold is N. 74° E. (*mag.*) It pitches to the east at an angle of 25° and to the west at a low angle, forming a long elliptical dome. The strata on the south side of the axis dip south at a low angle, increasing gradually to 45° at a distance of 500 feet to the south of it. The structure on the south dip does not appears to be favourable for the development of quartz veins. On the north side the dip increases more rapidly and reaches 80° at a distance of 500 feet. In the folding, the strata have been subjected to greater pressure on the north dip, producing fault-fissures along the bedding planes into which important auriferous veins have been segregated. Some of these veins, like the Coleman, Mill and Iron leads, have been traced for a length of over one mile. The greatest depth yet attained in the workings is 225 feet on the Mill lead at the Oxford mine. Rich streaks have, however, been worked on several veins along their outcrops, notably on the Coleman, Mill and Battery leads on the Oxford property, and on the Lake and Sheba leads on the John H. Anderson property. The late J. M. Reid, while in charge of the Oxford mine, kept many records and plans of the underground workings which should prove very valuable in directing further developments. He established three well defined rolls or pay-streaks in the works of the Coleman lead, lying under one another in undulations dipping at Lake Catcha gold-district. Extent of veins. Pay-streaks.

low angles in the plane of the vein. Some of these have not yet been worked out and it would be desirable to sink deeper to find out if other rolls exist beneath.

Zone of pay-ground.

"In looking over the plan of the district, we find that most of the best streaks on the Coleman, Mill, Battery, Lake and Sheba leads are situated along a well-defined zone. This zone leaves the anticlinal axis at the west end of the district, where rich drift has been discovered north-west of the Petite Mare bridge, on the Cogswell areas, and from there it runs N. 60° E. It therefore intersects the veins at an angle of 14°, until at the east end of the district it is found 1400 feet to the north of the axis. Much good ground is still undeveloped on the surface along this zone, on the Oxford, Anderson and Cogswell properties. In pushing the development work to greater depth, the dip of the pay-zone must be taken into consideration. The axis-plane of the fold dips to the south at an angle of 75°, and it is most probable that the pay-zone has the same dip to the south, so that cross-cutting south has to be done in this district, as depth is attained.

Direction of developments.

Auriferous fissure-veins.

"Two interesting auriferous fissure-veins are being developed in the district; one, the Cooper vein, occurs 3000 feet north of the anticline at the north-west end of the district and cuts the stratification in a north-east direction in the manner of an 'angular,' following a layer of slate for a short distance eastward, then cuts across a certain thickness of strata to another layer of slate which it follows to leave it again, and so on. It varies much in size, reaching four feet in places, and appears to show gold and sulphides more freely along certain belts of slate. The other fissure-vein, the Cogswell 'angular,' also cuts the stratification in a north-east direction, at the east end of the pay-zone, and it is more auriferous at its intersections with interbedded veins.

Faults.

"Several faults cut across the stratification and produce important displacements of the veins, often interfering with the progress of operations, but most of them have been accurately established by skilful developments. The most important is a right-hand fault on the Anderson property, running north-west and dipping south-west at an angle of 20°. The others are all high-angle breaks under forty feet, the eastern ones being left-hand breaks and the western ones right-hand breaks. However, there appears to be another prominent right-hand fault at the west end of the district, following La Petite Mare brook, the course of which is about N. 25°E., not yet exactly established, but important on account of the rich drift found on the undeveloped areas lying to the west of it. Total yield to October 1898 is 23,153 oz. of gold from 21,140 tons of quartz.

" *Tangier Gold District.*—Eighteen days were devoted to a survey of this district, one of the first discovered and most important in the province, and a plan on the scale of 200 feet to an inch is in course of preparation. All the veins operated belong to the interbedded class of fissure veins, and occur along the axis of the anticlinal fold furthest south on the Atlantic coast. This fold is the western prolongation of that passing through the gold districts of Harrigan Cove, Moosehead and Ecum Secum ; it has a general east-and-west (*mag.*) course, forms a long narrow elliptical dome and pitches to the east and west at angles under 15°. It dips to the north and south at angles reaching 70° on both sides, giving a perpendicular dip to the axis-plane.

Tangier gold-district.

" Auriferous veins have been developed extensively for a length of over two miles along this fold, the most important operations being confined to the veins on the south dip, along a narrow and well-defined pay-zone. This pay-zone touches the anticlinal axis at the centre of the dome, a couple of areas east of the original Free-claim area, where it has a width of some 200 feet, comprising the rich pay-streaks worked on the Big-south, Little-south, and Nugget leads to depths of 100 to 150 feet. From the centre of the dome the pay-zone runs east and west, keeping a few degrees to the south of the course of the anticlinal axis, and intersects the various leads at a slight angle, creating enlargements and enrichments on the veins which have successively been worked towards the west on the Nigger, Butler, Blue, Leary, Lake, Tennant, Field and Bingay leads, and towards the east on the Little-south, Nugget or Kent, Twin or Dunbrack, Forrest and Wallace leads.

Pay-zone well defined, but narrow.

" A few of these leads have been worked along their outcrops for nearly half a mile, but the greatest depths attained so far, are, only 240 feet on the Forrest, 160 feet on the Nugget and Leary, 140 feet on the Big-south, and 130 feet on the Little-south and Field leads. Most of these veins can certainly be successfully worked to greater depths. Still the pay-zone does not appear to have a great width, being only 200 feet wide at the centre and not much wider to the east and west, and, as its dip is about vertical and the veins dip between 55° and 65° to the south, the southern limit of the pay-ground will be reached at no great depth, especially on the southerly veins. Cross-cutting north will then have to be done to keep in the pay-zone, and new veins will thus be developed at their richest parts to great depths.

Developments should follow the pay-zone.

" Most of the district was formerly held in small areas and operated by private individuals with limited means, but it has recently been consolidated under the management of one company, and we may look

Cross-cutting to the north.

now for larger and more permanent operations. The attention of this company might be directed to the desirability of making developments by cross-cutting north from the deeper shafts on the Big-south, Little-south and Nugget leads in the vicinity of the Free-claim area. Likewise, cross-cutting north should be done from the deeper shafts on the Forrest lead on Strawberry Hill property. The Free-claim area may be mentioned as one of the most promising locations for a deep vertical shaft with a system of cross-cuts and levels, as it would develop veins which do not crop to the surface, in one of the richest part of the pay-zone.

Vertical shaft on Free-claim area.

"Very rich drift found south of the Essex mill has not yet been traced to its source. It should be looked for along the pay-zone to the north of the Dunbrack lead.

"Only a few veins have so far been opened on the north dip, and none to any extent, but those immediately north of the axis at the centre of the dome, near the Free-claim area, are certainly very promising.

Faults.

"The structure of the anticlinal fold of this district has been more disturbed than that of any other in the province, by two important series of small faults which have a general north-west and south-east direction, and all dip at high angles. The eastern dislocation occurs on Strawberry Hill and is composed of a series of right-hand faults with horizontal shoves ranging from 76 feet down to a few feet, giving a total displacement of some 280 feet. The extensive operations made on the Forrest lead, have determined exactly the horizontal thrusts of every one of these breaks; but many rich pay-chutes, dipping west at angles of about 45°, have been lost by these faults and might yet be recovered by determining the extent of the upthrows.

"The western dislocation is composed of a series of left-hand faults beginning at the Essex mill, with horizontal displacements along a north-west and south-east course varying from a few feet up to 150 feet, and giving a total displacement of 470 feet. All these faults have been exactly determined by the important surface developments made by John Murphy and the late A. M. Barton, in their endeavour to locate leads to the west of the Essex mill, the drift of which was found very rich along the main road. The block of strata comprised between these two main dislocations has been thrust to the north by lateral pressure and contains the above mentioned promising veins not yet developed, which should be looked for along the pay-zone passing north of the Dunbrack lead.

Diorite dyke.

"A dyke of diorite, 40 feet wide, the only one known in the gold districts of the province, cuts the strata and auriferous veins at right

angles on Strawberry Hill and has been traced in a straight line for two miles to Grum Point on the sea-shore. The dyke does not affect the richness or size of the veins and does not appear to be auriferous. It has, however, altered the adjacent rock for a short distance on each side of it.

"The total returns of the district, including the Mooseland mines situated on the next anticline to the north, are, up to date 20,491 ounces, valued at $721,183, from 43,092 tons of quartz. Yield.

"*Cow Bay Gold District.*—A hurried survey of this district has been made, but the plan is not yet plotted. Cow Bay gold-district.

"All the veins developed here are true fissure-veins running north-and-south and cutting the stratification at right angles with a vertical dip. A great number of them have already been opened, for a width of nearly four miles across the point of land stretching between the Eastern Passage of Halifax Harbour and Cole Harbour, and a few have been traced for over one thousand feet along their course, but none have yet been worked to any extent. The present developments prove that all these fissure-veins are more auriferous along a certain part of their course, corresponding with the crossing of a highly mineralized belt of gray felspathic quartzite about 100 feet wide, situated at the contact of the upper-slate group with the underlying whin group. Some layers are so heavily charged with specks of magnetic pyrites as to affect the needle of the compass. The strata of this mineralized belt dip to the south at an angle of 35° from the horizon, and the pay-chutes of the veins will necessarily dip to the south at the same low angle and ought to be developed on that incline to great depth. No doubt many of the failures met with in the present operations are due to the ignorance of this important fact." Fissure veins. Richness of veins affected by adjacent rocks.

CHEMISTRY AND MINERALOGY.

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

"1. Analyses of fuels—including lignite, lignitic coal, and coal. Analyses and assays.

"2. Analyses of natural waters—with the object of ascertaining their suitability for domestic or manufacturing purposes, or probable value as remedial agents—from various localities in the provinces of Quebec, Ontario and British Columbia, as also in the North-west Territory.

Analyses and assays.

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

"4. Analyses of iron ores, including magnetites and hæmatites, from certain localities in the provinces of Quebec and Nova Scotia.

"5. Analyses, in regard to nickel content, of certain ores from the provinces of Quebec, Ontario and British Columbia.

"6. Analyses of rocks from certain localities in the provinces of Quebec, Ontario and British Columbia.

"7. Analyses of several highly interesting minerals, some of which were not previously known to occur in Canada—amongst them, polycrase, a hydrous niobate and titanate of yttrium, erbium, cerium, and uranium; and others which, from a commercial standpoint, are of economic importance, as for example—wolframite, a tungstate of iron and manganese, a mineral not hitherto met with, in situ, in Canada, which has been found distributed through a quartz vein in Inverness County, Nova Scotia; 'natural soda,' which has been met with in considerable abundance in certain small shallow lakes—the deposit in one of which is estimated to represent, at present, some twenty thousand tons, not very far north of Clinton, Lillooet district, British Columbia; and an earthy variety of magnesite, the sender of which stated that it had been represented to him as having been found in considerable quantity, forming two distinct deposits, about forty miles from Quesnel Forks, Cariboo district, British Columbia—an occurrence which would appear to the writer to need further confirmation.

"8. Assays, for gold and silver, of ores from the provinces of Nova Scotia, New Brunswick, Quebec, Ontario and British Columbia, as likewise from the North-west Territory.

"9. Miscellaneous examinations, such as the examination, and, in many instances, partial analysis, of samples of bog manganese, iron ochre, iron sand, disseminated graphite, carbonaceous shale, marl, clay, and other material not included under the above headings.

Minerals examined.

"The number of mineral specimens received for examination amounted to eight hundred and sixty-one. Of these, very many were brought by visitors, who obtained the desired information in regard to them at the time of their visit, or failing that—owing to a more than mere cursory examination being necessary, or when a partial or even a complete analysis was considered desirable—it was subsequently conveyed to them by letter. The number of letters personally written

—chiefly of the nature of reports, and embodying the results of the examination, analysis or assay, as the case might be, of mineral specimens—amounted to two hundred and sixty-three; and of those received, to one hundred and twenty-three.

Work of assistants.

"Messrs. R. A. A. Johnston and F. G. Wait, assistants in the laboratory, have applied themselves with great assiduity to the work in hand, and as a result, accomplished a large amount of work, thereby rendering excellent service. The former has, apart from the carrying out of a large number of gold and silver assays, made many important mineral analyses, and likewise conducted a great variety of miscellaneous examinations; whilst the latter, in addition to numerous water-analyses, and others, of a more or less partial nature, of iron ores, manganese ores, and the like, has also conducted many miscellaneous examinations.

Museum work.

"In the work connected with the mineralogical section of the museum I have been very ably assisted by Mr. R. L. Broadbent. He has, in addition to the general museum work—such as the labelling and cataloguing of all newly received specimens, and the maintenance of the collection generally in an orderly condition—also arranged and catalogued the collection of rocks, consisting of some seven thousand specimens, contained in the drawers under the table-cases, and placed away a further thousand specimens, for which no room could be found in the drawers, in the annex to the Survey.

Contributions to museum.

"The additions to this section of the museum—which now contains over seven thousand specimens on exhibition—during the past year, amounted to one hundred and ten. Of these the following were :—

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

Adams, Dr. F. D. :—

a. Phlogopite, from the townships of Monmouth and Cardiff, Haliburton county, O.

b. Corundum, from the township of Methuen, Peterborough county, O.

c. Graphite, from the township of Monmouth, Haliburton county, O.

d. Molybdenite, from the township of Harcourt, Haliburton county, O.

Ami, Dr. H. M. :—

a. Limestone, from McLean's quarry, Lime Brook, Springville, Pictou county, N.S.

b. Sand, from Britannia Bay, Ottawa River, Carleton county, O.

c. Hematite, from Grand Pré, Kings county, N.S.

Contributions to museum—*Cont.*

Bailey, Professor L. W. :—

a. Manganiferous siderite, from Peabody farm, 2 miles south of Woodstock, Carleton county, N.B.

b. Chalcopyrite and pyrite, from Bull Creek, 3 miles below Woodstock, Carleton county, N.B.

c. Pyrite, galena and chalcopyrite, from Woodstock, Carleton county, N.B.

d. Coal, from Sandstone quarries, Clifton, Gloucester county, N.B.

e. Quartz, from Greer Creek, west bank of the St. John River, nearly opposite the mouth of Eel River, St. John county. N.B.

f. Briquettes of manganese, from Dawson Settlement, Albert county, N.B.

g. Sandstone, from Rockport, Westmoreland county, N.B.

h. Sand, from Lake Utopia, Charlotte county, N.B.

i. Conglomerate, from Turtle Creek, Albert county, N.B.

j. Bituminous shale, from Baltimore, Albert county, N.B.

k. Ferruginous clay, from Hopewell Cape, Albert county, N.B.

l. Silt, from Black's Harbour, St. George, Charlotte county, N.B.

m. Pyrrhotite, from St. Stephen, Charlotte county, N.B.

Barlow, A. E. :—

a. Quartz, orthoclase, and albite, from the township of Wicklow, Hastings county, O.

b. Mica, from the township of Dungannon, Hastings county, O.

c. Quartz crystals (red), from the township of Mayo, Hastings county, O.

Dawson, Dr. G. M. :—

a. Sandstone (Laramie), from Edworthy's quarry, Bow River, about four miles above Calgary, district of Alberta, N.W.T.

b. Magnetite, from the Pot-hook mine, near Sugar-loaf Hill, Yale district, B.C.

Ells, Dr. R. W. :—

a. Pyrite, from the township of Lanark, Renfrew county, O.

b. Phlogopite, from the township of Wright, Ottawa county, Q.

Faribault, E. R. :—

a. Limestone, from Goat Lake, Chester, Lunenburg county, N.S.

b. Limestone, from Indian Point, Lunenburg county, N.S.

McEvoy, J. :—

a. Native sulphur, from three miles above Jasper Lake, district of Alberta, N.W.T.

b. Cyanite and beryl, from the mica mine seven miles south of Tête Jaune Cache, Fraser River, B.C. Contributions to museum—*Cont.*

c. Cyanite, from mountain south of Camp River, Canoe River, B.C.

Willimott, C. W.—See beyond.

(B.) *Received as presentations :—*

Ade, Wm., Ottawa, O. :—
Dolomitic limestone, Ottawa.

Bostock, H., M.P., Monte Creek Ranch, Ducks, B.C. :—
a. Chalcocite, bornite and native copper, from the Pot-hook claim, 1¼ mile north-west of Sugar-loaf Hill, Kamloops, B.C.
b. Concretionary limestone. from Wardner, Yale district, B.C.

Bousfield, Rev. Geo., Billings Bridge, O. :—
Bog iron ore, from the township of Marlborough, Carleton county, O.

Constantine, Inspector C., N.W.M.P. :—
a. Gold nugget, from Eldorado Creek, Klondike River, Yukon district, N.W.T.
b. Auriferous gravel, from Eldorado Creek, Klondike River, Yukon district, N.W.T.
c. Fragment of mammoth-tooth with embedded gold nugget, from Eldorado Creek, Klondike River, Yukon district, N.W.T.

Donaldson, Morley, Canada Atlantic Ry., Ottawa, O. :—
a. Sand, from head of Round Lake, 12 miles from Killaloe, Renfrew county, O.
b. Sand, from foot of Round Lake.
c. Sand, from the Ottawa River, about seven miles below Ottawa City.

Doucet, M. J., Grand Etang, N.S. :—
Chalcopyrite, from Cape Rouge, five miles north of Cheticamp, Inverness county, N.S.

Douglas, Captain Bloomfield, R.N.R. :—
Garnets in mica-schist from St. Paul Island, Gulf of St. Lawrence.

Ferrier, W. F., B. Ap. Sc., Rossland, B.C. :—
a. Apophyllite, from the 600-foot level, LeRoi mine, Rossland, B.C.
b. Pyrite in quartz, from the Sunset claim, near Nelson, West Kootenay district, B.C.

Contributions to museum—*Cont.*

c Quartz with tourmaline and pyroxene, from cutting on Slocan River Railway, between Slocan Crossing and Slocan Lake, West Kootenay district, B.C.

d. Gahnite (zinc spinel) in corundum, from the township of Raglan, Renfrew county, O.

Gibson, R. H., Manitowaning, O. :—
Petroleum, from Manitoulin Island, Ont.

Latimer, F. H., Vernon, B.C. :—
Auriferous quartz, from the Falcon claim, near Vernon, B.C.

Leonard, R. W., Ottawa, O. :—

a. Disseminated graphite, from twelve miles west of Kazabazua, Ottawa county, Q.

b. Calcite, apatite, mica and fluorite, from Cobden, Renfrew county, O.

McCarty, P., Calgary, N.W.T. :—

a. Chalcopyrite, from between the head-waters of Cascade and Johnson Creeks, district of Alberta, N.W.T.

b. Galena, from Castle Mountain, near Eldon station, C. P. Ry., district of Alberta, N.W.T.

c. Sphalerite with pyrite, in quartz, from Storm Mountain, Rocky Mountains, district of Alberta, N.W.T.

McDougall & Secord, Messrs., Edmonton, N.W.T., per J. McEvoy, (Survey) :—
Pyrite, from Buffalo River, Great Slave Lake, N.W.T.

McGown Mining Company, Parry Sound, O., per Geo. Burn, Manager Bank of Ottawa :—
Bornite, native gold, and galena, from the McGown Mining Co's. property, township of Foley, district of Parry Sound, O.

McGregor, Robert, Calabogie, O. :—
Sand, from Calabogie Lake, township of Bagot, Renfrew county, O.

McKillip, A. T., per W. F. Ferrier, Rossland, B.C. :—
Cerussite, from Whitewater, Kaslo-Slocan Ry., West Kootenay district, B.C.

McLellan, Allan, Ottawa, O. :—
Chalcopyrite, from the township of Mayo, Hastings county, O.

Moxley, J. E., Ottawa, O. :—
Clay concretions, from Priest Creek, township of Portland East, Ottawa county, Q.

Contributions to museum—*Cont.*

Nordenskjöld, Baron A. E., Sweden :—
Fragment of core from boring.

Rutledge, J., Ottawa, O. :—
Three crystals of phlogopite from the township of Masham, Ottawa county, Q.

Sorette, H., Bridgewater, N.S. :—
Mica-diorite, from Welsford, Queens county, N.S.

Stewart, J., Grande Prairie, B.C. :—
Chalcopyrite, from the Key claim, Grande Prairie, Yale district, B.C.

Summers, B., St. Thomas, O., per L. M. Lambe (Survey) :—
Columnar limestone, from Springbank, St. Catharines, Lincoln county, O.

Taschereau, Fortier, St. François, Beauce Co., Q. :—
Grey granite, from St. François Nord-est, Beauce county, Q.

Tisdale, Col., M.P., Simcoe, O. :—
Auriferous quartz, from Michipicoten, district of Algoma, O.

Tunstall, J. C., Vernon, B.C. :—
Auriferous quartz, from the Cariboo mine, Camp McKinney, Osoyoos mining division, B.C.

Walker, Major J., Calgary, N.W. T. :—
a. Bornite, from deposit at head of Panther River, district of Alberta, N.W.T.
b. Chalcocite, from Castle Mountain, near Eldon station, C.P.Ry., district of Alberta, N.W.T.
c. Chalcocite, from between head-water of Cascades and Johnson Creeks, district of Alberta, N.W.T.
d. Chalcocite and galena, in quartz, from Ice River, about three miles from the head, S. W. side of valley, Rocky Mountains, B.C.
e. Muscovite, from about three miles up Ice River, Rocky Mountains, B.C.

Whyte, Wm., General Supt., Western div., C.P.R., Winnipeg :—
Sandstone, from C.P.R. quarry, about three miles west of Calgary, district of Alberta, N.W.T.

Winning, B., per Wm. McInnes (Survey) :—
Auriferous quartz, from Bad Vermilion Lake, Seine River, district of Rainy River, O.

Willimott, C. W., Ottawa, O. :—
Six twin crystals of sphene from the township of Litchfield, Pontiac county, Q.

Contributions to museum—*Cont.*

Willimott, R. R., Fort Steele, B.C. :—

Cerussite, from the North Star mine, Mark Creek, East Kootenay district, B.C.

Winter, S. & Co., Moncton, N.B. :—

Muscovite, from seven miles south of Tête Jaune Cache, Yale district, B.C.

Wood, Wentworth F., Kamloops, B.C. :—

a. Native copper, from the Pot-hook claim, one mile and a quarter north-west of Sugar-loaf Hill, B.C.

b. Chalcocite, from the Grey Eagle claim, two miles and a quarter west of Nesbitt on Meadow Creek, S.W. of Kamloops, B.C.

c. Chalcopyrite, from the Key claim, Grande Prairie, Yale district, B.C.

Educational collections supplied.

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

1.	Public School, Milton, Queens Co., N.S.	75 Sps.
2.	Toronto Church School, Toronto, Ont.	75 "
3.	High School, Brampton, Ont.	100 "
4.	" " Regina.	100 "
5.	St. Patrick's School, W. end, St. John, N.B.	75 "
6.	Waterloo Academy, Waterloo, Que.	75 "
7.	Brantford Young Ladies College, Brantford, Ont.	75 "
8.	Free Library, Brantford, Ont.	100 "
9.	Ecole St. Joseph, Montreal, Que.	75 "
10.	Public School, Souris, Man.	75 "
11.	Sussex School, Sussex, N.B.	75 "
12.	St. Patrick's Convent, Halifax, N.S.	75 "
13.	Public Library, Tweed, Ont.	75 "
14.	College St. Joseph, St. Ephrem d'Upton, Que.	75 "
15.	McAdam Superior School, McAdam Junction, N.B.	75 "
16.	High School, Watford, Ont.	100 "
17.	Public School, Milford, Hants Co., N.S.	75 "
18.	Department of Education, Toronto.	100 "
19.	University of Manitoba, Winnipeg, Man.	100 "
20.	High Commissioner's Office, London, Eng.	19 "
21.	Laval Business College, St. Vincent de Paul, Que.	4 "
22.	High Commissioner's Office, London, Eng.	14 "
23.	Imperial Institute, London, Eng.	5 "
24.	High School, Leamington, Ont.	100 "
25.	Central School, Hamilton, Ont.	100 "
26.	Collegiate Institute, Stratford, Ont.	100 "
27.	Public School, Penobsquis, N.B.	75 "
28.	St. Anthony's Academy, Montreal.	75 "
		2,067 "

"He also made up a collection of the more important Canadian economic minerals, including building stones and marbles, for the Omaha Exhibition, and also other smaller collections of miscellaneous minerals for various foreign institutions.

Collections made by Mr. Willimott.

"Apart from this, he visited in the course of the summer—for the purpose of procuring further material for the making up of collections of the nature above referred to—the townships of Hull, Calumet, Litchfield, Maniwaki, Kensington and Egan, in the province of Quebec; and of Hawkesbury, Pakenham, Fitzroy, Renfrew, Hagarty and Calvin, in the province of Ontario.

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

	Specimens.	Weight.
Allanite	9	
Beryl, in the matrix	21	
Iron- and copper-pyrites	5	
Mica, crystals	5	
Molybdenite, in the matrix		800 pounds.
" free from gangue		37 "
Pyrrhotite		50 "
Scapolite, crystals	30	
Sphene, crystals	10	

"In addition to these he collected twenty or more mineral specimens from a coarse granite vein in the township of Calvin, among which were specimens of the xenotime—referred to in my last report, and an associated mineral which has been examined by Mr. R. A. A. Johnston and shown to be polycrase. He likewise collected some thirty specimens representing what may be referred to as the niccolite locality on Calumet Island. These include some fine specimens of niccolite (nickel arsenide), and representative specimens of the nickeliferous pyrrhotite there met with.

"The foregoing included some good cabinet specimens. These have been placed in the museum.

Quarries visited in Western Ontario.

"Mr. Willimott subsequently visited numerous localities in the Western Peninsula of Ontario for the purpose of collecting specimens of building stone, limestones employed for burning, and samples of the lime prepared from the latter; also of cements. He obtained :—

"In duplicate, fragments suitable for dressing into six inch cubes, of material employed for building purposes—of limestone from St. Marys; of dolomite from Beamsville, Thorold, Niagara, Galt, Guelph, Puslinch and Owen Sound; and sandstone from Caledon and Mono.

Samples of limestone employed for burning, and of the limes prepared from the same, from Ballantyne kilns, Galt; Kennedy's kilns and Toronto Lime Co's. kilns, Guelph; Slater's kilns, St. Marys; and Toronto Lime Co's. kilns at Limehouse and Nassagaweya. Specimens of raw cement stone, and cement prepared from the same, from Battle's works, Thorold; Usher's works, Niagara; and Toronto Lime Co's. works, Limehouse. Samples of clay, marl, and cement prepared from the same, from the Owen Sound Cement works, Shallow Lake; and of marl from Caledon; and of clay from Garafraxa.

"Whilst engaged in this last mentioned work he collected much useful information in regard to the quarries, etc. This he has embodied in the following notes:—

Notes made on quarries.

"On the 17th of October I started for Western Ontario to visit a number of quarries, lime kilns and cement works. Valuable information was in the first place obtained from contractors, stone masons and engineers in the cities of Toronto, Hamilton and St. Catharines, regarding their estimation of the more important building stones, limes and cements, the preponderance of stone used in each city and the sources from which the several materials come.

Beamsville quarries.

"The Beamsville quarries in Clinton may be considered one of the principal sources from which nearly all the stone for bridge work on the Grand Trunk Railway is obtained. At the time of my visit a large number of car-loads of dimension stone were awaiting shipment to the Victoria Bridge, Montreal. It is anticipated that 6000 yards of stone will be shipped from these quarries this year.

Queenstown.

"Queenston Quarries.—These quarries are situated on the Heights in the township of Niagara, and show a quarry face of about twenty-six feet, consisting of twelve feet of grayish dolomite underlaid by fourteen feet of bluish dolomite in beds of six inches to six feet. This stone has been used in the power house, Niagara Falls, several bridges and the Brock monument, and is shipped to Buffalo, London, Hamilton, St. Thomas, etc. The upper beds are of a warm gray colour and very fine-grained, they take a high polish, and are largely used for monumental purposes.

Cement works.

"Adjoining these quarries are the Queenston Cement Works—employing about thirty men. The cement-stone used lies immediately below the twenty-six feet of dolomite mentioned above, and has an average thickness of six feet, which has been excavated over an area of six acres. This stone is burned in four draw-kilns, each having a capacity of 350 barrels a day. The burnt stone is then carried by shoots to the crushers, then through chilled iron plates and buhr stones, and finally

bolted. At the time of my visit, about 6000 barrels of cement were in the storehouse. This company expect the output this year to be between 40,000 and 50,000 barrels. This cement has been used in Sault Ste. Marie and St. Lawrence canals, Grand Trunk and Michigan Central railways, and also to a considerable extent for local purposes.

Battle Cement Works. Thorold.

"The Battle Cement Works at Thorold are working on a nine-foot bed of cement-stone overlain by fourteen feet of dolomite. This stone is burned at the quarry in draw-kilns, then carted in wagons to their mill in the village, about one mile. This cement is employed apparently for local uses such as the construction of silos, floorings and plastering the walls of houses. About 4000 barrels will be the output this year—240 pounds net to the barrel.

Melrose quarry, Galt.

"At the Melrose Quarry, Galt, a small quantity of dimension stone is being extracted. The Ballantyne Lime Works, in the same township, have in operation four draw-kilns, each having a capacity of 300 bushels. The lime, which is very white, is largely in demand in Toronto, Kingston and Galt, the output from the works depending upon requirements.

Quarries at Guelph.

"The Priest's, and J. Kennedy's quarries are both in operation, the former belonging to the Toronto Lime Co. These stones belong to the Guelph formation and vary in texture and colour, according to the depth from which they are taken. In the Kennedy quarry, they are working on lower beds than in the Priest's quarry, that appear to be much tougher and coarser grained. These stones are used extensively in Guelph and the western cities, London, Goderich, etc. A large Catholic church in Guelph was built with stone from the Priest's quarry. The stone is largely used also for burning and four draw-kilns are in operation, each with capacity of 340 bushels. This lime is used in all towns and cities in the north and east, as well as in Toronto. The output is about 40,000 bushels a year.

Kennedy lime works.

"The Kennedy Lime Works in connection with their quarry have three draw-kilns in operation, each having a capacity of 300 bushels. The principal markets for this lime are Toronto, London, Goderich and Sarnia. The output this year will be about 40,000 bushels.

St. Marys.

At the Elliott quarry at St. Marys, about twenty-five feet of beds have been cut, the beds varying from two inches to one foot. A large number of beds suitable for flagging might be obtained from this quarry. This stone has been used in buildings in London and Stratford as well as locally.

Slater kilns.

"The Slater Lime Kilns, in the same town, have two draw-kilns in operation and ship largely to the western and northern markets. Their output this year will be about 60,000 bushels at 16 cents a bushel.

Cement works at Shallow Lake.

"The Owen Sound Portland Cement Works, at Shallow Lake in the township of Keppel—are situated in close proximity to an extensive marl swamp, which being underlaid by a blue clay, affords an admirable material for the compounding of their cement.

"This marl extends over 500 acres, and is underlain by five feet of blue clay. These two ingredients are mixed in certain proportions, then burned to a clinker, after which it is ground to an impalpable powder.

"These works which employ 150 men, have nine bottle-kilns in operation, each having a capacity of 300 bushels, consuming seven car-loads of coke and three car-loads of coal a week. At the time of my visit extensive operations were in progress in enlarging these works. This cement, known as the Samson brand, is used throughout Western Ontario and Manitoba and has been employed in the Trent Valley Canal, Sault Ste. Marie Canal, Departmental Buildings, Ottawa, etc. About 70,000 barrels will be the output this year, price $2.30 a barrel. A large number of testimonials are furnished by the company, from engineers and others all over Canada, many of whom claim that this cement is equal if not superior to any other.

Owen Sound quarry.

"The Owen Sound quarry, owned by D. Chalmers, is being worked by a small force of men, on an average four-foot bed of dolomite, which is largely used for bridge work; the Sault Ste. Marie bridge being built of this stone, as well as many others on the Canadian Pacific Railway. The underlying beds, which are very shaly, are considered only fit for burning.

Marl deposit.

"In the township of Caledon, between the third and fifth concessions, near the town-line of Garafraxa, it is claimed that a deposit of shell marl extends over 350 acres, to the depth of thirteen feet, overlain by 5 feet of peat. Adjoining this deposit in the township of Garafraxa is a bed of clay that has been tested to the depth of sixteen feet over an area of 20 acres. This property is owned by the Orangeville Cement Company, Orangeville.

Quarry at Orangeville.

"The Owen Sound Stone Company's quarry at Orangeville, in the township of Mono, is in operation with about twenty men employed. This stone is a grayish, fine-grained sandstone, occurring in beds from four to seven feet thick, overlain by four feet of limestone and fifteen feet of alluvial soil. Dimension stone seven by seven feet, and any length can be obtained. The output this year (1898), it is stated, will be about 20,000 cubic feet. This stone is sold in Toronto, Windsor, Chatham and London It has been used in the construction of the new City Hall, Toronto; also the Episcopal church at Listowel and

the Methodist church at Arthur, Ont. Mr. Isaac Nicholson who owns the property adjoining the above-described quarry, also takes out a small quantity of stone annually, for local use.

"The Limehouse Cement and Lime Works owned by the Toronto Lime Co., have three draw-kilns and eight set kilns in operation.

"The cement-stone has an average thickness of seven feet, overlain by twenty-five feet of dolomite, both varieties of stone being burned at the quarry, producing cement and lime used in Toronto and Western, Ontario.

Townships of Esquesing and Nassagaweya.

"In the township of Esquesing sandstone is quarried by Mr. Bate, and in Nassagaweya, by Mr. McGibbon. This latter quarry was hurriedly visited. In it, beds from three to thirty inches and having a depth of about twelve feet, are worked. This stone is principally suitable for sills and flagging. Some beds are spotted with iron oxide.

Lime-kiln.

"A lime-kiln belonging to the Toronto Lime Co. is also in operation in Nassagaweya. One of the two draw-kilns was at work at the time of my visit. The beds at this quarry average about four feet in thickness, having a total thickness of about fifty feet, but they are apparently very much shattered by high explosives. The product is largely used in the crushed state in making paving in Toronto. The lime made from this stone is very strong, of a grey colour, and is used in Toronto, Peterborough, London, St. Thomas, etc. The output this year will be about 60,000 bushels, priced at 10c. a bushel at kiln.

Caledon.

"In the township of Caledon, lot 1, concession 2, is a quarry known as Smeaton's quarry. The upper bed or brown-stone, (sandstone) is three feet six inches in thickness. Underlying this are two beds of gray stone, (sandstone) two feet six inches and one foot respectively. These stones are largely use for curbing and sills and have been extensively used in Toronto, Berlin, London, St. Thomas, Windsor, etc. The Parliament Buildings, New City Hall and Forester's Temple in Toronto, utilized quantities of this stone.

"The quarries and lime-kilns mentioned above comprise the more important workings on the line of travel actually followed, but much information has also been secured bearing upon adjoining quarries and workings which were not actually visited. Statistical details respecting these were also obtained, and notes on other works of the same kind, all of which have been handed over to the Section of Mineral Statistics and Mines.

SECTION OF MINERAL STATISTICS AND MINES.

Mr. E. D. Ingall, the officer in charge of the section, reports as follows :—

Mineral statistics.

"There is nothing new to report in regard to the work of the section, which was carried on along similar lines to those followed in former years. The preliminary Summary Statement of the Mineral Production of Canada for 1897, was completed by the 23rd of February of the current year, and issued shortly afterwards. The work of preparation of the detailed report on the Statistics and Technology of the Mining Industry for 1897 was proceeded with, and that report is now going through press.

"Besides the above matters, the time of the staff has been occupied by such general work as that of the preparation of memoranda, giving information to inquirers on a great variety of subjects regarding technical matters, relating to the economic minerals of the country. The routine work was prosecuted as far as time and means at command permitted, and some progress was made in the effort to obtain and keep posted to date our records regarding the mineral deposits, borings and mining developments, and to keep the same fyled away systematically for reference. The necessity for the keeping of such records is evident, but it involves continuous work and with the limited means at command, the end desired can be only partially attained. Apart from the time occupied in the general supervision of the work, and in connection with the preparation of the annual report, my own efforts were, during several months, directed towards the completion of the report on the iron deposits of the Kingston and Pembroke Railway district. This was brought almost to completion and will be finished as soon as the work of putting the annual report through the press is done with.

"Owing to the pressure of office work, no time was available for the prosecution of any field-work.

"We are indebted to Mr. J. D. Fraser, Ferrona Iron Works, for a valuable series of analyses of Nova Scotia iron ores published in the last report.

"Mr. A. A. Cole, senior assistant on the staff left, in January, and the vacancy thus caused was filled by Mr. Theo. Denis, in April. To these gentlemen and to Mr. J. McLeish are due thanks for their able assistance.

PALÆONTOLOGY AND ZOOLOGY.

Mr. Whiteaves submits the following summary of the palæontological and zoological work during the year 1898. Palæontology

"The MS. of the fifth and concluding part of the first volume of Contributions to Canadian Palæontology, which was commenced in 1897, was completed in June, 1898, and the part itself has since been published and distributed. It consists of 76 pages large octavo of letterpress, illustrated by three full page plates and five woodcuts. The letterpress is made up of two papers, with general title-page, letter of transmittal and index. The first of these papers is entitled 'On some additional or imperfectly understood fossils from the Hamilton formation of Ontario, with a revised list of the species therefrom,' and the second (which is an appendix to the whole volume), a 'Revision of the nomenclature of some of the species described or enumerated in previous parts of this volume, and additional notes on others, necessitated by the progress of palæontological research.' The preparation of these papers has led to a considerable correspondence with local collectors and with specialists in the United States and Great Britain. It has also instigated the presentation of several rare fossils to the museum. The specimens from Thedford and Bartlett's Mills lent by the U. S. National Museum, and referred to in the Summary Report of last year, have been returned, and the nomenclature of the species has been revised. Publications.

"The MS. of the fourth part of the first volume of 'Mesozoic Fossils' has been written, but needs a final revision before it will be ready for publication, and the drawings for its illustration have yet to be made. The part is intended to consist of an illustrated monograph on the (animal) fossils of the coal-bearing rocks of the Cretaceous system in the Queen Charlotte Islands (B.C.), based largely upon collections made by Dr. C. F. Newcombe in 1895 and 1897, but comprising also additional notes on the species collected by Mr. James Richardson in 1872 and by Dr. G. M. Dawson in 1878, with a revision of the nomenclature of this local fauna up to date.

"By permission of the Director, a paper entitled 'On some fossil Cephalopoda in the museum of the Geological Survey of Canada, with descriptions of eight species that appear to be new,' has been prepared and published in the Ottawa Naturalist for September, 1898. It is intended to republish this paper, with illustrations, in one of the Survey publications.

"The somewhat extensive collection of fossils from the Cambro-Silurian, Silurian, Devonian, Cretaceous and Laramie rocks of Manitoba Collections examined.

and the North-west Territories, belonging to the Provincial Museum at Winnipeg, which was sent to the writer last autumn for examination and identification, was named as far as practicable, during the summer, and returned. A few fossils also, have been named for Mr. F. W. Wilkins, of Norwood, Ontario.

"A preliminary study has been made of the fossils collected by Mr. J. B. Tyrrell from the Cambro-Silurian, Silurian and Devonian rocks of northern Manitoba, in 1897, and by Mr. J. McEvoy from the Devonian, Carboniferous and Laramie rocks of the Rocky Mountains in 1898.

Collections loaned.

"A few types of critical species of Canadian fossils have been lent at various times to the Professor C. D. Walcott, Director of the U. S. Geological Survey, who has been engaged on a revision of the Cambrian Lingulidæ; to Prof. A. Hyatt, of Boston, Mass., who has long made a specialty of fossil Cephalopoda; and to Miss Donald, of Carlisle, England, who is making a study of the genus *Murchisonia* and its allies.

Zoology.

"The additions to the zoological collections in the museum during the past year have been fairly numerous. Among them are a number of skins of small mammals, a few bird-skins and a set of the eggs of Townsend's solitaire, collected by Mr. Spreadborough in the Rocky Mountains last summer; a head of the 'wood buffalo' from the District of Athabasca; a black variety of the red squirrel from New Brunswick; an albino or nearly albino scaup duck from Manitoba; and a set of the eggs of the rock ptarmigan from the summit of the Chilcat Pass. A large series of recent Chitonidæ that had been lent to Professor Pilsbry during the preparation of his monograph of that family in the fourteenth and fifteenth volumes of his continuation of Tryon's Manual of Conchology, has been labelled in accordance with the nomenclature in those volumes, and returned. All the Belas in the museum of the Survey, from the Atlantic and Pacific coasts of Canada, have been lent to Prof. A. E. Verrill, of Yale University, for study and comparison.

Official duties.

"The duties of Acting Director have been performed for about seven weeks, during the Director's absence in British Columbia and Nova Scotia.

Work by Dr. H. M. Ami.

"Dr. H. M. Ami spent some time last January in instituting comparisons between the fossils described from the Devonian and Carboniferous of other parts of the world and those assigned to the same periods in Nova Scotia. Advantage was also taken of the visit of Dr. David White, of the U. S. Geological Survey, to obtain his opinion on

the large collections of fossil plants made by Dr. Ami in Colchester, Pictou and Kings counties in the province. His observations on these collections have materially assisted in ascertaining more nearly than before the precise equivalency of the horizons represented in comparison with those recognized in the United States. At a later date, while on leave of absence in consequence of ill-health, Dr. Ami visited, in company with Dr. White, portions of the Pennsylvania Coal Field, where he found the character and succession of the beds to resemble closely that met with at corresponding horizons in Nova Scotia. The Pocono formation, in particular, recognized as the lowest subdivision of the Carboniferous in Pennsylvania, containing a flora closely resembling that of the Riversdale series in Nova Scotia. The information gained at this time was of material assistance in connection with the work noted on a later page.

Nova Scotia and Pennsylvania Carboniferous compared.

"Collections of fossils from the following localities received during the past year were also examined by Dr. Ami, and preliminary lists of the species made, as far as practicable, for future use and reference.

"From the North Slope, Springhill Mines, Nova Scotia, collected by Mr. Lee Russell, 1898. Several fine slabs of fossil plants, comprising six genera and as many species from the Cumberland Coal Field.

Collections examined.

"Supposed organisms from opposite the Mouth of Mactaquac River, a tributary of the St. John River, Lower French village, county of York, N.B., collected by Prof. L. W. Bailey.

"From Shaw's Mills, Beccaguimic River, collected by Prof. L. W. Bailey. A small series of imperfect Cambro-Silurian fossils from the semi-crystalline and dark-coloured limestones of the valley.

"Preliminary studies have also been made of collections from the Cambro-Silurian limestones of the Lower Ottawa, collected by Dr. Ells and Dr. Ami.

"Dr. Ami also determined and kept records of collections brought in from time to time by various persons in the Ottawa valley, and elsewhere. Some of these have proved interesting and useful to the Department. Among these may be mentioned several collections from the Utica, Trenton and Black River formations of Billings's Bridge, obtained by Mr. W. Roger of Billings's Bridge, and a number of specimens from the Devonian and Silurian of Western Ontario. Notes on the palæontology of the district, also, were prepared for Prof. Bailey's report on South-west Nova Scotia.

"Amongst other collections examined later in the year may be mentioned, one obtained by Mr. W. J. Wilson, in a rock-cutting on the railway six miles north of Canterbury station, N.B. The rocks here

had previously been referred to the Cambro-Silurian, but some nine species of Silurian fossils have been recognized. These are noted on p. 137.

Museum work.

"A good deal of time was also given to work more or less directly connected with the museum, in part relating to specimens which have been acquired, and in part to others sent to specialists for examination.

Drillings examined.

Samples of borings derived from several deep wells in Western Ontario, have also been examined and such information given as would serve to show the various geological formations penetrated by the drill, the approximate thickness of these formations, as well as the formations which lay below those traversed—with special reference to the occurrence of petroleum or gas.

"A good deal of time was also devoted to the arrangement, cataloguing and indexing of the Ethnological collections in the museum.

"In the spring, in consequence of illness, it became necessary for Dr. Ami to obtain leave of absence for three months. On his return to duty, he was assigned to field-work during the summer, upon which he makes the following provisional report:—

Duck Islands, Lake Huron.

"From July 15th to August 4th my time was occupied in the Duck Islands, and in the south-eastern portion of the Grand Manitoulin Island from Providence Bay to Owen Channel, Lake Huron, for the purpose of ascertaining whether evidence existed on which to determine the occurrence of rocks belonging to the Guelph formation in that part of the province of Ontario. The five islands that form the group called the Duck Islands, include Great Duck Island, Little Duck Island, Middle Duck or Gravel Island, Inner Duck or Thibeault Island, and Western Duck or Ile au Sable. These islands were all visited, and the first two were traversed in several directions, but no outcrops belonging to any of the Palæozoic formations were observed. The following notes bearing on the general structure and formation of the islands, however, were made:—

"The Duck Islands owe their present topography and aspect to the presence of partially eroded masses or accumulations of boulder-clay, more or less irregularly surrounded by zones or fringes of gravel and water-worn boulders of various sizes, with here and there occasional masses or deposits of sand and gravel, all of Pleistocene age.

Boulder-clays.

"The boulder-clay or till which is so extensively developed in the escarpments and higher levels of Great Duck Island, also on the south-east corner of Little or Outer Duck, and probably also in the central nucleus or axis of each of the other islands—underlying the sands and gravels found there to-day and resting probably on the Niagara—is

composed in large part of Archæan boulders mixed with a fair proportion of limestones, mostly of Silurian age. The materials which make up the boulder-clay, appear, largely, to have been carried by land-ice clear across the North Channel and the Grand Manitoulin Island, being derived from the Huronian and Laurentian rocks so characteristic of the islands of the North Channel and the mainland north of that channel.

Deposit of boulders.

"One of the best exposures of boulders from the till is to be seen at the south-eastern point and eastern side of Little Duck Island, where they have been freed from the till or boulder-clay by the water. These pebbles consist of white quartz, conglomerate, quartzite, jasper conglomerate, huronite and diorite, syenite, hornblendic, micaceous and granitoid gneisses, diorite, pegmatite and greenstones. These are often distinctly striated or polished, and vary in size from pebbles a few cubic inches in volume, to large masses containing fully 200 cubic feet of rock. Limestone pebbles of light yellowish-gray or drab colour and beautifully striated and polished, also occur in tolerable abundance with other *débris;* the greater portion of this limestone being evidently referable to the Niagara division of the Silurian, as developed in the more compact and heavy-bedded portion of that formation, on some parts of the Grand Manitoulin Island.

Boulder-clay.

"The till or boulder-clay of Great Duck Island, forms a rather bold and prominent ridge or bluff, that rises to a height of nearly 150 feet above the level of the lake at the northern fifth of the length of the island, and maintains a generally level surface and even trend as far as the southern third of the length of the island, from which point the surface slopes gently down to the shore; the southern part of the island being almost entirely made up of post-glacial deposits, or of fringes or zones of boulders washed out of the boulder-clay of the district, and redeposited around the shores of the lake at various periods and different levels, so as to form conspicuous zones of raised beaches at several heights above the present lake-level.

"Sand Point, the extreme north-east part of this island, is occupied by conspicuous sand-hills or dunes, of æolian origin, which extend over an area covering not less than one square mile.

Sand-hills.

"On the western side of this island and in the northern half of this side, lies Sand Cove or Horse-shoe Bay. This bay is surrounded on all sides by a fringe of sand-hills or dunes, especially at its eastern extremity. Evidence of the rapid accumulation of boulders in the south-eastern end of Great Duck Island, was noticed in several localities, but more particularly is this phenomenon observable in two prominent

Beach accumulations.

features:—(*a*). At and near a wooden pier or wharf erected some 25 years ago, on the east side of Great Duck Island, opposite the fishing station on Outer Duck. The pebbles or boulders of the beach have been accumulated to such an extent along the shore and pier as to cover the sides and face of the landing and completely interfere with its use. (*b*). At the south-eastern extremity of Great Duck Island, there is to be seen a body of water, not indicated in existing maps, one mile long and three-quarters of a mile wide. This lake, whose waters lie some ten feet above the present level of Lake Huron, is formed by the closing up of the mouth of a bay, which at one time existed in this portion of the island. This bay was bounded on the east and west by two bars or low gravel ridges, that owe their origin to the accumulation of boulders derived from the glacial deposits of Little Duck and Great Duck islands. There are also seen here zones of boulders, forming raised beaches that occupy the greatest proportion of the land area in this part of the island. As many as fourteen separate zones or fringes of rounded and polished boulders, forming raised beaches, can be counted at Lighthouse Point, from the shore north, in distance of 400 yards. These zones are not regularly concentric one to the other, but coalesce or anastomose. The Manitoba Shoal, consisting of an accumulation of rounded boulders closely packed together, lies one-quarter of a mile north of great Duck Island. The strong currents that prevail in the channel between Little Duck and Great Duck islands and also along the southern extremities of these islands, together with the storm-waves of the lake, play an important part in the building up of these fringes of boulders.

Manitoba Shoal.

"These islands were probably submerged below the lake in post-glacial times, and during the period of uplift, the cliff aspect of the central or axial portion of the Great Duck, was produced by waves acting at a higher level than the present.

Middle Duck.

"Middle Duck or Gravel Island, is only a few feet above the present lake-level, and consists for the most part of post-glacial sands and gravels, probably covering denuded portions of the till or boulder-clay of the island in glacial times. The island supports a luxuriant forest of vigorous young white and black spruce. Western Duck or Ile au Sable, is also a flat, low-lying island, fairly well wooded with conifers and occasional poplars, with sandy and gravelly shoals showing boulder bars or ridges, prominent especially at the southern extremity. One bar extends a long distance into the lake. Inner Duck or Thibeault Island is the smallest of the group, is flat, and supports a forest of conifers, mostly spruce.

"The soil on Great Duck Island is varied and in the higher parts supports a rich forest of hardwood trees, maple, birch and beech, whilst in the more sandy and marginal low-lying parts of the island, conifers, including white pine, white and black spruce, cedar and other trees abound. Hay, oats and other farm crops can be raised, while small fruits flourish, and an abandoned orchard with blue plums and apples carried an abundant crop when visited. Character of soil and trees on Great Duck Island.

"In order to ascertain precisely to what geological horizon to assign the rocks that crop out on the extreme southern shore of the Grand Manitoulin Island immediately north of the Ducks, Burnt Island and Green Bay and Point were visited. At the former locality the following fossils were obtained, which indicate the presence of a coral-line limestone referable to the Niagara formation and not very high up therein:— Grand Manitoulin Island.

Halysites catenulatus, (both the large and small variety).
Syringopora verticillata.
Syringopora, sp., with large corallites: probably *S. multicaulis.*
Favosites Gothlandica.
Favosites Niagarensis.
Eridophyllum, sp.
Strombodes, sp., with large corallites.

"These species are all characteristic of the Lower Niagara, and whereas the beds here, along the lake-shore at Burnt Island, are practically horizontal, and the Niagara formation as developed in the Grand Manitoulin Island is known to be at least 250 feet in thickness, it follows that, if no great faulting or dislocation occurs in the Silurian strata between the mainland and the Ducks, the formation underlying the Duck Islands is probably also referrable to the Niagara. Burnt Island.

"A careful examination was next made of four areas of Silurian rocks along the southern shore of the Grand Manitoulin Island, with a view of ascertaining if the Guelph formation of Ontario occurs on that island. The rock formations north and west of Michaels Bay, at Michaels Bay and east as far as South Bay Mouth post-office, between South Bay Mouth and the 'Slash,' and again between the Slash and Tekummah P.O., were examined, and throughout this entire area, as far as I could find, not a single characteristic species of the Guelph formation occurs, while abundant evidence was noted to refer the rocks of the whole area to the Niagara formation.

"Through the kindness of Mr. William J. Stewart, Chief Hydrographer, I was enabled to visit the west point and shore of Thomas Bay, the east shore of the same bay, the lake-shore east of Thomas Bay, also Perseverance Island, Cove Island and Flowerpot Island Islands examined.

where evidence was obtained which will enable the geological horizon to be satisfactorily determined.

"I have to acknowledge my further indebtedness to Major Gourdeau, Deputy Minister of Marine and Fisheries, to Capt. McGregor of the steamer *Bayfield;* to Messrs. W. Purvis, of Great Duck lighthouse; John Bain, of Outer Duck fishing station and W. Irving, of South Bay Mouth, for valuable assistance.

Work in Nova Scotia.

"In pursuance of instructions received, I left Ottawa for Nova Scotia on August 10th, to continue the palæontological examination of some of the rock series in that province; proceeding in the first instance to the typical sections of the Horton formation in the vicinity of Wolfville.

"Near the head-waters of Angus Brook, an interesting contact of two distinct formations is exposed. The older and underlying series consists of fine-grained red, green and mottled slates, cleaved and indurated, dipping at a high angle to the south-east, associated with beds of coarser material and sandstones. The slates hold abundance of *Dictyonema Websteri*, originally described from Beech Hill and New Canaan, near Kentville. These slates are overlain unconformably by about 250 feet of soft, unaltered and almost horizontal arkose sandstones and conglomerates, the pebbles of the conglomerate layers being made up for the most part of gray glossy slates and quartzites —generally of small size and rounded. The Dictyonema slates have been referred to the Silurian system, and from a locality about ten miles south-west of Angus Brook, Sir J. Wm. Dawson described certain coralline limestones, of Wenlock or Niagara age, associated with these slates, so that the Silurian age of these Dictyonema slates seems probable—the species resembling in many particulars the *D. reteformis*, of Hall, from the Silurian of Ontario and New York State. From the drab and dark-gray and black shales that overlie the arkose sandstones, an interesting series of fossils was obtained, including fine examples of *Cyclopteris (Aneimites) Acadica*, Dn., *Lepidodendron corrugatum*, Dn., besides ostracoda and fish remains.

Silurian strata.

Horton formation.

North shore Minas Basin.

"Some time was also spent in examining the numerous outcrops of fossiliferous strata along the north shore of the Basin of Minas, at Parrsborough, at McKays Head, Moose Creek, and particularly along the Harrington River. Foot-prints of Amphibia were found in abundance both at Parrsborough, near West Bay north-west of Partridge Island, and along the Harrington River. These are referable to the genera *Hylopus* and *Sauropus*. From the palæontological evidence obtained from the rocks in question on the Basin of Mines, I am now convinced that these rocks should be referred to the Carboniferous system. As pointed

out in reporting on my work last year, these same rocks, in other parts of the province hold a fauna and flora which has a decidedly Carboniferous facies. The ground upon which these rocks had been referred to the Devonian system was that they belonged to the same horizon as the fern ledges of Lancaster, New Brunswick, but these in turn may be said to hold a similar assemblage of forms with a decided Carboniferous facies. To whatever horizon the Lancaster plants are assigned, the rocks of the Harrington River, Riversdale and Union, and possibly of the Horton formation also must, it would appear, be assigned. Age of the rocks.

"Regarding the general results of this Devono-Carboniferous problem from a palæontological standpoint. It would appear, in reviewing the value and amount of the evidence afforded by fossils obtained during the past three seasons, that, in so far as the faunas are concerned, they clearly indicate a Carboniferous facies. These faunas include :— Palæontological evidence.

" *Insecta.*—The remains of a large wing of one of the Neuroptera has been submitted to Prof. Charles Brongniart, who states that it is referable to a well-known Carboniferous genus.

" *Phyllopoda.*—The occurrence of typical examples of the genera *Leaia*, *Estheria* and related genera of phyllopods, which all the world over are recognized as Carboniferous, also point to the Carboniferous age of the rocks in Canada, from which the above forms were obtained.

" *Xiphosura.*—This sub-class of Crustacea is represented in my collections by three small but eminently characteristic specimens belonging to the genus *Prestwichia*—a Protolimuloid, usually referred to the Carboniferous system.

" *Podophthalmata.*—This sub-class of the Crustacea, is represented by numerous examples of a genus allied to *Anthrapalæmon* of the Coal Measures, but as yet undescribed.

" *Amphibia.*—Numerous tracks, footprints, etc., of large-sized reptiles whose hind feet at least were furnished with five toes, occur in the collection. Some are referable to Lea's genus *Sauropus*, others to Sir. J. Wm. Dawson's genus *Hylopus* of which *H. Logani*, as represented in the collection at Ottawa, is the type. All the species of *Sauropus* previously described from North America are placed in the Coal Measures.

" *Lamellibranchiata.*—Numerous examples occur in the collections from the rocks under consideration which are clearly referable to the genus *Anthracomya*, Salter (=*Naiadites* Dn.) which genus also is characteristic of distinct zones or horizons in the Carboniferous and is closely related to forms known to occur in the undoubted Carboniferous of the Sydney, Pictou and Cumberland coal-fields of Nova Scotia.

Résumé.

"From the evidence thus far obtained, it would appear that in Nova Scotia the Carboniferous period began with shallow water conditions, producing the shales, sandstones, mudstones, marls, and grits of the Riversdale and Union series. The frequently ripple-marked and littoral character of these beds seems to indicate rapid submergences at the time of deposition and accounts for their great thickness. The fauna and flora of these series, as regards genera, are closely related to those characterizing the higher series of shales and sandstones that is separated from them by the marine Carboniferous limestone. The similarity, in my opinion, is so close, as to indicate that the whole different formations should be placed together in the geological time-scale as parts of the Carboniferous System.

"Further researches were carried on in Antigonish county, at McAra Brook and in the Lochaber Lake region—from which interesting suites of fossils were obtained.

Bone-beds, Antigonish Co., N.S.

"The bone-beds of McAra Brook, holding crustacean and fish remains, were again examined and additional exemples were obtained of a *Pteraspis*, which appears to be new (the genus having been identified by Dr. A. S. Woodward) and fragments of cephalaspidian and acanthodian species, besides indications of *Pterygotus*. The occurrence of *Pteraspis* and *Pterygotus* indicate that the beds at McAra Brook, above and below the post-road, are referable to the summit of the Silurian system or the lowermost portion of the Devonian.

Work by Mr. L. M. Lambe.

"Mr. L. M. Lambe reports as follows :—

"The revision of the fossil zoantharian corals, to which reference was made in the Summary Report of 1897, was proceeded with during the earlier months of the past year. Considerable progress has been made therein. The two groups of the *Zoantharia* now being studied, viz., the *Aporosa* and the *Rugosa*, include eight families known to occur

Palæozoic corals.

in the Palæozoic rocks of Canada and are represented by twenty-six genera, embracing over one hundred species. Of these species all but nineteen have so far been revised. Special attention has been paid to the internal structure of the corals and all available material has been examined with care. I am under many obligations to Professor H. Alleyne Nicholson, who kindly lent for examination a number of the type specimens and thin sections that were used in the preparation of his two reports upon the Palæontology of Ontario, 1874 and 1875. Thanks are also due to Sir J. Wm. Dawson for having placed at my disposal some types from the Lower Carboniferous rocks of Nova Scotia, the property of the Redpath Museum, McGill University, Montreal.

"During the past year the collection of recent marine sponges from the Atlantic and Pacific coasts has been placed in proper jars and all the specimens have been relabelled. A small series of sponges from Behring Sea, collected by Dr. Leonhard Stejneger, has also been examined and the specimens named for the Smithsonian Institution, Washington. Recent marine sponges.

"Drawings of a number of fossils from the Hamilton formation were made for plates XLVIII, XLIX and L, illustrating part V, volume I, of the Contributions to Canadian Palæontology.

"In pursuance of instructions to make further collections of fossils from the Cretaceous rocks exposed along the Red Deer River, Alberta, I left Ottawa for the North-west early in July. During the season of 1897, collections had been made by me from the rock-exposures on the Red Deer River from Red Deer village to Dead Lodge Cañon, a distance of about two hundred miles, in which the Laramie, Pierre and Belly River formations are successively exposed. The work of last summer was, however, confined to the area of 'bad-lands' lying between the mouth of Berry Creek and Dead Lodge Cañon, where it had been found that good results could be obtained, the main object of the work being to make a thorough search for dinosaurian and other organic remains in the rocks of the Belly River formation. Medicine Hat was selected as a starting point. From this place, where provisions were obtained and two men engaged, the Red Deer River was reached by wagon on the evening of July 24th and camp pitched opposite the mouth of Berry Creek. Here the 'bad-lands' extend along the river for seven or eight miles, running back on each side a distance of from three to four miles from its banks, and forming an almost circular area, through the centre of which the river flows. It had been intended to follow down the river on either side, camping at convenient points in order to facilitate collecting, but it was found that on the south-west side dry water-courses allowed of the passage of a wagon for a distance eastward of only from about one and a half to two miles, while on the opposite side any movement except on foot was prevented by the broken character of the ground. A month was spent in examining the numberless buttes and the labyrinth of deep coulées, a fortnight being given to either side of the river. Owing to the weight of the larger bones and the distance from camp at which most of them were found, the difficulty of collecting was very much increased, as they had to be carried to camp in an improvised stretcher often for some miles and over extremely rough ground. Of the fossils secured, in number dinosaurian remains and those of turtles predominated, fish remains and those of crocodiles being very scarce, as Red Deer River district, Alberta. Bad-lands.

were also fossil leaves, although silicified wood with the structure well preserved was everywhere abundant.

Collections made.

"The material secured during the past summer, together with that obtained in 1897, affords a comprehensive representation of the vertebrate fossils and plant remains of the Laramie, Pierre-Fox Hill, and Belly River formations in the Red Deer River district. By far the larger number of fossils were, however, secured from the Belly River beds, which are especially interesting, as representing a terrestrial fauna separated from that of the Laramie by the thick marine beds of the Pierre.

"The collection will require careful study before it can be definitely reported on, but a preliminary examination renders it possible to assign some of the remains with a tolerable degree of certainty to genera or even species already described. Much of the material is believed to represent new forms.

"The principal specimens in the collection belong to the class *Reptilia* and represent the three orders *Chelonia*, *Crocodilia* and *Dinosauria*. The remains of the last, in point of number, far exceed those of the other two orders and form the greater part of the collection.

Reptilian remains from the Belly River formation.

"Considering first the fossils from the Belly River formation, the following provisional enumeration may be made of them :—

1. Chelonia :—

   Fragments of the dorsal and ventral shield of *Plastomenus coalescens*, Cope.*

2. Crocodilia :—

   Parts of the rami of mandibles of a species of *Bottosaurus*, Agassiz.

3. Dinosauria :—

   a. Numerous maxillæ and rami of mandibles and some of the principal bones of *Trachodon mirabilis*†, Leidy.

   b. A maxilla with teeth, a separate tooth and a right ramus of a species of *Triceratops*, Marsh.‡

   c. Separate teeth and terminal phalanges of *Lælaps incrassatus*,‖ Cope.

   d. The upper part of the cranium of a species of *Nodosaurus*, Marsh.

*Report on Geology and Resources of the Forty-ninth Parallel, by G. M. Dawson, 1875, appendix B, p. 337.

†Proceedings of the Academy of Natural Sciences of Philadelphia, vol. VIII., p. 72, 1856.

‡American Journal of Science and Arts, vol. XXXVIII., 1889, p. 173; also Sixteenth Annual Report of the United States Geological Survey, 1896.

‖ Proceedings of the Academy of Natural Sciences of Philadelphia, October, 1876, and December, 1876, p. 340.

"Of the remains referred to *Plastomenus coalescens*, a species de cribed by Cope from fragments collected by Dr. G. M Dawson from the Fort Union (Laramie) Cretaceous in the 'bad lands,' south of Wood Mountain, Assiniboia, the following may be mentioned specially :— Turtle remains.

"A costal plate with a surface ornamentation of shallow pits separated by distinct reticulating ridges. It is ten inches long, with an average thickness of between five and six lines ; two inches broad at its inner end and four inches in breadth at the outer end, where it terminates in a thin bevelled edge. Plastomenus.

"A large fragment, about sixteen inches broad and thirteen inches long, of the anterior end of a plastron, that had an entire breadth, when perfect, of not less than two feet. It exhibits definite deep sutural markings, is sculptured similarly to the costal plate and in outline is rounded in front and deeply concave on either side. It is about four inches thick in the central part and about an inch and a-quarter thick at the margin. Mr. R. G. McConnell, in 1882, also obtained fragments of the plastron of this species from the Belly River beds of this district. According to Lydekker* the genus *Plastomenus*, Cope is not properly distinct from *Trionyx*, Geoffroy.

"Besides the above, are marginal parts of both ends of a single plastron of the same species, fragments of shell that may represent other species, and vertebræ, terminal phalanges and numerous other bones of the endoskeleton of turtles.

"The remains of *Crocodilia* consist of a few small deeply pitted oblong or oval, apparently non-articulating plates and fragments of mandibles. The most perfect specimen of the latter consists of the anterior part, five and a-half inches long, of the left ramus of a mandible with the symphysis, showing sixteen sockets for teeth the roots of which in a few cases remain. Crocodilian remains.

"Cope has described a species *Bottosaurus perrugosus*,† from the Fort Union (Laramie) group of Colorado, from portions of jaws that strongly resemble those from the Red Deer River. Zittel places this genus with the *Alligatoridæ*, to which family he assigns also the genera *Diplocynodon*, Pomel, and *Alligator*, Cuvier, the latter being a living genus.

The *Dinosauria* are represented by well preserved separate parts of jaws, horn-cores, bony scutes (some of large size,) vertebræ, ribs, a perfect sacrum and parts of sacra, limb-bones, the largest of which is a femur four feet in length, and many other bones. Dinosaurian remains.

* Manual of Palæontology by H. Alleyne Nicholson and Richard Lydekker, third edition, 1889, vol. II., p. 1118.

† The Vertebrata of the Cretaceous Formations of the West. Rep. U. S. Geol. Surv. of the Territories vol. II., 1875.

Genera represented.

"The greater number of maxillæ and separate rami of mandibles, in some of which the teeth are beautifully preserved, are referable to the genus *Trachodon* (*Hadrosaurus*), Leidy, and probably also to the original species of the genus *Trachodon mirabilis*, Leidy,* from the Upper Cretaceous (Judith River or Laramie) beds of Nebraska, U.S.A. This genus and species were founded on specimens of teeth discovered by Dr. F. V. Hayden in the bad lands of the Judith River, Nebraska. The genera *Diclonius*, Cope, and with less certainty *Thespesius*, Leidy, are regarded by some authorities as synonymous with the above genus. *Cionodon*, Cope and *Claosaurus*, Marsh, are two other upper Cretaceous genera closely allied to *Trachodon* and characterized by the same type of dentition.

"Within an area twelve feet square, a number of bones representing the remains, no doubt, of a single individual were found. They are as follows:

Remains of Trachodon.

"An almost entire fore-leg represented by a humerus (two feet four inches long), an ulna and a radius (both about two feet four inches long), a metacarpal (one foot long), phalanges, and terminal phalanges (from three to four inches broad) found together in their proper relative order and indicating an individual of large size. With these were a rib (three feet six inches long), portions of vertebræ and fragments of jaw holding teeth of the *Trachodon* type, as well as parts of the ossified rod-like tendons of the median dorsal region, resembling those referred to and figured by Marsh in his description of *Claosaurus annectens*† from the Upper Cretaceous of Wyoming. With the above occurred other bones, viz. a second humerus, a number of ribs, vertebræ and some of the large bones of the hind legs, but it was impossible to remove them, as they were in a crumbling condition. The characters of the teeth suggest an individual that probably belongs to the species *Trachodon mirabilis* or is nearly related to it. The humerus, ulna and radius bear a strong resemblance to corresponding bones of *Trachodon Foulkei*, Leidy,* a species from the Upper Cretaceous of New Jersey, closely allied to the western form.

Triceratops.

"The second species of herbivorous dinosaurian is represented by a well preserved left maxilla with teeth in place. With these may be grouped, as probably belonging at least to the same genus, an almost perfect right ramus of a mandible, sixteen inches long, without teeth in the sockets, and a separate tooth having two roots. These specimens

*Proceedings of the Academy of Natural Sciences of Philadelphia, vol. VIII, p. 72, 1856.

†First described in 1890, from a specimen obtained by Professor Marsh in 1872 from the Cretaceous of Kansas and referred to at length in the Sixteenth Annual Report of the United States Geological Survey, part I., 1896.

are referable probably to one of the genera of the *Ceratopsidæ*, and judging from the teeth most probably to the genus *Triceratops*, Marsh* (said to be synonymous with *Agathaumas*, Cope).

"A third species of dinosaurian from the Belly River formation is represented by teeth and terminal phalanges that are referable to the carnivorous species *Lælaps incrassatus*, Cope. Lælaps.

"Taking into consideration the prevalence in the exposures of the Belly River formation on the Red Deer River of undoubted *Trachodon* remains and the scarcity of those that represent other genera, it is presumed that the majority of the larger bones that were found in this district separately or in twos and threes are referable to *Trachodon*. Among the larger bones of the collection are the following:— A complete sacrum, two feet seven inches long and seventeen inches broad at its widest part, having nine co-ossified vertebræ, and the two ends of a second sacrum that was three feet long and entire, but of which only the ends were secured owing to the fragility of the specimen. A number of femora, the largest of which is slightly over four feet long, several tibiæ of which two are three and a-half feet long, an ilium and a perfect biconcave caudal vertebra, all strongly resembling the corresponding bones of *Trachodon Foulkei*, Leidy. Reference of large bones.

"There are also many vertebræ a scapula, and a large number of other bones not yet definitely referred.

"A number of horn-cores and bony scutes of various sizes and shapes, the remnants of a protective covering, are of particular interest. With one horn-core, a foot long and between four and five inches in diameter at the base, to which a small portion of the skull remains attached, was found parts of a maxilla with teeth of the *Trachodon* type. Judging from the want of bilateral symmetry in this horn-core, it is reasonable to suppose that two horns, one on either side of the median line of the head, proceeded upward from the top of the skull; also, from the association of teeth of this type with the horn-core, it would appear that the species of *Trachodon* here represented, (possibly *T. mirabilis*, Leidy,) which with its allies have been supposed to be hornless, had well developed and formidable horns. The largest dermal (?) scute, one foot five inches long, seven inches broad and seven inches thick, consists of an asymmetrical massive base that is prolonged in front into a stout sharply-pointed spine directed slightly to one side. Horn-cores.

*Proceedings of the Academy of Natural Sciences of Philadelphia for 1858, vol. X. p. 213.

"A slender bone three feet seven inches long, supposed to be an ischium, is very similar in size and general proportions to the corresponding bone of *Claosaurus annectens* as figured by Marsh (*op. cit*).

Head armature.

"A specimen that appears to be the upper part of the cranium of a dinosaur was found at the mouth of Berry Creek, and with it were a number of large sharply keeled plates that evidently formed part of a dermal armature. The former measures ten inches in length by nine inches in breadth, and is covered above and on the sides with flat bony plates. The dermal plates are about six inches long and three and a-half inches high, each being hollowed out behind, presumably for the reception of the anterior border of the plate immediately following. The dinosaur represented by these remains may have been a Cretaceous representative of the genus *Scelidosaurus*, and perhaps nearly allied to *S. Harrisonii*, Owen, from the Jurassic of England. The surfaces of the bony plates covering the Red Deer River specimen, show markings similar to those noticed by Marsh and described by him as characteristic of the ossicles of *Nodosaurus textilis** a Cretaceous species of a genus of *Stegosauria* related to *Scelidosaurus*.

Reptilian remains from the Laramie formation.

"The more important specimens from the Laramie series consist almost entirely of dinosaurian remains, and are more fragmentary as well as fewer in number than those from the Belly River beds.

"The order *Chelonia* is not represented amongst the specimens from the Red Deer River, but in 1881 Dr. G. M. Dawson collected from exposures of the Willow Creek (Laramie) beds on the Oldman River, Alberta, fragments of a plastron that are apparently of the same species with the specimens from the Belly River series of the Red Deer River, referred above to *Plastomenus coalescens*, Cope.

"No crocodilian remains were found in the rocks of this formation.

Dinosaurian remains.

"The bones collected in 1897 include, besides vertebræ and a number of broken femora and tibiæ, a very large tibia, four feet long, and the distal or lower end of a femur, that, judging from its breadth (sixteen inches), must have had a length in the neighbourhood of five feet. Most of these bones are thought to belong to *Trachodon mirabilis* on account of their resemblance in structure to corresponding ones from the Belly River beds.

"Fragments of jaws of *Trachodon mirabilis*, with teeth in place, were collected by Mr. T. C. Weston in 1881 on the Red Deer River in range XXI, township 32, west of the fourth principal meridian.

**Vide* Sixteenth Annual Report, United States Geological Survey, part I, page 225, pl. lxxv, fig. 5.

"In 1882 Mr. R. G. McConnell obtained a femur three feet ten inches long, from the Laramie of Scabby Butte, Alberta. It appears also to be referable to *Trachodon mirabilis*.

"Previous to 1897, the collection of dinosaurian remains from the Laramie beds of the Red Deer River included a skull of *Lœlaps incrassatus*, Cope, obtained by Mr. J. B. Tyrrell in 1884 on the west bank of Knee Hills Creek about three miles from its mouth, and a jaw of the same species collected by Mr. Weston in 1889 on the east bank of the Red Deer River at a point about twenty-one miles above Knee Hills Creek. These specimens were submitted for examination to Professor Cope * who referred them to his species described in 1876 † from teeth derived from the Fort Union (Laramie) formation of Montana and described more fully in the same year from a dentary bone from the same region.

"Comparing the reptilian remains from the Belly River beds with those from the Laramie, it would appear that there are probably three species common to both formations, viz.,—*Plastomenus coalescens*, *Trachodon mirabilis* and *Lœlaps incrassatus*, also that these are the three forms most abundantly represented in the collection. Remains of *Plastomenus coalescens* seem to be not uncommon in both formations, those of *Trachodon mirabilis* are abundant in the Belly River rocks but are not often met with in the Laramie, whilst the reverse is the case with those of *Lœlaps incrassatus*. Comparison of faunæ.

"In concluding his report on 'The Invertebrata of the Laramie and Cretaceous Rocks of the vicinity of the Bow and Belly rivers and adjacent localities in the North-west Territory ‡' Mr. Whiteaves gives it as his opinion that 'the invertebrate fauna of the Belly River series seems to be essentially the same as that of the Laramie of the United States and Canada, unless more than one formation has been confounded under the latter name.' This expression of opinion is corroborated to a certain extent by a preliminary review of the vertebrate faunæ of the same formations.

"Toward the latter part of September, a visit was made to Muirkirk, Ontario, where it had lately become known to the Department that fossil elephantine remains had been discovered. The bones, which proved to be those of a mammoth, were purchased. Notes were taken on the circumstances attending the discovery of the bones, their posi- Mammoth remains in Ontario.

* On the skull of the Dinosaurian *Lœlaps incrassatus*, Cope, American Philosophical Society, vol. XXX., 28th May, 1892.

† Proceedings of the Academy of Natural Sciences of Philadelphia, for October, 1876, p. 248, and December, 1876, p. 340.

‡ Contributions to Canadian Palæontology, vol. I., p. 89, 1885.

tion relative to the deposits in which they were found and the physical features of their surroundings."

Contributions to museum.

The following is a list of specimens collected by or received from officers of the staff, during the year 1898 :—

Dr. R. Bell :—

About thirty fossils from the drift of the north shore of Lake Superior at Michipicoten.

J. B. Tyrrell :—

About a dozen pieces of slate with fragments of fucoids (*Bythotrephis ?*) from seven miles north of Daltons Post, Unahini River, Yukon District.

Twelve specimens of Cretaceous plants from Nordenskiöld River, Yukon District.

Specimens of fossil wood from Alsek River, Yukon District.

Set of eggs of the Rock Ptarmigan from the summit of the Chilkat Pass.

W. McInnes :—

Skull of black bear (*Ursus Americanus*) from the Rainy River District, Ont.

Bone scraper from Mameigwess Lake, in the same district.

About forty pieces of Indian pottery collected by Mr. A. Boyer at the foot of the Long Sault Rapids, on the Canadian side.

Dr. H. M. Ami :—

A large number of fossils from the palæozoic rocks of Kings, Hants, Colchester, Cumberland, Annapolis and Antigonish counties, N.S., and from the vicinity of Courtnay Bay, N.B. Among them there is a series of reptilian and other footprints, referable to the genera *Sauropus* and *Hylopus*, from the Horton formation of Kings county and shales of the Riversdale series in Colchester and Cumberland counties.

About 200 Silurian fossils from various localities on Grand Manitoulin Island, Lake Huron.

A small collection of marine invertebrates from the shores of the Avon River, near the bluff at Horton Lighthouse, Nova Scotia.

Skull of Red Fox from Manitoulin Island, Ont.

L. M. Lambe :—

A large collection of dinosaurian, turtle and crocodilian remains from the Belly River formation of the Red Deer River in the neighbourhood of Berry Creek. It includes also a few fish and plant remains.

Contributions to museum—*Cont.*

A. E. Barlow :—

Set of eggs of Loon (*Urinator imber*) from Loon Lake, Peterborough county, Ont.

Three flint arrow-heads from Blackfish Bay, Kaminiskeg Lake, Renfrew county, Ont.

J. McEvoy :—

198 specimens of fossils from the Devonian, Carboniferous and Laramie rocks at various localities in the Rocky Mountains, west of Edmonton.

A number of skins of small mammals, a few bird skins and a set of the eggs of Townsend's Solitaire, collected by W. Spreadborough in the Rocky Mountains, west of Edmonton.

D. B. Dowling :—

Pale variety of the American Hare (*Lepus Americanus*)

A fossil coral (*Diphyphyllum*) from the drift of the north shore of Lake Nipigon.

W. J. Wilson :—

About 250 specimens of Silurian fossils from the Silurian rocks six miles north of Canterbury station on the C.P.R., in Carleton county, N.B.

Prof. L. W. Bailey :—

Three small collections of fossils from the Palæozoic rocks at different localities in New Brunswick.

The additions to the palæontological, zoological and ethnological collections from other sources during 1898 are as follows :—

By presentation :—

(A.—*Palæontology.*)

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

105 specimens of fossils from the Cambro-Silurian, Silurian, and Devonian rocks of Ontario.

U. S. National Museum, Washington, D.C. :—

Four specimens of *Chonetes vicina* (Castelneau) and one example of *Favosites Alpenensis*, Winchell, from the Hamilton formation of Ontario.

G. Kernahan, Thedford, Ont. :—

Thirty-five specimens of ten species of fossils from the Hamilton formation of Ontario.

Contributions to museum—*Cont.*

B. E. Walker, Toronto :—

Specimen of a large species of *Trochoceras* from the Corniferous limestone of St. Marys, Ont.

F. W. Wilkins, Norwood, Ont. :—

Specimen of *Asaphus* (*Isotelus*) *maximus*, (or *gigas*) from the Galena-Trenton limestone at Cat Head, Lake Winnipeg; and one of *Corbicula occidentalis*, from the Laramie deposits of Alberta.

(B.—*Zoology.*)

U. S. National Museum, Washington, D.C. :—

Specimen of a rare calcareous sponge (*Grantia monstruosa*, Breitfuss) from Copper Island, Commander Islands.

Commander Wakeham, Ottawa :—

A number of marine invertebrata from Hudson Bay, collected by the "Diana" expedition.

Richard Shillington, City View, near Ottawa :—

Set of four Shrike's eggs from near Ottawa.

F. White, Comptroller N. W. Mounted Police, Ottawa :—

Head of Wood Buffalo, from near Athabasca Lake.

John Fannin, Provincial Museum, Victoria, B.C. :—

Set of five eggs of Gambel's Sparrow (*Zonotrichia Gambeli*), from Beacon Hill Park, Victoria.

W. G. Paterson, Thedford, Ont. :—

Specimen of the Star-nosed Mole (*Condylura cristata*) in the flesh.

D. Lee Babbitt, Fredericton, N.B. :—

Black variety of the Red Squirrel, shot on Miscou Island.

Dr. James Fletcher, Ottawa :—

Six shells of *Arianta Townsendiana*, from a farm at Salmon Arm, Shuswap Lake, B.C.

W. E. Saunders, London, Ont. :—

Sets of eggs of eight species of birds from various localities in Western Ontario.

L. M. Lambe, Ottawa :—

Skull of American Bison from Old Wives Lake, Assa.

(*C.—Ethnology.*)

Contributions to museum—*Cont.*

Department of Indian Affairs:—

(From Mr. James Wilson, Indian agent on the Blood Reserve, N.W.T.):—

Medicine-pole Bag willed by "Charcoal" previous to his execution, who wished it to be "placed in a museum."

N. J. Slater, Ottawa:—

Old iron axe head dug up at Clear Lake, ten miles above Eganville.

W. R. White, Pembroke, Ont.

Two copper adzes found in 1897, by workmen excavating in C.P. R. Co's. yard at Pembroke.

W. H. Robson, Lethbridge, Alberta (per J. B. Tyrrell):—

Stone hammer found at Stonewall, Manitoba.

F. Dunn, Barrys Bay, Ont. (per A. E. Barlow):—

Piece of Indian pottery and six stone adzes or scrapers, from Welshman Island, Barrys Bay.

P. Kelly, Carlow township, Ont. (per A. E. Barlow):—

Stone gouge from Carlow township, Hastings county, Ont.

By exchange:

D. W. McDonald, Edmonton, Alta.:—

Skull of Musk Ox from roof of tunnel run in the north bank of the Saskatchewan, about one mile below Edmonton.

By purchase:

(*A.—Palæontology.*)

Remains of a mammoth found on the farm of Mr. Charles Fletcher, about a mile and a-half north-east of Muirkirk, Ontario, in 1895, as follows: Lower jaw with teeth in place; upper molars with parts of cranium; portions of the tusks; a few vertebræ and ribs; part of a scapula, two humeri, an ulna and radius, and all of the bones of the hind legs, except some of the smaller ones of the feet.

A fine series of specimens of "*Lituites undatus*," from the Black River limestone at the falls of the St. Charles River at Lorette, P.Q.

A number of choice fossils from the Levis limestone at Point Levis, P.Q.

Contributions to museum—*Cont.*

Five rare fossils from the Hamilton formation of Ontario.

Specimens of forty-five species of fossils from the Cambrian rocks of Newfoundland, many of which have been recently described and figured by Dr. G. F. Mathew.

187 specimens of fossil plants and insects, some of them undescribed, from the Devonian rocks at the Fern Ledges, near St. John, N.B.

(*B.—Zoology.*)

Albino or nearly albino Scaup Duck, from Whitewater Lake, Manitoba.

Male Saw-whet or Acadian Owl, (*Nyctala Acadica*) in dark-brown and not quite adult plumage, from the forks of the Blindman and Red Deer rivers, Alberta.

Two sets each of the eggs of the Great Black-backed Gull and White-throated Sparrow, and one set each of the eggs of the Olive-sided Flycatcher, Pine Siskin, Swamp Sparrow and Magnolia Warbler, from Nova Scotia.

One Osprey's egg from Nova Scotia, and one unspotted white Murre's egg from Labrador.

(*C.—Ethnology.*)

Ninety-four objects of Indian manufacture and three Indian skulls, collected by Dr. C. F. Newcombe at the Queen Charlotte Islands.

C. Hill-Tout, Vancouver, B.C.:—

Stone pipe from Lytton.

NATURAL HISTORY.

On the work done by himself, or under his immediate control, Professor J. Macoun reports as follows :—

Work done during winter of 1898.

"After the completion of my last summary report I spent the winter months writing a catalogue of the Water Birds of Canada, which includes notices of the breeding habits and geographical distribution of each species so far as known to us. The birds of Alaska, Greenland and Newfoundland, as well as those of the Dominion itself, have been included in order to render it as complete as possible.

"A good deal of time was also spent in working up the collections of cryptogams made in the Rocky Mountains during the summer of 1897.

This with the regular routine of the office kept me fully employed until the spring was well advanced.

"My work on the Lichens of the Dominion was also advanced a stage by the collections of the preceding summer in the Rocky Mountains, and the question arose whether the 'barrens' of Cape Breton Island did not produce a lichen flora that would connect that of Quebec with that of Labrador.

Field work, 1898.

"In accordance with your instructions I started for Cape Breton Island on the first of July last in order to make an examination of the flora of that part of Canada. In the summer of 1888 I made an examination of Prince Edward Island, forming a high opinion of its agricultural capabilities. This season's work has convinced me, that, in regard to agriculture, the capabilities of Cape Breton have been much underrated. While on the island I travelled in a wagon to Margaree, Cape North and Louisbourg, besides making numerous minor trips. I collected extensively at all points. As a result of my two months work I brought back over one thousand species of plants, not one of which indicated a frosty summer climate.

No boreal plants on Cape Breton Island.

"I had heard much of the 'barrens' of the north end of the island, and expected to find growing on this elevated plateau many plants identical with those of Labrador, but I failed to discover any. It is true there were lakelets, ponds, marshes, bogs and bare rocks with a very varied vegetation, but nothing more arctic than could be found within thirty miles of Ottawa.

"Along the north shore, at McNeil Harbour and Aspy Bay, I expected to find boreal vegetation, but failed just as completely as on the 'barrens.' Being still unsatisfied I examined the vegetation on Boulardarie Island, at both North and South Sydney, at Mira Bay, at Louisbourg and its vicinity, and although the whole region about Louisbourg was bathed in fog and gave evidence of almost continual saturation, yet boreal vegetation was wanting.

Newfoundland climate.

"Three years since, Dr. B. L. Robinson, curator of the Gray Herbarium at Cambridge, Mass., made extensive collections on Newfoundland along the line of the new railway. A set of these plants was presented to our herbarium, and they, too, point to a much better climate in southern Newfoundland than has generally been attributed to it.

Agriculture on P. E. Island.

"When I made my examination of Prince Edward Island, ten years ago, the agricultural standing of the island was not very high, the land although well cultivated in many places was wet and undrained and poor crops were being raised. Cheese making had been tried and had

failed and many of the farmers saw no prospect of bettering themselves. More light has since been shed on old methods, a new start in cheese-making has been made and Prince Edward Island has now over 300 cheese factories in successful operation.

Agriculture on Cape Breton Island.

"Agriculture is much more backward on Cape Breton Island now than it was ten years ago on Prince Edward Island. The cause of this is not, however, a climatic one. Its inhabitants are not an agricultural people, and consider farming as merely an adjunct to fishing, which was formerly very profitable, but now is too uncertain to make it the chief business. The mines have also drawn many from the land. On all parts of the island where cultivation is attempted I saw good crops. Oats, wheat, barley and potatoes were excellent, but much of the hay, which was the chief crop, was poor.

"Owing to inequalities of surface there are few level fields except in the valleys of streams, and a regular system of agriculture was not observed anywhere. Generally a farm consists of pasture and hay-meadow with patches of oats, barley or potatoes scattered about without any system. Although the meadow next to the oats produced poor hay which in many cases was chiefly ox-eye daisy (*Chrysanthemum Leucanthemum*), the oats were always tall and well headed, showing that the poor hay was not the result of poor soil but of want of culture. Everywhere I went it was painfully evident that agriculture was neglected on the island, and the people were falling into the belief that their soil could not compete with that of other lands in the raising of any kind of produce.

"Farming of a better class was found on Boularderie Island, but even there, vegetables and fruits were nowhere seen. The most notable thing on the whole island was the absence of gardens containing vegetables, and, dependent on this, the absence of vegetables on the table. I asked in many localities why the farmers raised no vegetables, and was told that formerly fish were traded for vegetables, and that as the fisheries became reduced vegetables were no longer obtainable.

Fruit, grain and vegetables.

"As a result of my observations on the routes already noted, it appears that there is not only abundance of moisture both in the soil and atmosphere, but sufficient summer heat both by day and night to produce an extraordinary amount of growth in July and August. With the permission of Mr. Alex. Graham Bell, who owns 1100 acres on a point stretching into Bras d'Or Lake at Baddeck, I made a careful examination of his farm and gardens, and found that his was a real experimental farm. Wheat, oats, barley, potatoes and all kinds of vegetables were excellent, the only desideratum being better under-

draining. There was a fine orchard with abundance of fruit, the only drawback being the too great growth of new wood, a circumstance paralleled, in so far as my experience goes, only in the Fraser valley in British Columbia, where a similar equable temperature and saturated atmosphere exist.

"At Baddeck Mr. Blanchard also has both an orchard and a garden, and although the land is neither well drained nor well cared for, growth and production were wonderful. But with Mr. Bell's farm and Mr. Blanchard's garden as object lessons, scarcely any attempt is being made by others to improve the system of agriculture, and young people continue to emigrate to the New England States in search of inferior positions, while the natural resources of their own country remain undeveloped.

"This state of things is, however, not likely to last much longer, as tourists from many parts of the United States and Canada are now becoming acquainted with the possibilities of the region.

Climate suitable for fruit growing.

"As you are aware, I have had the opportunity of studying the vegetation of nearly every part of Canada, and from the relation of flora to climate I feel quite safe in predicting a great future for Cape Breton. Many years ago I spent some time in the Annapolis valley, and am satisfied that that part of Cape Breton Island about the Bras d'Or lakes is equal to the Annapolis valley as a fruit-growing country. Why the people have been so long in ignorance of their great opportunities and the capabilities of their country is not for me to say, but in the production of butter, cheese and beef Cape Breton should in each case show as good results as Prince Edward Island. Potatoes, which at present are largely imported from Prince Edward Island, are just as sure a crop in Cape Breton, and a similar amount of enterprise will produce equally good results in both places.

"As to fruit-growing a few words more may be said: Mr. Blanchard of Windsor, Nova Scotia, a leading fruit grower there, was at a public meeting in Baddeck addressed by me last August. At this meeting I asserted that the Bras d'Or lakes were as well suited for the growing of apples as the Annapolis valley. After I had finished speaking, Mr. Blanchard said that he held opinions identical with my own, and hoped that he would live to see their proof.

Equable temperature.

"According to Mr. Bell, the thermometer in winter never goes lower than 10° below zero, and often the Bras d'Or Lake is not frozen over until the end of January. The spring is late, but as the buds do not develop too early, this is really a safeguard against injury. The heat of summer is tempered by the adjoining waters, and in autumn it is maintained by the heated waters of the Bras d'Or Lakes. Middle

River, Lake Ainslie, Margaree district, and many other smaller areas are just as good as that specially referred to above, but the future of one and all lies in the education of the people to the possibilities of their country.

Distribution of trees.

"The distribution of the trees of the natural forest is much the same in Cape Breton as that found elsewhere in the maritime provinces. Generally spruce and fir are found both on hill sides and level spots, but in all cases they are on land where the soil is impervious. These trees form the bulk of the forest vegetation in the vicinity of Baddeck, but in the interior of the island and in the northern peninsula much birch is mingled with them; and beech and sugar-maple, though not so abundant, are also found in considerable quantity. The last-named trees are found chiefly on rocky slopes or on better drained soil than that on which birch grows. All the species of trees found on the island were vigorous, and in no case seemed out of range. When cleared lands are encroached upon by young growth, however, they become invariably covered with spruce and fir. This shows the necessity of draining in order to keep the land in a fertile state, suitable to the growing of crops. Unless this be done, no success can be expected.

"Fine large red oaks (*Quercus rubra*), though few in number were seen on the north side of Smoky Mountain, nearly 1000 feet above the sea. On the plateau between Halfway House and Aspy Bay, a fine tract of old forest was passed through, where yellow birch and sugar-maple constitute a large part of the growth and many trees of a large size were seen.

Climate.

"A word or two must be said of the Bras d'Or Lake and of the Little and Big Bras d'Or. Owing to the narrowness of the latter, cold sea-water can scarcely affect the lakes, so that there is an interior basin filled with warm water during the summer, which keeps the lands around it bathed night and day in an atmosphere in a more agreeable condition than that of any other locality I know of. The advance of the spring is slow, but the air is not chilled, nor does the temperature rise very high, so that there is every condition necessary to the growth of fruits requiring a fairly low summer temperature. Growth in July and August is luxuriant, and the long autumn without heat or frost is quite analogous to that which gives the Annapolis apples their high flavour and great market value.

"The real mildness of the climate can be better understood when it is known that amongst other tender shrubs, grown by Prof. Bell, rhododendrons flourish, and are not in the least injured in the winter.

These shrubs do not grow well in Ontario, except in the south-western peninsula, and even there success is not certain.

"In the neighbourhood of Ste. Ann Harbour and at Louisbourg, certain species of plants were collected that seemed to have been introduced in the period of the French occupation. Amongst these are :—*Alopecurus pratensis* (French timothy), *Angelica sylvestris*, *Senecio sylvatica* and *Scabiosa succisa*. Introduced plants.

"Before going to Cape Breton, I had, like many others, a very mistaken notion of the 'barrens' in the northern part of the island. After spending some time in the north and on the plateau, the conditions producing these barrens became evident. Along the base of the escarpment bordering the plateau, the subsoil is generally impervious, and here spruce and fir occupy the ground. The broken face of the escarpment is usually covered with broad-leaved trees, such as maple, beech and birch, because it is well drained.

"The 'barrens' themselves are classified by the fruits they produce, as, blue-berry barrens, bake-apple barrens, etc., but the cause of all is the same. The soil is but a light covering and of a peaty nature. Owing to the impervious character of the rock below, all water that falls lies on the surface, producing marshes or peat-bogs, while the higher levels or slopes may be wet or dry forest or devoid of trees; in such cases they form 'blue-berry barrens.' The 'bake-apple barrens' are great bogs covered chiefly with *Rubus Chamæmorus* (the bake-apple) and a few ericaceous shrubs. Character of "Barrens."

"That this general statement is true is verified by the streams descending from the eastern side. These run in channels cut out of the granite, and have white sand in their beds and no mud, yet all the water discharged by them is dark-coloured and is nothing more nor less than the surplus bog water that has oozed over the rim of the various depressions at higher levels.

"The 'intervales' are the river-valleys, and these always have good soil, but during very high water are subject to overflow. Here the American elm (*Ulmus Americana*) attains a large size, and gives a more western character to the country than any other object. Here also are the best farms and the future seats of the cheese and butter industry which in the near future is certain to render Cape Breton wealthy. "Intervales."

"My chief scientific work in Cape Breton was of course in connection with its flora. A number of interesting species were collected in various parts of the island, and some new points as regards distribution brought to light. An island flora is always interesting and the comparatively Natural History collections.

small number of species that were of general distribution goes to show that the majority of the forms were late comers, as very many of them were found in only one or two localities.

"In the ravines at the Big Intervale, were very many beautiful ferns, prominent among which were the Male fern (*Aspidium Filix-mas*) and Braun's fern (*Aspidium aculeatum* var. *Braunii.*) Dr. Geo. Lawson many years ago found the Male fern by Ste. Ann Harbour and on the slopes of Smoky Mountain, and here too the writer found it in abundance. Another of Dr. Lawson's finds—*Potentilla Tormentilla*—was observed by me at Port Bevis, very near where he collected it.

"Notes were made on the birds seen during the summer but no specimens were collected.

Autumn collections.

"Early in September I returned to Ottawa and at once commenced to collect and examine the fungi of the neighbourhood, working steadily at this until the season was closed by severe frost early in November. Over 600 species were collected, and the great majority were determined, but there still remain a number of undetermined forms which require study.

"Since the close of the collecting season I have been engaged in determining the mosses; liverworts, lichens and fungi collected while in Cape Breton.

Work of assistant.

"My assistant, Mr. J. M. Macoun, remained in the office during the whole year, his only collecting being in the vicinity of Ottawa. No general collection was made, his work in the field being confined almost entirely to the two genera *Viola* and *Carex*. Three species of violets new to science were discovered near Ottawa, and one that had not before been found in Canada. About seventy species of *Carex* were collected and identified.

Determination of specimens.

"The routine work increases from year to year, and the number of specimens sent for determination has grown so large that much time is occupied in it. Small collections of a few species come from all parts of Canada, and during the year several collections of from 100 to 300 species have been determined. The specimens are often far from good and the time spent in determining them is frequently out of all proportion to the value of the information gained. I cannot, however, suggest any improvement in the way this work is now done, as from the most unpromising collections valuable information as regards the distribution of our plants is often obtained.

Work of local botanists.

"The most important botanical work now being done in Canada outside our own department, is on the east and west coasts of the continent. Mr. Lawrence W. Watson is working up the flora of Prince Edward Island, and Mr. J. R. Anderson, Deputy Minister of Agricul-

ture for the province of British Columbia, is doing work on similar lines on the west coast. These gentlemen and others working with them have sent their difficult species to us for determination, and while we have been of some assistance to them, their work has added much to our knowledge of the distribution of Canadian plants.

"The botanists of South-western Ontario are also doing good work and from J. Dearness, Public School Inspector, London, Ont.; Dr. J. Carroll and J. A. McCalla, St. Catharines, Ont.; J. M. Dickson, Hamilton, Ont., and W. Scott, Head Master, Normal School, Toronto, we have received valuable contributions to our knowledge of the flora of Ontario.

Geological Survey collections.

"The most important collections made by Geological Survey parties were those brought in by Mr. Jas. McEvoy and Mr. J. B. Tyrrell. Mr. Spreadborough, who was attached to Mr. McEvoy's party, though without any special botanical knowledge, made excellent collections of the plants of the Rocky Mountains east and west of the Yellow Head Pass, which may be considered to very completely represent the flora of that region. More than 500 species of flowering plants were brought back, besides many cryptogams. So far as his collection has been worked up, it includes only one new species, *Viola cyclophylla*. but the northern limit of many forms has been extended, and several plants were found by him that have not been collected since Drummond's time. His collection of skins, and notes on the fauna of the same region, add much to our knowledge of bird and mammal distribution. Mr. Tyrrell's collection of plants, though not large, included one species new to Canada and several that had not before been recorded from the Yukon District.

Published work.

"The records of new species and extensions of limits have been noted by my assistant and published either in the *Canadian Record of Science* or the *Ottawa Naturalist*. Reprints of these notes, as well as a list by myself of the cryptogams found in the vicinity of Ottawa, have been distributed to the principal natural history museums and the leading botanists of Europe and America.

"So much time has been spent on routine work, that the accumulated material of our own collecting of previous years has not yet been worked up; only 2515 sheets of specimens have been mounted, as follows:—

Canadian flowering plants	1,025
United States " "	466
Foreign " "	506
Cryptogams	518
	2,515

Plants distributed.

"The distributions from the herbarium have not been large, little time being available for this purpose. But 1740 specimens were sent out, nearly all of these being in exchange for specimens received in previous years."

Report by Dr. J. Fletcher.

Dr. James Fletcher, F.R.S.C., Entomologist and Botanist to the Central Experimental Farm, in his capacity as honorary curator of the entomological collections of the Geological Survey, contributes the following brief report:—

Entomological collections.

"I have the honour to report that the entomological collections are in good condition. The only additions made during the past year are some species from Banff collected by Mr. N. B. Sanson and some others collected by myself at the same place and in British Columbia. These referred to are all Lepidoptera. In addition I was glad to have an opportunity last autumn to secure a good series of Canadian specimens of the Rocky Mountains Locust (*Menaloplus spretus*, Uhler) together with some of its parasites. These were from southern Manitoba.

Lepidoptera at Banff.

"The collection of Lepidoptera for the Banff museum, made in accordance with your request, has been added to, and will, I trust, be of interest to the many visitors who call at the museum at Banff. Mr. N. B. Sanson has made some interesting captures. Mr. Dippie, of Toronto, has also presented a specimen of the rare *Agynuis astarte* for this collection, taken by him at Banff last summer. This species was taken in the Rocky Mountains early in this century by a collector sent out by Lord Derby; but the specimen was lost and the species was not again seen until re-discovered by Mr. I. E. Bean at Laggan a few years ago. That was the only known locality until Mr. Dippie took the specimen referred to, which, although in very poor condition, will serve to identify any captures that in future may be made at Banff.

"No collections were this year made by officers of the Geological Survey. If some of those who may go to the Yukon District could be induced to collect, every specimen sent in would be of extreme interest."

Maps.

Maps.

Mr. James White, Geographer and Chief Draughtsman, reports as follows on the mapping work and related subjects:—

"During the past year Mr. C. O. Senecal has compiled the additions to the 'Three Rivers' sheet of the 'Eastern Townships' map, and

to the 2nd edition of sheets I, II and III of the Yukon map, and autographed the map of the 'Corundum Belt.' Mr. L. N. Richard has compiled the Nottaway River map, completed the Western Nova Scotia map, and has made zinc-cut drawings for several reports. Mr. W. J. Wilson has been employed on the map of the Dominion, on general draughting work and has calculated the latitudes and departures of the surveys made by me last autumn. Mr. Wilson was detached from August 5th to October 25th to assist Mr. R. Chalmers in the area covered by the Fredericton sheet (1 N. W. New Brunswick). Mr. J. F. E. Johnston has completed the compilation of sheet 121, Ontario and Quebec. Mr. Johnston also assisted me in the field for a short time. Mr. O. E. Prudhomme has traced for the engraver seven plans of Nova Scotia gold districts, has been employed on the revision of portions of the map of the Dominion and has had charge of the stock of maps held for sale and distribution. Mr. W. M. Ogilvie was employed on general draughting work to February 28th, when he left to accept the position of mining engineer to a Yukon company. Mrs. Sparks has been employed on the cataloguing of the maps and plans since November 7th. Maps—*Cont.*

"There is at present a congestion of mapping work in the office, leading to delay in the preparation of several maps. An additional map-compiler is required to catch up with the work, particularly as the increasing demand for the maps of the Survey is rapidly exhausting them in certain districts, especially where mining development or prospecting is being carried on, necessitating the publication of revised editions of many of them. The additions and corrections required to bring these new editions up to date frequently involve almost as much labour and time as the preparation of a new map.

"During the year, eleven new maps and a second edition of the three sheets of the Yukon map were published and twenty-five maps are now being engraved or photo-lithographed. Amongst these are sheets 42 to 49 and 56 to 58, Nova Scotia, the colour-stones for which will be completed for printing as soon as certain questions connected with the geological classification are determined. A second edition of the Sydney coal-field maps is nearly ready for publication and will be issued early in 1899. Similar editions will shortly be required of the Rainy Lake, Moose River and Louisbourg sheets.

"The Glace Bay sheet has been engraved on copper and the West Kootenay and Three Rivers sheets are now being engraved. The capability of showing minuter details, its lightness and the fact that corrections and additions can be made by 'beating up' without injuring the other work, gives the copper-plate many advantages over the stone. It

Maps—*Cont.* is therefore desirable that all maps of the standard series should be engraved on copper, thus allowing the publication of subsequent editions, with corrections, with the quality of the work unimpaired.

"The compilation of the altitudes of the Dominion has been continued and much information on the subject has now been collected, which, however, requires a great deal of collation and arranging before publication. Information has been supplied to members of the staff and others who have applied from time to time.

"From March 14th to 25th was spent by me in Montreal, copying levels from the profiles in the Grand Trunk and Canadian Pacific Railway offices. It is to be regretted that the engineers of railways do not generally recognize the usefulness of such a compilation and, as has been done in the United States, furnish blue-prints of their condensed profiles. A general knowledge of the altitudes of a district through which a proposed line of railway is to run, would often save a company thousands of dollars and much time. Many of the railway profiles filed in the Department of Railways and Canals are inaccurate and deficient in information as regards the position of stations and other important points, which increases the difficulties encountered in reducing the levels to a common plane of reference and in correlating them with those of other railways.

"From September 7th to October 7th was spent in the field. Transit and chain traverse-lines were carried, by way of the Canadian Pacific Railway, from Ottawa to Sharbot Lake, 90 miles, from Carleton Junction to Chalk River, 98 miles, and by way of the Kingston and Pembroke Railway, from Renfrew to Barryvale, 16 miles. These will form base-lines for the compilation of sheets 119 and 122 of the Ontario series and, with the work of previous years, give a traverse of Ontario from Ottawa to Georgian Bay with a connection, at Kingston, with the triangulation of the U. S. Coast and Geodetic Survey. Unfortunately, circumstances prevented the extension of the Chalk River line to Mattawa which has been determined in longitude by the Department of the Interior and Quebec Government. Similar traverses were also made of the M. & O., C. A., N. Y. & O., St. L. & O., and C. P. R. (North Shore) railways in the vicinity of Ottawa, to form a basis for a map on a scale of one mile to one inch, of the city and surrounding country within a radius of ten miles.

"The following positions have been determined by the surveys of the past summer :—

	Long.	Lat.
Ottawa, flagstaff Parliament Buildings...	75° 42′ 02.″8	45° 25′ 28″
Stittsville station.....	75° 55′ 20″	45° 15′ 31″
Carleton junction.....	76° 08′ 21″	45° 08′ 09″

Maps—*Cont.*

	Long.	Lat.
Franktown station	76° 04′ 56″	45° 01′ 39″
Perth "	76° 14′ 54″	44° 54′ 18″
Maberly "	76° 31′ 13″	44° 49′ 57″
Sharbot Lake "	76° 41′ 39″	44° 46′ 27″
Arnprior "	76° 21′ 39″	45° 26′ 03″
Sand Point "	76° 26′ 09″	45° 29′ 19″
Renfrew "	76° 41′ 04″	45° 28′ 31″
Pembroke "	77° 05′ 41″	45° 49′ 48″
Chalk River "	77° 25′ 58″	46° 00′ 58″
Calabogie "	76° 42′ 12″	45° 18′ 20″

"Below are some magnetic declinations deduced from readings of a five-inch needle on the transit :—

Ottawa, Sept., 1898	11° 45′
Franktown, Sept., 1898	11° 25′
Elmsley " "	10° 46′
Perth " "	10° 00′
Arnprior " "	10° 40′
Calabogie " "	10° 10′
Cobden " "	10° 00′
Graham " "	9° 15′
Pembroke " "	9° 20′
Petewawa " "	9° 45′
L'Amable P. O., Sept., 1896 (mean of two)	8° 20′
Ormsby " "	8° 40′
Gelert, Sept., 1895	6° 50′
Kinmount, Sept., 1895 (mean of eight)	8° 02′
Oakhill P. O. " " (mean of two)	6° 37′
Horncastle P. O. " "	6° 13′
Dalrymple P. O. " "	6° 35′
Silver Creek station, Sept., 1895 (mean of two)	5° 30′

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

Maps printed in 1898.

		Area in square miles
275	Yukon District and Northern portion of British Columbia—Sheet I —Dease and Stikine Rivers (2nd edition)—Scale 8 miles to 1 inch.	36,540
276	Yukon District and Northern portion of British Columbia—Sheet II —Upper Liard, Frances and Pelly Rivers (2nd edition)—Scale 8 miles to 1 inch.	36,540
277	Yukon District and Northern portion of British Columbia—Sheet III —Lower Pelly River and Lewes and Taiya Rivers (2nd edition)—Scale 8 miles to 1 inch.	45,680
639	Ontario—Corundum Belt in Hastings and Renfrew Counties—Scale 5 miles to 1 inch.	755
624	Nova Scotia—Sheet No. 50—Moose River Sheet—Scale 1 mile to 1 inch.	216
654	Nova Scotia—Sheet No. 135—Glace Bay Sheet—Scale 1 mile to 1 inch.	216

Maps—*Cont.*

		Area square miles
641	Nova Scotia—Western Nova Scotia—Scale 8 miles to 1 inch.....	6,850
622	" —Killag Gold District—Scale 500 feet to 1 inch.....	
642	" —Oldham Gold District—Scale 500 feet to 1 inch.....	
643	" —Caribou Gold District—Scale 500 feet to 1 inch.....	
645	" —Goldenville Gold District—Scale 250 feet to 1 inch....	
646	" —Moose River Gold District—Scale 250 feet to 1 inch....	
647	" —Salmon River Gold District—Scale 250 feet to 1 inch..	
649	" —Forest Hill Gold District—Scale 500 feet to 1 inch....	

Maps, engraving or in press.

	Dominion of Canada, 2 sheets, each 28" x 34", including the Dominion from the Atlantic to the Pacific and from the International boundary to Hudson Strait and Great Bear Lake—Scale 50 miles to 1 inch.....	3,500,000
604	British Columbia—Shuswap Sheet—Geology—Scale 4 miles to 1 inch.....	6,400
669	British Columbia—Shuswap Sheet—Economic Minerals and Glacial Striæ—Scale 4 miles to 1 inch.....	6,400
663	British Columbia—West Kootenay Sheet—Scale 4 miles to 1 inch...	6,400
664	Manitoba and Keewatin—Lake Winnipeg Sheet—Scale 8 miles to 1 inch.....	45,680
605	Ontario—Sheet No. 126—Manitoulin Island Sheet—Scale 4 miles to 1 inch.....	3,456
630	Ontario—Sheet No. 129—Mississauga Sheet—Scale 4 miles to 1 inch..	3,456
626	Ontario—Map showing the occurrences of Iron Ores and other minerals in portions of the counties of Frontenac, Lanark, Leeds and Renfrew—Scale 2 miles to 1 inch.....	1,700
667	Ontario and Quebec—Sheet No. 121—Grenville Sheet—Scale 4 miles to 1 inch.....	3,456
665	Quebec—North-west Sheet "Eastern Townships" map—Three Rivers Sheet—Scale 4 miles to 1 inch	7,200
593	Nova Scotia—Sheet No. 42—Trafalgar Sheet—Scale 1 mile to 1 inch.	216
598	" —Sheet No. 43—Stellarton Sheet—Scale 1 mile to 1 inch.	216
600	" —Sheet No. 44—New Glasgow Sheet—Scale 1 mile to 1 inch.....	216
608	Nova Scotia—Sheet No. 45—Toney River Sheet—Scale 1 mile to 1 inch.....	216
609	Nova Scotia—Sheet No. 46—Pictou Sheet—Scale 1 mile to 1 inch...	216
610	" " —Sheet No. 47—Westville Sheet—Scale 1 mile to 1 inch.	216
633	" " —Sheet No. 48—Eastville Sheet—Scale 1 mile to 1 inch.	216
634	" " —Sheet No. 49—Musquodoboit Sheet—Scale 1 mile to 1 inch.....	216
624	Nova Scotia—Sheet No. 50—Moose River Sheet—Scale 1 mile to 1 inch.....	216
635	Nova Scotia—Sheet No. 56—Shubenacadie Sheet—Scale 1 mile to 1 inch.....	216
636	Nova Scotia—Sheet No. 57—Truro Sheet—Scale 1 mile to 1 inch....	216
637	" " —Sheet No. 58—Earltown Sheet—Scale 1 mile to 1 inch.	21
652	" " —Sheet No. 133—Cape Dauphin Sheet—Scale 1 mile to 1 inch.....	216
653	Nova Scotia—Sheet No. 134—Sydney Sheet—Scale 1 mile to 1 inch.	216
648	" " —Mooseland Gold District—Scale 250 feet to 1 inch.....	

		Area square miles	Maps—*Cont.*
650	Nova Scotia—Fifteen-mile Stream Gold District—Scale 500 feet to 1 inch		
656	Nova Scotia—Upper Seal Harbour Gold District—Scale 500 feet to 1 inch		
	Nova Scotia—Sheet No. 53—Lawrencetown Sheet—Scale 1 mile to 1 inch	216	

Maps, compilation incomplete.

Western Ontario—Sheet No. 4—Manitou Sheet—Scale 4 miles to 1 inch	3,456
Ontario—Lake Nipigon map—Scale 4 miles to 1 inch	
Quebec—Basin of Nottaway River—Scale 10 miles to 1 inch	56,800
New Brunswick—Sheet 1 N. W.—Fredericton Sheet—Surface Geology—Scale 4 miles to 1 inch	3,456
New Brunswick—Sheet 2 S. W.—Andover Sheet—Surface Geology—Scale 4 miles to 1 inch	3,456
Mineral Occurrences in New Brunswick—Scale 10 inches to 1 inch	38,000
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 and 66-69—Scale 1 mile to 1 inch	1,296

LIBRARY.

Library and publications.

Dr. Thorburn, librarian, reports that during the year ended December 31st, 1898, there were distributed 7,852 copies of the Geological Survey publications, consisting of reports, special reports and maps. Of these 5,803 were distributed in Canada, the remainder, 2,049 were sent as exchanges to other countries.

There were received as exchanges 2,778.

The number of publications purchased was 161, and in addition there were 30 periodicals subscribed for.

The number of letters dealing with library matters sent out during the year, was 1,217, besides 694 acknowledgments.

The number of letters received was 1,542 and of acknowledgments 656.

The number of publications sold was 4,730, for which $1,035.77 was received.

The number of volumes bound during the year was 207.

There are now in the library about 12,500 volumes, in addition to a large number of pamphlets.

NOTE.—The books in the library can be consulted during office hours by any one who wishes to obtain information on scientific subjects.

Visitors to Museum.

Visitors to Museum.

The number of visitors to the Museum during the year 1898 has been 33,183, being an increase on that registered during any previous year.

Staff, Appropriations, Expenditure and Correspondence.

Staff.

The strength of the staff at present employed is forty-eight.

During the year the following changes have taken place :—

Mr. W. F. Ferrier, resigned.

Mr. James M. Macoun, appointed assistant naturalist.

Appropriation and expenditure.

The funds available for the work and the expenditure of the Department during the fiscal year ending the 30th June, 1898, were :—

——	Grant.	Expenditure.
	$ cts.	$ cts.
Civil list appropriation	50,600 00	
Geological Survey appropriation	50,000 00	
Boring appropriation	7,000 00	
Civil list salaries		49,904 12
Exploration and survey		18,815 57
Wages of temporary employees		11,473 93
Boring operations		7,000 00
Printing and lithography		12,939 46
Purchase of books and instruments		2,095 75
" chemical apparatus		34 20
" specimens		540 50
Stationery, mapping materials and Queen's Printer		1,076 21
Incidental and other expenses		1,404 21
Advances to explorers on account of 1898-99		17,288 15
		122,572 10
Deduct—Paid in 1896-97 on account of 1897-98 $16,250.00		
Less—Transferred to casual revenue 582.02		
		15,667 98
		106,904 12
Unexpended balance civil list appropriation		695 88
	107,600 00	107,600 00

The correspondence of the Department shows a total of 9241 letters sent, and 8896 received.

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

GEORGE M. DAWSON,
Deputy Head and Director.