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 1899

BY

THE DIRECTOR

OTTAWA

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OTTAWA, January 20, 1900.

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

SIR,—As required by the Act relating to the Geological Survey Department, I have the honour to submit this the Annual Summary Report, giving an account of the condition and work of the Survey during the calendar year 1899.

Character of information given in this report.

It has in late years been found advantageous to increase the length of some of the reports included in this Summary, in order to afford a prompt means of publication of the more important results, particularly of those accruing from field-work and exploration. This, in a measure, meets the demands made for early information in regard to districts in which the staff of the Survey is known to be engaged, although several years of work are generally necessary for the complete examination of any particular area, and time is also required for the study of specimens collected and the compilation and engraving of suitable maps. This Summary Report also gives an annual statement of the executive work of the department.

Contents of last Annual Volume.

Volume X of the new series of Annual Reports of the Geological Survey (English Edition) was completed for issue before the close of the year. The edition in French is still in progress at the Printing Bureau. The volume, as issued, comprises 1,046 pages, with numerous illustrations, and is accompanied by eight maps.

The reports included in this volume, each of which had previously been issued separately, are as follows :—

Summary Report of the Geological Survey Department for 1897, by the Director.

On the Geology of the Area covered by the Seine River and Shebandowan map-sheets by W. McInnes.

Report on the Area covered by the Nipissing and Temiscaming, map-sheets by A. E. Barlow.

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 of Volume XI.

Of the report by Professor Bailey, on the Mineral Resources of New Brunswick, a special edition was struck off and supplied to the government of that province, at the expense of paper and press-work.

The printing of part of Volume XI (new series) is in progress, and the manuscripts of most of the reports which will be included in that volume are in hand, while some of the maps intended to accompany it are ready. It may be explained that, in the case of such maps completed before the reports to accompany them can be printed, the maps themselves are not withheld from the public, but may be obtained by any one requiring them at the usual nominal rate of ten cents per sheet. A very considerable number, for instance, of the completed plans of gold districts in Nova Scotia have thus been issued to meet immediate requirements, brought about by the recent mining developments in connection with the auriferous veins of that province.

Other publications.

The preliminary statistical abstract of the mineral production of Canada in 1898 was completed for issue on February 21, 1899.

In the palæontological series of publications, Part 1 of Volume IV, *Contributions to Canadian Palæontology*, by Mr. L. M. Lambe, has been completed and printed, while the plates for Part 4, Volume I of *Mesozoic Fossils*, by Mr. J. F. Whiteaves, have been struck off and the MS. of the text is in the printer's hands.

The printing of the first part of a systematic *Catalogue of Canadian Birds*, by Professor J. Macoun, is well advanced toward completion, and this should now soon be ready for issue.

In connection with the issue of three revised map-sheets of the Sydney coal-field in Cape Breton, a short descriptive pamphlet has been compiled by Mr. H. Fletcher, and is at the present moment in press.

Maps printed.

During the year 1899, fourteen maps have been completed and printed. These, together with those in process of engraving or compilation, are enumerated in the report of the Chief Draughtsman on a later page.

Correspondence.

The correspondence dealt with in my own office has, during the past five years, more than doubled in volume, a result largely due to the increasing interest taken in mining and related industries in all parts of Canada. Many of the inquiries received require more or less

reference or examination in order that they may be suitably answered, and this occupies a good deal of time in the aggregate. It is, however, one of the most direct ways in which the information gained by the Survey may be usefully applied, whether in regard to questions of a purely technical character, or merely in the way of placing producers and consumers of various mineral substances in communication.

Minerals and ores inquired for.

The following are among the ores and minerals that have been particularly inquired for by intending purchasers during the past year, in alphabetical order:—Amber, apatite, borax and borates, corundum, chromic iron ore, chalk, clays for various purposes, dolomite or magnesian limestones (chiefly for use in wood-pulp manufacture), felspar, graphite or plumbago, hæmatite ores free from sulphur, limestone (pure, for the manufacture of calcium carbide), magnetic iron sands, magnetite, manganese ores, marbles, molybdenite, nickel ores, ochre, onyx, petroleum, platinum, peat deposits, pyrites (iron or copper, for use as sulphur ore), sand for glass making, shell marls, soapstone, vanadium, wolframite.

In addition to the above, there has been much general inquiry in regard to iron ores and copper ores of all classes, consequent on the high prices ruling for those metals, as well as with reference to gold, silver and zinc deposits.

Work connected with Paris exhibition.

Preparations for the representation of the mineral products of Canada at the forthcoming exhibition in Paris have necessarily occupied much of my own time during the past year. It had been decided that the Canadian exhibit, in whatever lines, should be given a general or Dominion character; the very limited amount of available space, apart from other considerations, rendering it undesirable, if not impossible, to contemplate the separate participation of the several provinces as such in this international event. The restricted space accorded to the geological, mining and metallurgical exhibits, also rendered it apparent that it would be unwise to attempt to give the prominence to the scientific side of the work of the Geological Survey that has usually been possible in previous exhibitions, where palæontological, lithological and natural history collections have been displayed and recognized by awards and honorary mention. It was in fact determined, at an early date, to confine the representation of Canada almost entirely to an adequate display of the economic minerals of the country.

Exhibit purely economic.

Collection representing Canada as a whole.

Having been appointed one of the Exhibition Commissioners for Canada, and particularly charged with the organization of the exhibit in the above-mentioned classes (included under Group XI of the official general classification), I at once entered into correspondence with the provincial authorities with the object of securing their active sympathy

and coöperation in the work in hand. In some cases there appeared to be a very distinct feeling in favour of a provincial representation, or even for the representation of certain regions or mining districts separately. Appropriate as such a local arrangement might be in any exhibition held within the limits of Canada, it was felt that in going to a foreign country Canada should appear as a whole. This is particularly the case in regard to mineral products and mines, for it is to Canada as a whole that we may hope to attract capital, and in regard to which confidence may be induced. Subordinate to this general aspect the several districts and 'camps,' with their respective products, more or less distinct in conditions and nature and characterized by their differences, afford a second line of classification, leading the enquirer interested in coal, iron, copper or any other product to the particular places in Canada where it is worked or known to exist.

Coöperation of provincial authorities.

After some little discussion of the above and other considerations bearing upon the general plan of exhibition of mineral products, no difficulty was met with in obtaining the coöperation of the provincial authorities, and the Mining Bureaus of British Columbia, Ontario and Nova Scotia have particularly exerted themselves to procure and furnish suitable specimens of economic minerals. Where gaps in the general representation appeared likely to occur, special measures have been taken directly by the Geological Survey, and the resulting collection—already for the most part on its way to Paris —will, it is believed, prove to be the most complete of its kind ever prepared by Canada for any international exhibition.

Specimens dealt with and catalogued at Ottawa.

All the collections have been forwarded to Ottawa for arrangement, cataloguing and repacking, or have been examined and sent forward from other points under the supervision of the Survey. Mr. C. W. Willmott has been particularly efficient and painstaking in this work, to which he was detailed.

Special exhibition publications:

A descriptive catalogue of the Canadian mineral exhibits as a whole is in course of preparation under the supervision of Mr. E. D. Ingall, and it is intended to print large editions of this both in English and French for use and distribution during the exhibition. It is likewise intended to print a special edition of the detailed report of the section of Mineral Statistics and Mines for the purpose of the exhibition. Special editions of one or more of the provincial reports have also been promised, and previous issues of these reports as well as of the reports and maps of the Geological Survey will be sent to Paris for purposes of reference.

The number of Canadian entries under Group XI, at the present time exceeds one thousand, and to this considerable additions are likely to be made before the date of opening of the exhibition.

Director's visits of inspection in the field.

The above-mentioned work in connection with the preparation of the collection for Paris, involving correspondence with all parts of the Dominion, rendered it more than usually difficult for me to devote any considerable time to inspection or examination of work going on in the field. During the autumn, however, a few days were spent with Dr. Adams and Mr. Barlow, in that part of Central Ontario where they have been engaged for several seasons in determining and mapping the relations of the old crystalline rocks—more particularly those of the Hastings and Grenville series. The field-work necessary for the map and report on this district is now nearly completed. It is being elaborated, so far as possible, as a typical district, and interesting and important results have been developed, as explained by Messrs. Adams and Barlow on a later page of this report.

A short time was also given, at a later date, in company with Mr. W. McInnes, to the inspection, of the contacts in the vicinity of Thunder Bay of the Animikie formation with the older Keewatin (Huronian) and Laurentian rocks of that vicinity. This is a crucial question from a classificatory point of view, and the facts noted by us are entirely confirmatory of the observations already made by Dr. Selwyn and originally by Sir William Logan, leaving no room for doubt as to the entire unconformity of the Animikie upon the Keewatin schists and foliated granitic rocks with which they are there associated.

Work proposed on iron ore district of Western Ontario.

The extraordinary activity manifested in the extraction of iron ores in the northern portion of Minnesota, adjacent to that district of Ontario situated to the south-west of Thunder Bay, appears to render it immediately desirable that the part of the province referred to should be subjected to a careful geological examination and properly mapped. Here, as in Michigan and Minnesota, iron ores are known to occur both in the Keewatin and Animikie rocks; those of the Matawin and Atikokan districts, upon which numerous claims have been taken up and some work of an exploring character has been done, being referable to the first-named formation. These ores are chiefly magnetites, but there seems to be some possibility that 'soft ores,' for which so great a demand now exists because of the facility of their extraction at a low cost, may yet be discovered in important quantity, particularly in association with the Animikie rocks, within the area occupied by which a number of claims have also been taken up. It is therefore proposed, during the coming season, to undertake work upon the map-sheet immediately to the south of the Shebandowan sheet, or No. 8, in the Western Ontario Series. As about half of the rectangular area of this sheet overlaps the State of Minnesota, the survey of its Canadian portion should not occupy a very long time.

Necessity for new museum building.

Since the date of the last Summary Report, no substantial progress has, unfortunately, been made toward the provision of a suitable building for a museum and offices of the Geological Survey. Preliminary plans have, however, been drawn, and the necessity for such a building has been strongly supported in the House by members of Parliament during the past session. So far no material loss has occurred, except that of a negative character arising from the impossibility of properly representing the mineral wealth of the country to the public, and particularly to the large and increasing number of mining men from all parts of the world who now visit Ottawa. The risk of the total loss of the collections of the Survey by fire, continues, however, to be excessive, and particularly in respect to the large number of type specimens contained in the collections, it is difficult to exaggerate the serious character of the situation. It must be remembered that the present unsafe building also holds the entire reserve of publications of the Survey for past years, including maps and reports, together with many thousand plans and books of field notes, all frequently in requisition for the purpose of affording information to the public. It would be a neglect of my duty as Director of the Geological Survey to fail to again point out, in the strongest possible terms, the extreme importance of the immediate provision of fire-proof and commodious quarters for the museum and offices.

National museum advocated by Sir W. Logan.

In this connection it is interesting to note that in his Report of Progress for 1851–52, Sir William Logan, under whom the Geological Survey had already been in progress for some years, writes as follows of the quarters at that time assigned to the Survey in Montreal, with its then small collection: 'The building in which the government has at present lodged the Survey, is as well calculated for the display of these various objects as any one not expressly erected as a museum can be expected to be, but some outlay would be required for fittings. It may, however, be a consideration whether a growing country like Canada could not afford to anticipate what its future importance may require in the nature of a national museum, and at some time not far distant, erect an appropriate edifice especially planned for the purpose.'

Forty-seven years have passed since this was written, but the objection then outlined by Logan has not yet been attained. It is to the credit of Canada that the current work of the Survey has never since its inception been absolutely interrupted by the failure of financial support; but the accumulated results of this work, both of a scientific and practical kind, have been increasing from year to year, and it would indeed be unfortunate if these should eventually be lost to the country.

Mr. B. E. Walker on Canadian museums.

Mr. B. E. Walker, in his late address as president of the Canadian Institute at Toronto, has directed attention in a very forcible way to the requirements of Canada in the matter of explorations, surveys and museums, from a strictly practical point of view. His remarks on the last-mentioned point may appropriately be quoted here. He says:—

'The Dominion Government at Ottawa and each province, at its city of chief importance, should have a museum belonging to and supported by the people. These museums should contain exhibits of the metallic and non-metallic minerals of the country, both those of economic and of merely scientific value, the forest trees, with the bark preserved, in say six feet sections, cut also and partly polished, and each specimen accompanied by a small map showing its habitat; the fresh water and sea-fishes mounted after the modern methods; the fur-bearing animals, the game birds and the birds of our forests, fields and sea-coast, many of them mounted so as to tell a child their habits at a glance; the reptiles, crustaceans, insects, plants, indeed as complete a record of the fauna and flora of the country as possible; the rocks of stratigraphic importance and all the varieties of fossils which can be gathered in this country; the archæological and ethonological evidences of the races we have supplanted in Canada, and much more that does not occur to me at the moment. I should not like to suggest a limit of expenditure on such museums. The necessity of a new building at Ottawa is admitted. The crime of leaving exposed to fire, in a wretched building never intended to protect anything of value, the precious results of over fifty years of collecting, has been pointed out in a recent official report. . . . . .
I can only repeat that we are rich enough to bear the cost with ease, but we are not intelligent enough to see our own interest in spending the money.'

Additions to ethnologica collection.

Several rather important additions have been made to the ethnological collections during the year, chief among which is the acquisition of the Aaronson collection by purchase. This collection comprises over 500 objects, many of them old and rare, derived from the Indian tribes inhabiting the coast of British Columbia. There is not sufficient space to display these in the present condition of the Museum, but the opportunities of obtaining such valuable material are so fast passing away that it was thought desirable to acquire this collection, even if it must for the present be merely stored. Dr. C. F. Newcombe, of Victoria, kindly supervised the listing, checking and packing of the collection. We are also indebted to Dr. Newcombe and to Mr. C. Hill-Tout for frequent assistance in connection with specimens of the kind from British Columbia.

Field-work.

The number and distribution of the field parties employed during the past summer, may be stated as below :—

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

Special examinations in the field.

In addition to the above-mentioned parties occupied in the field during the greater part of the season, special examinations or inquiries were carried out by other members of the staff. Dr. Ami continued palæontological investigations in parts of Nova Scotia and New Brunswick. Mr. Willimott visited a number of places for the purpose of obtaining specimens for the Paris Exhibition ; Mr. Denis spent some weeks in inquiring into recent developments of the oil and gas fields of Ontario, and Prof. Macoun visited Sable Island.

By Professor Osann.

Professor A. Osann, of Mülhausen, Germany, the distinguished petrographer with whom some correspondence had been carried on in regard to petrographic work, having volunteered to carry out some such work on terms very advantageous to the Survey, arrangements were made for this and Dr. Ells and Mr. Ingall accompanied him in the field for several weeks. The special problem to which Professor Osann directed his attention while in Canada, was the nature of the rocks associated with the apatite and graphite deposits found in that part of Quebec north of the Ottawa River. Large suites of specimens were collected, of which sections for microscopical study are now being made, and the report which Professor Osann is to furnish upon this work will be awaited with much interest.

By Dr. Matthew.

Dr. G. F. Matthew of St. John, New Brunswick, who has long devoted himself to the study of the older faunas, and particularly to that of the Cambrian in eastern Canada, was induced to undertake for the Survey an examination of the Cambrian of Cape Breton Island. A short preliminary report of Dr. Matthew's is given on a later page.

By Professor Dresser

The Survey is also indebted to Professor J. A. Dresser, of Richmond, Quebec, who has continued his petrographic examination of Shefford Mountain. A statement in regard to this work is given further on,

and it appears that it may now be possible to complete a detailed report upon this limited area which presents some features of particular interest.

Experimental Borings in Northern Alberta.

Boring operations were resumed early in the summer at Victoria, on the Saskatchewan, where a depth of 1,650 feet had been attained when work stopped in the autumn of 1898. It was anticipated that a depth of some 2,000 feet would have to be reached at this place before the possibly petroleum-bearing strata of the base of the Cretaceous formation would be penetrated and tested. From the report of Mr. W. A. Fraser, the contractor for the work, given below, it will be found that it proved impossible to carry the boring beyond 1840 feet. Operations were then suspended, and after extracting as much of the casing from the hole as possible and storing this and other Government property, the contractor and his men returned. Boring operations for petroleum.

As explained in previous Summary Reports, the difficulties met with in carrying out these experimental borings have proved to be exceptionally great. To this there are several contributary circumstances, but the principal one is the generally soft and incoherent character of the great mass of the overlying Cretaceous rocks to be penetrated. This renders it necessary to case every bore-hole throughout and to carry down the casing *pari passu* with the drill. When casing of any particular diameter can be driven no further, another and smaller one requires to be provided, and the liability to accidental stoppage of the casing is so serious that the only certain means of attaining great depths would consist in beginning with a bore-hole and casing of very large diameter. This, of course, would imply greatly increased cost. Exceptional difficulties met with.

The first boring was that undertaken at Athabasca Landing, and this was carried to a depth of 1,770 feet, when it had to be abandoned without actually reaching the basal beds of the Cretaceous formation. Following this, a boring was put down on the Athabasca near the mouth of the Pelican River, about ninety miles down-stream from the Landing. The thickness of the overlying beds was here known to be much less and the boring reached a total depth of 837 feet, actually penetrating in part the lower beds of the Cretaceous and revealing the presence of a thick petroleum or maltha, together with that of a great quantity of natural gas. The gas rendered it impossible to prosecute this boring further. The third boring, that at Victoria, has already been referred to above. Resumé of borings carried out.

For particulars in regard to the borings and general conditions of occurrence of the great quantities of tar or maltha in the lower rocks of the Cretaceous in the Athabasca region, (believed to indicate the existence of an important oil-field) reference may be made to previous Indications still favourable.

Summary Reports, and particularly to that for 1898. It may here be repeated, however, that the failure in two cases to actually test the lower beds of the Cretaceous which were sought, has not in any way decreased the probability of ultimate important developments in this great northern region. The information gained in regard to the thickness, character and continuity of the strata is of much value and such as to materially assist in further operations, which will undoubtedly be undertaken in the near future.

Summary of results attained.

In the present condition of the work, it appears to be of interest to bring together, in a generalized form, the sections found in the several bore-holes which have been given in detail, as operations progressed, in previous reports.

With the assistance of Mr. R. G. McConnell, the driller's log of the Victoria borings, as well as the entire suite of specimens accompanying it, have been carefully examined and compared with his measured section on the Athabasca River, and with the logs of the borings at Athabasca Landing and Pelican River. In the accompanying table an attempt is made to show, in comparative form, the equivalency and thickness of the formations penetrated in the several bore-holes. The Athabasca River section will be found in the Annual Report, Vol. V. (N.S.) part D. The table may also be compared with the sections given by Mr. Tyrrell and myself for parts of Alberta further to the south, in Vol. II. (N.S.) part E, and in the Report of Progress, 1882-84, pp. 112c to 118c.

Comparison of sections in borings.

The section met with in the Victoria bore-hole is evidently intermediate in character between that of the Athabasca and that of Southern Alberta, but more closely corresponds with the former. The Belly River brackish-water and fresh-water formation that forms so important an intercalation at or about the base of the Pierre proper in the south, cannot here be recognized. The lacustrine or estuarine conditions producing it have, apparently, not extended so far to the north. This formation was recognized by Mr. Tyrrell on the Battle River and probably as far north as the Vermilion River, as indicated in his report above referred to and on the map accompanying it.

On the other hand, the upper part of the Victoria section seems to correspond very closely with the Pierre proper of Southern Alberta, showing, as in the Red Deer River sections, about 500 feet of brownish or 'coffee-coloured' shales at the top,* but having, apparently, in the aggregate a somewhat greater volume. It appears also to be a little thicker than the upper part of the La Biche shales assigned to the Pierre on palæontological grounds by Mr. McConnell.

* Report of Progress, Geol. Surv. Can., 1882-84, p. 115c.

In the sections on the Athabasca, including the borings at Athabasca Landing and Pelican River, the persistence of the Pelican and Grand Rapids sandstones render it possible to fix equivalency of horizons with considerable accuracy, but neither of these sandstone intercalations occur in recognizable form at Victoria, and it does not appear to be possible to draw any line of demarcation until a depth of about 1,500 feet is reached, at which depth it seems probable that beds representing the Grand Rapids sandstones may be entered. The assignment of beds made to this formation, however, as well as that in the case of the underlying Clearwater shales, can not be accepted as at all definite. It is based on such indications as the specimens afford, together with a consideration of the relative thickness of the shaly beds met with, which, it may be assumed, is probably pretty constant in this region at places not very remote from each other. Equivalency fixed with difficulty Victoria

From all the evidence now available, it would appear that the Victoria bore-hole penetrated to within about 250 feet of the top of the 'Tar-sands,' should these occur here, this horizon being at a depth of about 2,100 feet from the surface. At Athabasca Landing the bore-hole probably reached to within a very few feet of the top of the 'Tar-sands,' which may there occur at a depth of about 1,800 feet. At the Pelican River the same horizon was reached, nearly as anticipated, at 750 feet from the surface, and the 'Tar-sands' were penetrated for a further depth of eighty-seven feet before the gas and tar necessitated the abandonment of the work. Horizons at which boring terminated.

The depths above given may practically be considered as measured from the water-levels of the Saskatchewan and Athabasca rivers at the places mentioned, as all the borings began on low river-flats.

The thickness of the 'Tar-sands' where measured in natural exposures by Mr. McConnell, further down the Athabasca, varied from 140 to 220 feet. Had it been possible to do so, the attempt would have been made not only to traverse this formation, but to penetrate the Devonian limestone which is supposed continuously to underlie it, as it is no doubt from these Devonian rocks that the petroleum or maltha accumulated in the 'Tar-sands' has originally been derived. Probable source of oil

On the right-hand margin of the table, the probable equivalency of the formations met with in the borings with those recognized to the south and south-east is indicated. The reference of the several lower formations to the Dakota, depends upon observations made on the Athabasca River by Mr. J. B. Tyrrell, in accordance with which the Grand Rapids sandstones, Clearwater shales and 'Tar-sands' appear to represent a marine formation of that period with a nearly homogeneous fauna.* The Belly River formation is, as above indicated, Comparison of sections with others.

* Ottawa Naturalist, May, 1898.

probably represented by shales of marine origin, but these do not appear to show the highly calcareous character of the typical Niobrara group, as recognized in parts of Manitoba and in the region to the south of that province, although the Belly River and Niobrara are undoubtedly, in part at least, contemporaneous.

The table here given will, it is believed, serve as a useful reference in connection with further boring operations.

Report on Victoria bore-hole.

Mr. W. A. Fraser's report upon the operations at Victoria is as follows :—

'Boring operations at Victoria had ceased in the fall of 1898 with the sudden stopping of the $4\frac{5}{8}$ inch casing at a depth of 1,650 feet.

'It was thought that by introducing 4 inch casing into the boring it might be carried on down to the desired depth of 2,000 feet or more. To this end the necessary casing was purchased, the 4 inch tools brought up from Pelican River, and improved patent under-reaming bits obtained for these small tools. A very efficient staff was engaged, including the same driller who had been in charge of the boring during the preceding season.

'As had always been the case in the different borings which had been sunk in Alberta, great caving was encountered continually. But the drilling progressed favourably up to the very day the casing became jammed so tight that it could neither be pulled up nor driven down.

'The driller was of the opinion that a piece of the hard sandstone had fallen in beside the casing and wedged it. This had occurred twice before during the season's drilling. Each time he had managed to loose the casing again without great difficulty, but this time it resisted all our efforts.

Cause of stoppage of work.

'The driller, Mr. William Slack, had been a master-driller for at least thirty years, had drilled in different foreign countries, and had great experience and a high reputation as an exceedingly skilful, careful driller. During my own twenty-three years of experience I had acquired a fair knowledge of the work, but our united efforts could not avail, assisted by the very best and latest improved machinery, to overcome that seemingly simple accident of the casing having become wedged hard and fast at a depth of 1,840 feet. We pulled on it with strong iron blocks and broke spruce logs 18 inches in diameter used as levers. We pulled to the last limit of the strength of the casing and might have pulled it in two, but that would have availed nothing; besides it would in all probability have prevented us from saving the several thousand feet of casing we eventually recovered from the bore. We also drove on it with a large sinker until we battered in the end of the top length. No blame could be attached to any one in connection with this unfortunate ending.

'I then wired to the Department at Ottawa asking for instructions. In compliance with your answer I recovered from the boring the casing as per list furnished you by me.

'At this depth, 1,840 feet, there was no indication of petroleum nor any indication of the "Tar-sands," encountered at 800 feet in the Pelican boring on the Athabasca. It appears to me probable that if the "Tar sands" exist here they are at a very great depth.

'In compliance with your instructions all the casing was carefully piled, an inventory taken and forwarded to you. All the government property other than casing, was taken to Edmonton, and stored in the Hudson's Bay Company's warehouse, and inventory also furnished to you. Casing and appliances stored.

'The work for the season has been uneventful, with the exception of the sudden stoppage of progress, so there is little of interest to chronicle.

'If further borings are to be made in that section the experience of the past may be of value. The bore-holes will need to be commenced with a very large diameter, and a higher price paid for the work in consequence. Indications for further borings.

'I append the record of strata pierced as kept by the driller in charge. It was monotonously recurrent in irregular thickness, sandstone and shale.

'These strata of hard sandstone make the drilling precarious and difficult. The soft shale caves away and leaves no supporting wall to guide the tools straight through the hard strata, and the caving clogs the bit so that the casing must constantly be kept within a few feet of the bottom.

'With that difficult formation the element of chance must always be prominent. A string of casing may be carried for a thousand feet, or it may suddenly become wedged hard and fast after it has been driven two or three hundred feet. The natural obstacles are so great that the driller or person in charge, if using his utmost endeavour to make the boring successful, should hardly be held answerable for a failure to reach the required depth. I doubt if any man in Canada would be found willing to take the risk.'

The following section, as returned by the driller, is in addition to that given in the last Summary Report, p. 36 A :— Additional depth gained in 1899.

1,650–1,665 feet, sandstone.

1,665–1,669 feet, dark shale.

1,669–1,680 feet, very hard sandstone.

1,680–1,840 feet, dark-blue shale, intersected by strata of hard sandstone, varying in thickness from one to four feet.

YUKON DISTRICT.

Yukon District.

Mr. R. G. McConnell, during the summer of 1899, continued his examination of the richly auriferous territory in the Klondike division of the Yukon district. He was assisted by Mr. J. F. E. Johnston, who undertook the topographical work necessary for the mapping of the rock formations and gold-bearing gravels. Because of the amount of inquiry directed to this region, Mr. McConnell has been requested to furnish a somewhat full preliminary report upon it, which follows.*

Work by Mr. R. McConnell.

The Klondike Region.

Geography of Klondike region.

'The Klondike gold fields are situated east of the Yukon River in latitude 64° north. They are bounded in a general way by the Yukon River on the west, by the Klondike River on the north, by Flat Creek a tributary of the Klondike, and Dominion Creek, a tributary of Indian River, on the east, and by Indian River on the south. The area included between these boundaries measures about 800 square miles. The streams flowing through the area described are all gold-bearing to some extent, but only a limited number have proved remunerative. The most important gold-bearing streams are Bonanza Creek, with its famous tributary Eldorado Creek, Bear Creek and Hunker Creek flowing into the Klondike, and Quartz Creek and Dominion Creek, with Gold Run and Sulphur Creek two tributaries of the latter, flowing into Indian River. A good deal of prospecting has been done outside the area described, but with the exception of a few claims on Eureka Creek, a tributary of the Indian River from the south, no pay-gravels have so far been discovered, although good prospects are reported from many places.

Topography.

Physical features.

'The Klondike region may be described as a high plateau cut in all directions by numerous deep and wide branching valleys. The general aspect viewed from one of the higher elevations is rough and hilly but fairly regular. The outlines are rounded, the slopes even, and sharp peaks are notably absent. The region is really formed of a system of long, branching, round-backed ridges, separated by deep, wide, flat-bottomed valleys. Most of the ridges, speaking broadly, centre in the Dome, the highest eminence in the district.

'The ridges have an average elevation above the valley-bottoms of 1500 feet. They are deeply gashed on both sides by steep gulches and are surmounted by numerous bare rounded prominences separated by wide depressions. They radiate out in irregular curved lines from

* This report, in practically identical form, has already been printed in advance as a separate pamphlet.

the Dome and descend gradually, throwing off branches at intervals, towards the main water courses. Yukon District—*Cont*

'The elevation of the ridges and surmounting hills is fairly uniform. The Dome has an elevation of about 4,250 feet above the sea, 3,050 above the Yukon at Dawson and about 500 feet above the ridges at its base. It is not conspicuously higher than other hills in the neighbourhood, and the gradual decrease in elevation outwards along the ridges is scarcely noticeable to the eye. Elevations.

'The valleys are wide and flat-bottomed in their lower parts, but gradually narrow towards their heads into steep-sided narrow gulches, which terminate abruptly in steep, rounded, cirque-like depressions cut into the sides of the ridges. The valley-flats are marshy, partly wooded, and are wider on the Indian River than on the Klondike slope. The flats bordering the lower parts of Dominion Creek have a width in places of nearly half a mile. Valleys

'The streams are small, seldom exceeding 15 feet in width, even at their mouths, and along the productive portions of the valleys are much less. They fall rapidly near their heads, but in descending the valleys the grade soon diminishes, and in the case of Dominion and other Indian River creeks does not exceed, in the lower parts of the valleys, 25 feet to the mile. The Klondike streams are somewhat steeper, the grade averaging in the lower parts of the valleys about 40 feet to the mile. Streams.

'The Klondike River is a large rapid stream averaging about 150 feet in width. It is interrupted by frequent bars, and has a fall of from 12 to 15 feet to the mile. Indian River, which forms the southern boundary of the district, is a much smaller stream. It has a width of from 20 to 40 yards, but is very shallow, the water on the bars seldom exceeding a few inches in depth. The channel is filled, for long stretches, below Quartz Creek, with large angular boulders and the navigation of the stream, even with small lightly loaded boats, is very difficult. The fall of the valley from Australia Creek to the mouth averages about 18 feet to the mile. Klondike River.

Forest—

'The forest trees consist of the white and black spruces, the aspen and balsam poplars and a species of birch. No pine or fir trees were noticed. The lower ridges and the slopes of the higher ones up to a height of 3,500 feet above the sea, are generally wooded, and stunted spruces occur sparingly on the highest points in the district. The valley-flats are only partly wooded. Groves of spruce and poplar occur at intervals, but alternate with bare swamps and marshes too soft to support a forest growth. Forest.

Yukon District—*Cont.*

Spruce.

'The white spruce is the most important tree for general purposes in the district. It is usually small on the ridges, seldom exceeding a foot in diameter, but in the valley-flats occasional specimens attain a diameter of over two feet and a large proportion of the logs cut for lumber, measure from nine to fifteen inches across. The supply for the mills at Dawson is obtained mostly from the flats and islands along the upper Yukon, and from the Klondike valley and is ample for all purposes for many years to come. The Klondike is bordered at intervals all the way from its mouth to the mountains by groves and small tracts of spruce forest of surprising size and quality considering the latitude, and supplies of well grown spruce timber are also available from all the larger tributaries of the Upper Yukon as well as from the main valley, and can be easily and cheaply floated down to Dawson.

'The supply of large timber on the producing creeks themselves is limited, but the bordering ridges are nearly everywhere, except on the higher points, clothed with an open forest of small spruce, birch and poplar ranging from a few inches to a foot or more in diameter. A portion has been destroyed by forest fires, but sufficient remains to furnish all the fire-wood and most of the lumber required for mining purposes for a considerable time.

Geology.

Rock-series represented.

'The geology of the gold region is complicated and need only be briefly described here. The rocks are separable into the following divisions, none of which can, as yet, be exactly correlated with formations described in previous reports on British Columbia, the Yukon District or Alaska. The order is ascending, so far as known.

Stratified and foliated rocks, mostly Palæozoic
- Indian River series.
- Hunker series.
- Klondike series.
- Moose Hide group (in part.)

Tertiary.

Eruptive rocks
- Granites.
- Later eruptives.

Indian River series.

'*Indian River Series.*—The Indian River beds consist mainly of dark slates, often hard and quartzitic, and occasionally passing into a rock of gneissic appearance from the development of biotite along the cleavage planes. The slates are associated with bands of grayish crystalline limestones often several hundred feet across, quartzites, and toward the upper part of the formation by green schists of volcanic origin.

'The Indian River beds occur along the Yukon River from Indian River down to a point three miles below Ensley Creek, and are exposed

with few breaks along the whole course of Indian River. They strike in a direction a little south of east and dip as a rule to the north at high angles, but are irregular in this respect. Their thickness is not known. Yukon District—*Cont.*

'*Hunker Series.*—The Hunker beds are mainly lead-coloured and dark graphitic schists somewhat resembling the softer portions of the Indian River series. They include, on Hunker Creek, small bands of limestone and dolomite and some green schists. They are very irregular in their distribution and often occur in narrow, short bands folded in with the Klondike series. They are found in considerable volume along the lower part of Hunker Creek and in narrow disconnected bands crossing Bonanza, Eldorado, Dominion and other creeks of the district. Hunker series

'*Klondike Series.*—The Klondike series is the most important group of rocks in the district, as it constitutes the country-rock along the productive portions of all the richer creeks, and is, apparently, genetically connected with the occurrence of the gold. The rocks of this series are now mainly light-coloured and greenish micaceous schists, the principal minerals present being quartz, orthoclase, some plagioclase, and sericite. The ferro-magnesian minerals are almost entirely absent. The rocks are greatly crushed and altered and in places are almost entirely recrystallized. They have not, as yet, been closely studied microscopically, but appear, with little doubt, to have originated from eruptives and in part at least to have been derived from a quartz-porphyry. On Sulphur Creek the rocks of this series pass gradually into a granitoid condition. Klondike series includes principal gold-bearing rocks.

'The principal varieties are a soft, well foliated light-grayish sericite schist, and a harder schistose rock occurring in flags and heavy beds, often sprinkled with rounded quartz blebs and occasionally with angular felspar crystals. They include also a fine-grained hard rock resembling a quartzite. In the eastern part of the district the light-coloured varieties alternate with bands of green well foliated schists, which may belong to an older period.

'The rocks of the Klondike series occur along the Yukon from the northern boundary of the Indian River series down nearly to Dawson, and extend in an easterly direction in a wide band across Bonanza and Eldorado creeks, Quartz and Sulphur creeks, and the upper parts of Hunker and Dominion creeks. They occur also on Flat Creek, further to the east, but their limits in this direction are not precisely known, as they pass east of Flat Creek below a heavy covering of gravel. The outline of the area is fairly regular, but is broken in places by occasional spurs from the central mass. Distribution.

'*Moose Hide Group.*—Under this head I have included a group of green igneous rocks which occurs in Moose Hide Mountain and other Moose Hide group.

Yukon District—*Cont.*

points along the northern border of the district. They are schistose in places, but are usually massive and range in texture from a moderately granular to a compact condition. They belong mostly to the diabase group, and have been altered more or less completely over wide areas into serpentine. The rocks included in this group belong to different periods, as some of the members, notably the fine-grained massive variety forming Leotta Mountain, are quite recent, while those at the mouth of the Klondike have a much older look and have been crushed into schists, especially around the edges of the mass. Bands of green schists of uncertain age also alternate all along the lower part of the Klondike with the dark Hunker schists and other rocks.

Distribution.

'The Moose Hide group of rocks occurs in angular and rounded areas and wide bands, distributed at intervals along the Klondike valley from its mouth easterly to Flat Creek. Rocks of this group are also found on the ridge separating Hunker Creek from the Klondike and at one point on the ridge east of Hunker.

Tertiary rocks.

'*Tertiary Beds.*—Beds referred to the Tertiary occur at several points around the outskirts of the gold district. A wide band follows the Yukon valley above Dawson, on the north-east side, and continues on in a direction a little south of east to the Klondike, which it crosses a short distance above the mouth of Rock Creek. It then follows the Klondike River to the mouth of Flat Creek, and probably underlies the belt of plateau country that borders the latter and extends through to the Stewart.

Lignite.

'Exposures of these beds on Rock Creek and the Klondike River consist mostly of soft, grayish sandstones, indurated clays and shales, and occasional beds of ironstone. A thick lignite seam is reported to outcrop on one of the branches of Rock Creek, and other seams occur along the band in its north-westerly extension. A seam, or group of seams, said to be fifteen feet in thickness, is being worked on Cliff Creek, about seventy-five miles below Dawson, for the supply of that place.

'A small area of dark sandstones, agglomerates, hardened clays and shales, was found on Last Chance Creek, a tributary of Hunker Creek, lying at angles on the schists. The sandstones contain small particles of carbonaceous matter, but no lignite was noticed.

'Tertiary beds were also found along the southern boundary of the district on Indian River. The northern limit of this area follows Indian River valley from Quartz Creek to a point above New Zealand Creek, and the band extends southward beyond the region examined. The beds lie in easy folds, and consist mainly of soft, light-grayish sandstone, dark, coarse, agglomeratic sandstone, soft, dark shales, and, at one point, of heavy beds of coarse conglomerate. Fragments of

fossil plants occur throughout the formation, but no determinable specimens were found. Yukon District—*Cont.*

'*Granites.*—A small area of granite occurs on the Yukon River below the mouth of Indian River, and stretches eastward in a band a couple of miles wide towards the head of Ensley Creek. It is a coarse-grained, grayish biotite variety, and as a rule is coarsely porphyritic. Granites.

'A large area of granite also occurs at the heads of Burnham and Australia creeks, east of Dominion Creek, and extends southward towards the Stewart. It appears to be older than the mass on the Yukon River, is very coarse-grained, often porphyritic, and in many places has been crushed into an extremely coarse augen-gneiss. Exposures of this rock occur in conspicuous crags along the crests of the ridges separating the tributaries of Dominion Creek from those of Australia Creek.

'A third area of granite extends from the mouth of Dominion Creek up to a point two miles above Sulphur Creek and also runs for some distance up the latter creek. It appears to pass gradually, going up Sulphur Creek, into the schists of the Klondike series. It is grayish in colour, medium-grained, and is of the ordinary biotite variety, with few accessory minerals. The biotite gradually disappears on approaching the schists, and is replaced by light-coloured micas, principally sericite.

'*Later Eruptives.*—Small bosses of recent eruptive rocks cutting all the older formations occur everywhere throughout the district. The principal variety is a light-grayish acid rock with a compact base, sprinkled with small dark quartz crystals, and is probably a rhyolite or closely allied rock. In some of the sections felspar phenocrysts occur with the quartz, and in other places the rock becomes granular. The areas seldom exceed a quarter of a mile in width, and are more numerous around the outskirts of the gold district than towards its centre. Small areas of later eruptives.

'A dark rock, which macroscopically appears to be an augite-andesite, occupies a small area bordering the granite below Indian River, and dark basaltic-looking dikes occur on Indian River, below the mouth of Quartz Creek. A few small trap-dikes cross Eldorado Creek, and a large quartz-porphyry dike forms a point projecting into Bonanza valley at No. 60 below Discovery claim.

'The total area covered by the later eruptives is small, but their wide distribution in small bosses and dikes makes them a conspicuous feature in the geology of the district.

'*Quartz Veins.*—Quartz veins are exceedingly abundant in the schists of the Klondike series and also occur, but more sparingly, in Quartz veins.

Yukon District—*Cont.*

the Indian River group and the Hunker schists. The veins as a rule are short and small, but often swell out into large lenticular masses of quartz. They follow in the majority of cases the planes of foliation or cut these at a low angle. A few veins were noticed cutting directly across the strike of the rocks, and these as a rule are more regular and persistent than those which follow the foliation; they may belong to a different group. In addition to the multitude of quartz veins varying in size from mere threads up to huge masses nearly a hundred feet in thickness like that on the Yukon River two miles above Caribou Creek, which follow or intersect the schists of the Klondike series, these schists themselves are often more or less silicified along wide zones, occasionally to such an extent as to resemble quartzites.

Character of quartz.

'The quartz in the smaller veins is usually milky or light-grayish in colour and often when weathered assumes a granular appearance. The veins contain occasional crystals and small patches of felspar and dolomite. The large vein above Caribou Creek has a more compact texture and weathers to a light-yellow colour.

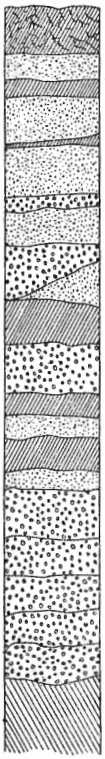
Metallic contents.

'The principal metallic minerals of the veins are pyrite, chalcopyrite, galena (usually argentiferous) and occasionally free gold. The veins are not as a rule well mineralized and the great majority contain nothing except a few scattered grains of pyrite. A number of specimens collected in various parts of the district and analysed in the laboratory of the survey were all barren, with one exception, and that contained only traces of gold. On the other hand, a number of assays made in Dawson from different veins were seen by the writer that showed good values. There can be no question that the placer gold, like the accompanying gravels, is of local origin and is derived from the quartz veins and silicified schists of the district. The large nuggets nearly always inclose fragments of quartz, and quartz pebbles specked with gold are occasionally found. A boulder found on No. 4 Bonanza Creek, weighing 60 ounces, contained 20 ounces of gold. Evidence of the local origin of the gold is also afforded by the markedly angular and unworn character of the grains and nuggets found in the gulches and along the upper parts of the productive creeks. It is highly improbable that the gold-bearing veins have all been swept away and their metallic contents concentrated in the valleys, great as the erosion in the district has been, and there is every reason to believe that productive veins or zones of country-rock will eventually be discovered. The prospecting of the past two seasons has resulted in the staking of a great number of quartz claims, but very little development work has so far been done. Prospecting can only be carried on at present over a small portion of the district, as the country-rocks are nearly everywhere concealed beneath a heavy blanket of moss.

Connection of gold with quartz.

Gravels—

Yukon District—*Cont.*



Section of stream-gravels, claim 27 above Discovery, Bonanza Creek. Scale 4 ft. to 1 in.

Classification of gravels.

'The gravels of the district are of four different kinds, as follows, beginning with the latest:—

Stream-gravels (present).
Terrace-gravels.
River-gravels.
'Old valley-gravels (quartz-drift and yellow-gravels).

'The gravels are described in connection with the creeks, and with the exception of the quartz-drift will only be briefly referred to here.

Stream-gravels.

'*Stream Gravels.*—The stream-gravels form a sheet generally from four to ten feet in thickness, flooring the bottoms of all the valleys. They rest on broken and decomposed schists, and are overlain by a bed of dark frozen "muck" or peaty matter. They are very uniform in character, and consist entirely of the schists and other rocks of the district. In the lower parts of the valleys, the schist pebbles are usually flat, but are fairly well worn. They measure, as a rule, from one to two inches in thickness and from two to six inches in length. They lie in a matrix of coarse sand, and are associated with a varying proportion of rounded and sub-angular quartz pebbles and boulders, and, less frequently, with pebbles derived from the later eruptive rocks. Small beds of sand occasionally occur toward the top of the section, but, in most cases, the deposit is remarkably uniform from muck to bedrock. In the upper part of the valleys, the gravels become coarser and more angular, and a considerable proportion of the material consists of almost unworn fragments of country-rock washed down from the adjacent slopes.

Terrace-gravels.

'*Terrace Gravels.*—Narrow rock-cut terraces occur in an interrupted manner along Eldorado, Bonanza and Hunker creeks, below the level of the old valley, and a wider series along a portion of Dominion Creek, at an elevation of from fifteen to forty feet above the present

Yukon District—*Cont.*

flat. The terraces support beds of gravel, usually from six to fifteen feet in thickness, very similar to that in the valley-bottom, but showing somewhat more wear. They are covered in a few places with muck.

River-gravels

'*River Gravels.*—At the mouth of the Hunker and Bonanza creeks the quartz-drift is overlain by a heavy bed of well rounded pebbles, evidently representing a former wash of the Klondike River. The pebbles consist largely of hard slates, quartzites and other rocks foreign to the gold-bearing creeks. Wide terraces built of similar material also occur at the mouth of the Klondike and at intervals along the valley of that river.

Old valley-gravels.

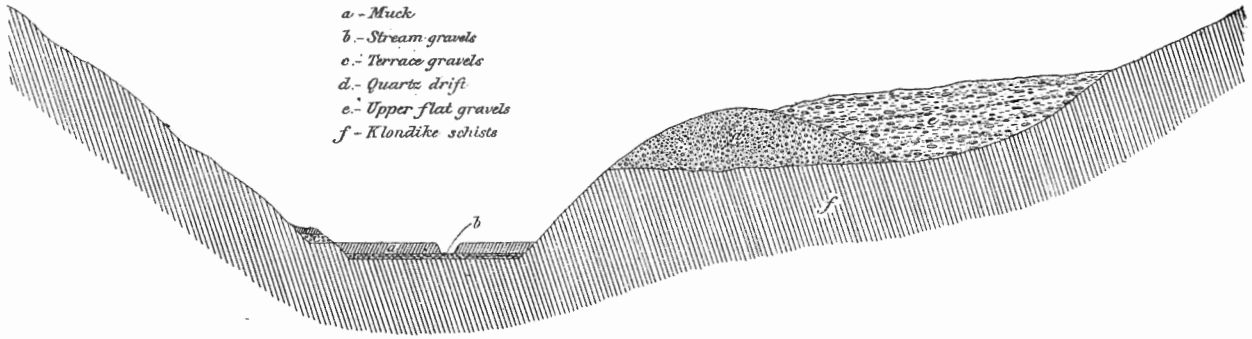
'*Old Valley Gravels.*—These gravels, bordering parts of Bonanza, Eldorado, Hunker and other creeks of the district, consist of a deposit known as the quartz-drift, resting on bed-rock, and an upper set of flat rust-coloured gravels.

The quartz-drift.

'The quartz-drift differs markedly in many of its characters from any deposit either marine, lacustrine, fluvial or glacial, known to the writer. It is uniformly grayish to nearly white in colour throughout, except near the surface, where it has been oxidized to varying depths and in places has a reddish coloration, and in the upper portions of some of the streams, where the grayish colour becomes somewhat darker. The colour does not vary to any material extent with differences in the subjacent rock, as in many places heavy deposits of the quartz drift, looking almost white at a distance, rest on wide bands of dark graphitic schist. It consists essentially of a compact mixture of small, clear, little worn and often sharply angular quartz grains, and minute scales of sericite, thickly packed with rounded, sub-angular, and wedge-shaped boulders of quartz, and less frequently of grayish mica-schist, the principal rock of the district. The deposit is remarkably uniform from top to bottom. Beds of coarse sand were noticed, but are infrequent, and in the great majority of the sections the silicious sands and the light micaceous minerals have not been sorted into separate beds but remain intimately commingled throughout. The sands become noticeably coarser toward the limit of the deposit on the upper parts of the creeks.

Boulders in quartz-drift.

'The boulders of the quartz-drift are always more or less rounded and water-worn, and are found in all sizes from small pebbles up to boulders two and three feet in diameter. They occur scattered irregularly through the sandy matrix, or roughly stratified in it, but were nowhere found forming heavy homogeneous beds. They do not show evidence of prolonged rolling. Rounded boulders are occasionally present, but in the majority of cases the edges only are worn away, and wedge-shaped sub-angular fragments, still preserving approxi-



Generalized cross-section of Bonanza Valley below Eldorado Forks

Scale 400 feet to 1 inch

Yukon District—*Cont.*

mately the shape of the short blunt veins from which they originated, are very common. The proportion of quartz to schist boulders was estimated at fully four to one, and in some sections the ratio is even higher than this. No fragments originating from the bands of dark graphitic schists which cross the valleys at various points, were noticed.

Thickness of quartz-drift.

'The quartz-drift varies in thickness from a few feet up to about 120 feet, and in width from 300 feet to half a mile or more. The deposit is narrow near the heads of the creeks and attains its greatest development near the lower parts of Hunker and Bonanza creeks, but the increase in volume in descending the valleys is not uniform. It is piled up to great depths on Gold Hill and Adams Hill on Bonanza Creek, decreases in amount on the succeeding hills and in places is absent altogether, and, farther down, after crossing the valley, continues on to the mouth in greatly increased volume.

Overlying gravels.

'The quartz-drift is overlain in places by loosely stratified gravels of a very different character. These gravels are usually of a rusty colour, are more distinctly stratified than the quartz-drift and consist mainly of flattened schist pebbles and boulders lying loosely in a coarse sandy matrix. Quartz pebbles and boulders are also present, but are less abundant than in the quartz-drift. The passage from one formation to the other is usually gradual, but in some places is fairly abrupt.

Character of these upper gravels.

'The upper gravels resemble the stream-gravels in the present valley bottom, and have probably a similar origin, but do not carry much gold. They are found on French Hill, Gold Hill, Adams Hill and other places on Bonanza Creek and at several points along Hunker Creek. At Gold Hill they fill a depression about a quarter of a mile in width and 115 feet in depth between the ridge of quartz-drift and the southern slope of the valley. They rest near the valley on the quartz-drift, but further back overlap it and lie directly on the bed-rock. The same relationship between the two deposits obtains on Adams Hill and probably at other points, but it is only at present determinable in places where shafts have been sunk to bed-rock across the whole width of the old valley.

Distribution of old valley-gravels.

'The quartz-drift and associated upper gravels occur on Eldorado and Bonanza creeks and are found for some distance up Gauvin Gulch and Adams Creek, tributaries of the latter; on Hunker Creek and its tributary Last Chance, and on Quartz Creek and its tributary Little Blanche. They were not found on Sulphur or Dominion creeks or on any of the Indian River tributaries except Quartz Creek.

'The precise origin of the quartz-drift is still somewhat obscure. It resembles a glacial deposit in appearance, and the writer, as a

result of a hurried examination in 1898, attributed it in the Summary Report of the Survey for that year, to small local glaciers. Further and more detailed work, however, has failed to reveal any evidences of ice action either on the boulders or on the surface of the bed-rock. It is not a lake deposit, as both the upper and lower surfaces slope up valleys, heading together and running in all directions, and it does not answer to the character of an ordinary stream deposit. The angular character of the grains and the comparatively unsorted condition of the deposit, show that it has not travelled far, and it is probable that it really represents a comparatively sudden inwash from the neighbouring slopes, conditioned by an increase in precipitation acting upon a surface that had previously been deeply decomposed by a long process of subaerial decay, and operating in conjunction with a stream moving slowly down the valley. The boulders were probably rounded to some extent *in situ* and would necessarily suffer more wear on the short journey than the small particles. The sudden and somewhat tumultuous mode of deposition indicated would also account for the marked absence of differentiation of the constituents of the mass into separate beds.

Yukon District—*Cont.*

Mode of origin of quartz-drift.

Gold in Gravels—

'Gold in paying quantities occurs in the stream-gravels, the terrace-gravels and the quartz-drift, but so far has not been found in the old valley-gravels overlying the quartz-drift or in the gravels here designated as river-gravels.

Auriferous gravels.

'Gold is found in the stream-gravels everywhere, but in productive quantities only along portions of the valleys. The richest stretches usually occur about midway in the length of the streams. The distribution is however irregular and no fixed rule can be formulated in regard to it. The total length of the paying portions of the different creeks, including some intervening barren parts, aggregates about fifty miles. It is impossible to give even an approximate estimate of the value of this great stretch of pay-gravels, owing to the irregularity of the concentration and the difficulty in obtaining trustworthy returns from most of the mines. It may be stated, however, that the product of a few of the 500-foot claims on Eldorado and Bonanza creeks will exceed a million dollars each; while a considerable number on the same two creeks (in fact, the majority of the lower Eldorado claims and a few on Hunker Creek) will yield over half a million each, and claims running from a quarter to half a million are common on all these creeks and also on Dominion and Sulphur creeks. Assuming a quarter of a million as the average, and that three-quarters of the claims in the distance given above are rich enough to work, the total value approaches $95,000,000, a figure

Gold in stream-gravels.

Possible total gold-content of these gravels.

Yukon District—*Cont.*

which is well within the mark. In this rough estimate, no account has been taken of long stretches of gravel on all the creeks, that is too low in grade to work at present, but will eventually become payable with improved conditions and cheaper methods of working, nor does it include probable further discoveries along the numerous gulches and small streams of the district, few of which have so far been carefully prospected.

Gold in terrace-gravels and quartz-drift.

'The terrace-gravels on Eldorado, Bonanza, Hunker and Dominion creeks include a few rich claims, and a large number that pay fairly well, but statistics of production are entirely wanting.

The extensive deposits of quartz-drift along Bonanza, Hunker, Eldorado and Quartz creeks, almost rival in importance the creek gravels themselves. They are everywhere more or less auriferous and are very rich over wide stretches. They suffer, however, from the scarcity of water on the hill-sides, and the ruinous methods the miners are forced to adopt, when operating on a small scale, prevent any but rich claims from being worked.

Methods of working—

Working of creek claims.

'Creek claims are worked either by sinking and drifting, or by open-cuts. The former method was the one first employed and is still very generally used, as operations can thus be carried on during the winter. The ground is frozen everywhere, and, except where the muck is free from sand or gravel and can be picked out, thawing is always necessary. This is done either by wood fires, heating the water at the bottom of the shafts with hot stones, or by steam thawers. The latter method is gradually superseding the two former and is a very simple one. A small boiler is generally used, from which the steam is passed through rubber hose, to the ends of which pointed steel tubes about four feet in length are affixed. The latter are driven into the frozen gravel, and steam is forced through them for six or eight hours. They are then withdrawn and the thawed material, removed. The points require steam equal to about one horse-power each, and thaw from one to three cubic yards of gravel at a shift. The introduction of the steam thawer is of recent date, and marks a great advance in the mining methods of the district. It thaws more rapidly than wood fires, requires at least a third less wood to do the same work, and can be used in summer as well as in winter. It has also the further great advantage over wood fires of purifying the air in place of fouling it.

Washing.

'The material drifted out from around the foot of the shaft is piled up in dumps, when the work is done in winter, and washed during the spring floods. In summer work the two operations of drifting and washing the excavated pay-gravels are carried on at the same time, if water can be obtained.

'Timbering is seldom required in summer and never in winter, as the bed of frozen muck that overlies the gravel forms an extremely tenacious roof, and chambers of astonishing size can be excavated beneath it in winter without danger. In one case on Dominion Creek, a muck roof, unsupported by pillars, covered a vault said to measure 140 feet by 230 feet which remained unbroken until midsummer. It then sank slowly down in one block, until it rested on some piles of waste material which had been heaped up to prevent accidents in case of a collapse. Examples of muck roofs spanning vaults over a hundred feet in width are common on all the principal creeks. Yukon District—*Cont.* Timbering workings.

'In working claims by the second method, that of open-cuts, the first object is to get rid of the muck covering. This is easily done in early spring by taking advantage of the spring floods and leading the water by several channels across the claim. The muck thaws readily, the streams soon cut down to the gravel, and the channels then gradually widen until they meet. In some cases the process is hastened by blowing the walls of the channel down into the stream with powder. When the muck covering is removed, the gravels soon thaw to bedrock. The upper portion, if barren, is then removed, usually by hand, and the underlying pay-gravel is sluiced in the ordinary way. Open-cast workings.

'The open-cut method of working claims leads to a more complete extraction of the gold and is the one generally preferred whenever the muck covering does not exceed 10 or 15 feet in thickness, a condition which obtains along the greater part of the principal producing creeks, with the exception of Sulphur Creek.

'The terrace-gravels are usually comparatively thin, and where uncovered by muck, are worked by open-cuts, where covered, by drifts. The pay-gravels in a few cases are sluiced in the valley-bottom, but as a rule are washed in rockers. Working of terrace-gravels.

'The quartz-drift, like the terrace-gravels, suffers from the scarcity of water, and rockers are employed for washing the pay-gravel at nearly all the working claims. A few of the principal mines have gravity trams, and when arrangements can be made with the owners of the creek claims, the creek water is used for sluicing purposes. The extent and richness of this great deposit appears to fully warrant capital in undertaking the construction of some comprehensive scheme for delivering water along the principal hills, and until this is done the greater part of the deposit must remain unworked. Of quartz-drift.

'*Machinery*—The employment of machinery in the working of Klondike claims is gradually increasing, but is still insignificant, a fact due largely to the absence of roads and the consequent impossibility of transporting heavy pieces up the creeks. Steam thawers are largely used and steam pumps are gradually replacing hand pumps, Chinese pumps and water-wheels for draining the pits. Steam hoists Machinery.

Yukon District—*Cont.*

are employed at a few of the mines, but are not in general use. The greater part of the work of the camp is still done by hand, and this, notwithstanding the fact that, taking into consideration the high price of labour, nowhere in the world could machinery be more profitably employed.

Production of District—

Approximate amount of gold produced.

'The gold production of the district can only be given approximately, but the following figures are probably nearly correct.

1897	$ 2,500,000
1898	10,000,000
1899	16,000,000
	$28,500,000

'It is unlikely that the rapid increase in production of the last two years will be continued, as serious inroads have already been made on the rich portions of Eldorado and Bonanza creeks, and to a less extent on Hunker and Dominion creeks, but the amounts remaining, with the long stretches of medium and low grade gravels still untouched on all the creeks, ensure a high production for a number of years.

Description of Creeks.

Bonanza Creek—

Description of Bonanza Creek.

'Bonanza Creek is the most important of the gold-bearing creeks of the Klondike district, and is the one on which gold in large quantities was first discovered. It heads in the Dome Ridge with branches of Quartz and Hunker creeks and empties into the Klondike River a mile and quarter above Dawson, after a course in a north-northwest direction of a little over seventeen miles. It has a drainage-area of approximately 113 square miles. It is a comparatively small stream even near its mouth, where it measures, in ordinary stages of the water, about fifteen feet in width by three or four inches in depth on the bars. It flows, however, a steady stream and furnishes at least a sluice head of water throughout the season all along the productive part of the

Tributaries.

valley. The principal tributaries of Bonanza Creek are Eldorado Creek, Adams Creek, Boulder Creek, Forty-nine Creek and Sixty-seven Creek on the left, and Carmack Forks, Homestake Creek, Gauvin Gulch, Queen Gulch and Mosquito Creek on the right.

Present valley.

'*Valley.*—The valley of Bonanza Creek is characterized principally by its markedly angular trough-like shape. The present valley has been cut down in the floor of an older valley and that rapidly and almost continuously, as shown by the steep lateral walls and the absence

Yukon District—*Cont.*

of continuous lines of terraces in the newer valley. The present valley usually shows a flat bottom of varying width, commonly measuring from 300 to 600 feet, bounded by steep sides 150 feet high at the Eldorado forks, and gradually increasing in elevation down the valley, or, with a steep wall of the same height on one side, and an easier slope on the other. It follows a sinuous line, bending with short curves round points that project alternately from either side. The present valley is excavated, as a rule, along one side of the older and much wider valley, and the general effect produced is asymmetrical. On one side the slope is broken, at an elevation usually of from 200 to 300 feet, by a rough plain of irregular size, but often a third of a mile wide, beyond which is an easy ascent of a thousand feet or more to the summit of the bordering ridge, while on the other side, the slope though varying in steepness is continuous throughout.

Old high-level valley.

'The plain of the older valley is not noticeable in the upper part of the present valley, but becomes a marked feature at McKay Creek, three miles above the mouth of Eldorado Creek, and is then traceable along the right bank down to the Eldorado Forks. At the Forks it crosses to the left and follows the left bank to Sixty-seven Creek, then re-crosses and continues on down the right side to the point of the ridge separating Bonanza Creek from the Klondike River. Above McKay Creek, the slopes of the valley become more uniform, but continue for some distance steeper on the left limit than on the right. The bottom gradually narrows in until the valley assumes the V-shaped or gulch type and shortly after it terminates in a steep-sided, amphitheatrical depression cut out of the Dome Ridge.

Gradient of old valley.

'The grade of the older valley is less than that of the modern one. The rim of the older valley at McKay Gulch is 110 feet above the present valley-bottom; at the Forks it is 150 feet, and at the mouth its elevation is increased to about 300 feet. The grade of the present valley below the Forks averages about fifty feet to the mile, and that of the older valley thirty-three feet to the mile. Between Eldorado Forks and Carmack Forks, the grade of the present channel averages one hundred feet to the mile, and further up it rapidly increases. Besides the wide-spread bottom or plain of the older Bonanza valley, a number of more recent terraces occur at lower elevations. These terraces are rock-cut as a rule, are usually quite narrow, are only traceable for short distances, and occur at irregular heights. They are found at intervals all the way from Lovett Gulch up to near Victoria Gulch.

Terraces.

Country-rocks

'*Country Rocks*—The rocks along Bonanza Creek consist almost entirely of the light-grayish and greenish sericite-schists of the Klondike series, alternating in the upper part with bands of green chloritic schists. Narrow bands of dark graphitic schists cross the valley above the mouth at Adams Creek and at one

Yukon District—*Cont.*

or two other points, and a wide porphyry dike forms a point about a mile below Boulder Creek. The light-coloured schist, which, as elsewhere stated, probably represents a crushed acid eruptive, occurs in heavy beds, in hard flags, and as a finely foliated and soft rock. It is nearly everywhere more or less silicified and incloses numerous quartz veins, most of which run parallel to the schistose structure, although a few cut across it.

Classification of gravels.

'*Gravels*—The gravels along Bonanza Creek fall into five groups. In order of age, commencing with the oldest, the *quartz-drift*, comes first, followed in succession by the associated *yellow-gravels*, the *river-gravels*, the *terrace-gravels*, and the *valley-gravels*. In order of economic importance the present valley-gravels come first, then the quartz-drift, followed by the terrace-gravels. The two other groups have so far not proved productive.

Valley-gravels

'The valley-gravels consist of clean, flat, fairly well worn pebbles mostly from one to six inches in length and one to two inches in thickness, derived from the light-grayish and light-greenish micaceous schists of the neighbourhood, associated with rounded and sub-angular pebbles of quartz, and occasional large quartz boulders usually angular in form. A few pebbles of dike-rock are also usually present. The material is wholly of local origin and is derived from the rocks outcropping along the valley. The pebbles are roughly shingled up stream, lie in a matrix of coarse sand and are occasionally interstratified, especially in their upper part, with beds of sand. They rest on a floor of broken and decomposed bed-rock, into which the gold has often penetrated to a depth of three or four feet. The gravels form a fairly uniform covering of from four to eight feet in thickness all across the flat bottom of the valley. Their width varies with the enlargements and constrictions of the valley, but usually measures from 300 to 600 feet, with occasional enlargements to 900 feet or more. The width increases gradually but irregularly down the valley.

Muck.

'The gravels are overlain by a bed of black frozen muck all along the valley from five to fifteen feet in thickness. The muck occurs in most places in a massive bed, but is also found interbanded with layers of sand. Small beds of impure muck occur in places in the lower gravels almost down to bed-rock.

Terrace-gravels.

'The terrace-gravels have a general resemblance to the stream-gravels. They are formed of the same materials but the pebbles show as a rule more wear. They are roughly stratified and include beds of fine pebbles and sand often showing cross-bedding. The terrace-gravels are of limited extent. They rest on short narrow rock-shelves distributed irregularly along the valley, on flat projecting points; or are built up at the mouths of gulches and streams. Their thickness is

from six to ten feet. They are uncovered at some points and in other places are deeply buried beneath an accumulation of muck and rocky débris from the sides of the valley. Yukon District—*Cont.*

'The river-gravels which occur in the lower part of the valley, overlying the quartz-drift, differ altogether in character from the valley-gravels. They show more wear, are better rounded, and include hard slate, quartzite and other pebbles derived from rocks not found along the creek. They are similar to the gravels in the Klondike River terraces, and as they occur only on the flat plateau separating the lower part of Bonanza Creek from the Klondike, there is little doubt that they represent the wash of the latter stream at a period previous to the general cutting down of the valleys. They measure fully 200 feet in thickness. Similar gravels also occur on the left side of Bonanza Creek, a short distance above Examiner Gulch and extend in a series of descending terraces or benches down Bonanza Creek and the Klondike River, to the Yukon valley. River-gravels.

'The quartz-drift, which with the associated yellow-gravels floors the older and more elevated Bonanza valley, has been described generally on a previous page. This unique and important accumulation of angular quartz grains, sericite and quartz boulders, is extensively, but not continuously distributed along Bonanza Creek. It is necessarily absent where the ancient and modern valleys coincide and has also been swept away in other places by erosion. It is found in descending the creek, covering small areas below McKay Creek and Homestake Creek and a much larger area below Gauvin Gulch. At the latter place it rests on a nearly level rock-floor at an elevation of about 140 feet above the present valley-bottom. It occurs uncovered along the edge of the valley, but farther back is buried beneath an accumulation of loosely stratified gravels and sand. The total width of both deposits at this point measures approximately 2000 feet, and the depth ninety feet. A shaft sunk to bed-rock, 450 feet back from the rim, showed fifty-five feet of the loose upper gravels and thirty feet of quartz-drift. The gravels of the old valley extend from Gauvin Gulch down Bonanza almost to the Eldorado Forks, but the upper gravels only are present along part of this distance, and are also traceable in a narrow band up Gauvin Gulch for a considerable distance, at an elevation of about 100 feet above the stream. Quartz-drift.

'At Eldorado Forks, the plain of the old valley crosses to the left side of Bonanza Creek. A small patch of gravel has been left on the point of the ridge separating the two creeks, and immediately opposite the Forks and extending for some distanee up Eldorado Creek and down Bonanza Creek to Big Skookum Gulch, is the important Gold Hill deposit. The gravels here cover an area about half a mile in length Plain of old valley at Eldorado Forks.

Yukon District—*Cont.*

by 1,500 feet in width and have a maximum thickness of about 116 feet. The white quartz-drift outcrops at an elevation of 150 feet and appears, so far as can be judged by the shafts, to form a great ridge following the edge of the valley, a hundred feet or more in height and 500 to 600 feet in width, with the hollow behind filled up with the yellow-gravels. The rock surface on which the gravels rest is roughened with small hollows and ridges. It extends back from the river at nearly the same general elevation for several hundred yards, then rises somewhat abruptly to the surface.

At Adams Hill.

'The quartz-drift was not observed between Big Skookum and Little Skookum gulches, but comes in again below the latter on Adams Hill and continues to Adams Creek. The gravels on Adams Hill have a width of 1,200 feet, and a depth, 550 feet back from the rim, of 130 feet. The arrangement of the quartz-drift and the upper gravels is similar to that on Gold Hill. Below the break formed by the valley of Adams Creek, the quartz-drift and stratified gravels overlaying it, occur pretty constantly, except where cut away by gulches, all the way down to Forty-nine Creek; and at one point below Mosquito Creek the upper gravels cross the valley and appear in a band 450 feet wide and ten to twenty feet in thickness on the right side. The thickness of the deposit on the left limit often exceeds 125 feet. The width is variable but usually measures from 1,200 to 1,500 feet.

Below Forty-nine Creek.

'Below Forty-nine Creek, the quartz-drift becomes less continuous for some distance. A small patch occurs below the mouth of Forty-nine Creek, a second opposite claim fifty-seven, below Discovery, and another and the last, on the left limit below Sixty-seven Creek. At the latter point it crosses the valley to the right limit above Cripple Creek, and continues down, gradually increasing in width, past Trail and Lovett gulches and across the plateau in which the ridge separating Bonanza Creek from the Klondike River terminates, to the valley of the latter. The volume of the deposit becomes greatly increased after crossing the valley. Its thickness on the hill between Trail and Cripple creeks is 225 feet, and on Lovett Gulch is not less than 110 feet. The width near the mouth of the valley is fully a mile.

Gold contents of gravels.

'*Gold contents of Gravels.*—The creek-gravels of Bonanza Creek have been found productive from near Victoria Gulch down into the eighties below Lower Discovery, a distance, measured along the valley, of over eleven miles. The values are however not uniform, and stretches occur which have proved too barren to work under present conditions. The richest and most uniform part of the creek extends from Victoria Gulch down stream for about two miles. A number of claims in this stretch will yield over half a million dollars each, or at the rate of $1,000 or more per running foot, while the product of one or two

claims is expected to double this amount. The gold contents of the gravels diminish on approaching Eldorado Forks but increase again below the Forks. A short stretch of the creek about Discovery claim, half a mile in length, including No. 2 above and the famous fraction at the mouth of Skookum Gulch, is extremely rich and in spots almost fabulously so. There is little doubt that the stream-gravels along this part of the valley have been enriched in places by gold derived from the old valley-gravels, and the same process is noticeable at other points farther down. In the lower parts of the creek, the gold in the gravels becomes finer and less plentiful, but paying claims are being worked almost down to the mouth of the valley. Gold is everywhere present, and many claims too poor to repay the great expense of mining at present, will become valuable with improved methods and reduced cost of supplies and labour. Yukon District—*Cont.*

'The Bonanza creek claims are worked both by open-cuts and by sinking and drifting. The former method is the more economical, and is the one generally employed on the more important claims, as the muck covering is comparatively thin in most places and is easily thawed and got rid of by a judicious management of the increased flow of water in the spring. The old plan of sinking and drifting is still employed on some of the claims in summer, increasingly so since the introduction of the steam thawer, and is of course the only method possible in winter. Working of creek claims.

'The terrace-gravels, except on one or two points, are usually quite narrow, and are consequently soon exhausted. They are not so productive as the creek-gravels, but a considerable number of the claims pay good "wages," or from $8 to $16 per day per man, and a few yield much higher returns. They are worked largely by rockers. Of terrace-gravels.

'The quartz-drift or old valley deposit is of scarcely less importance than the creek-gravels themselves. Claims of varying richness, often several tiers deep, have been staked on this deposit wherever it occurs, all the way from McKay Gulch down to the lower end of the valley. The most productive part extends from Eldorado Forks down-stream to near Boulder Creek, a distance of about three miles. Pay-gravels are not, however, restricted to this stretch, as good claims, by which is meant claims that yield over $10 per day per man, are being worked on the hill below Gauvin Gulch, on Lovett Gulch, near the mouth of the valley, and at a number of other points. The values could not be accurately ascertained, as statements of all kinds are current. "Colours" of gold occur all through the deposit, but the paying portion is usually confined to a band about two feet thick resting on bed-rock. The gold does not penetrate the bed-rock to the same extnt as the creek gold, and is also more patchy and irregular in its distribution. Claims on quartz-drift.

Yukon District—*Cont.*

Working of quartz-drift.

'The quartz-drift is not, as a rule, overlain by muck, and the claims in the first tier are usually worked as open-cuts until the gradually increasing thickness of the deposit compels the use of drifts. In the back tiers the claims are worked from shafts. A few of the mines tram their pay-gravels down to the bottom of the valley and use the water of the main creek or some of its tributaries for sluicing purposes; but in the majority of cases the gold is separated from the gravels by the slow and expensive method of rocking. Water is very scarce all over the area of the hill claims, but a small supply, sufficient for rocking purposes, is usually obtainable from the seepage of the mines. The richness of the hill-gravels is demonstrated by the fact that many of the claims yield high returns, notwithstanding the very heavy expense entailed in thawing out frozen gravel and washing the extracted material in ordinary rockers, in a region where labour commands a dollar an hour and supplies are purchased at rates proportionately high.

Character of gold.

'Bonanza Creek gold occurs in coarse, rough and flattish grains in the upper part of the creek, and in heavy flakes in the lower. Nuggets are not plentiful as a rule, but occur in considerable abundance near the mouth of Skookum Gulch, where they are evidently largely derived from the hill-gravels. The value of the gold is variable, but is usually about $16.50 per ounce. The gold in the quartz-drift is lighter in colour than the creek gold, is of lower grade, and is more angular and includes a large proportion of nuggets.

Bonanza Gulches—

'The most important gulches worked along Bonanza Creek are Ready Bullion, Victoria, Big Skookum and Magnet.

Ready Bullion Gulch.

'Ready Bullion enters Bonanza Creek from the left about a mile and a half above Carmack Forks and several miles above the proved productive part of the creek. It is a typical gulch, about a mile and a half in length, with a fall of nearly 300 feet in the lower mile. The valley is narrow and V-shaped above, but widens out and develops a small flat towards its mouth. The narrow gutter-like bottom of the valley is covered with from four to eight feet of coarse angular gravel and slide-rock, overlain by a few feet of muck. The stream is small, and the scarcity of water interfered seriously with mining operations during the past season. This gulch has been staked for a mile or more above its mouth. Some of the claims afford good prospects, and some gold has been extracted, but the amount of work so far done is insufficient to prove its value. The gold is coarse, rough and angular.

Victoria Gulch.

'Victoria Gulch enters Bonanza Creek from the left, one and three-quarter miles below Carmack Forks and almost at the head of the productive part of the creek. It heads with Gay Gulch, a gold-bearing

tributary of Eldorado Creek. It is about one and a half miles in length and in character conforms strictly to the gulch type. At the head is a steep regular amphitheatrical depression leading into a narrow angular valley, that gradually enlarges down the stream. It has a fall of about 900 feet. The gravels are coarse and intermixed, especially in the upper part, with unworn slide-rock. They are not deep, ranging in this respect from two to seven feet, and their width is small in the upper part of the gulch. Work has been done along the gulch for a distance of about a mile above the mouth, and on some of the claims very satisfactory results have been obtained. The gold is coarse, and in the upper part of the valley is rough and angular, with unworn edges, looking if it had just dropped out of crevices in the quartz. Yukon District—*Cont.*

'A small tributary of Victoria Gulch known as No. 7, has also been found gold-bearing for a distance of half a mile above its mouth. It joins Victoria Gulch on No. 7 claim above the mouth, and is a short, shallow gulch with a steep grade, the first 1700 feet showing a rise of 400 feet. The pay-streak is narrow, but is fairly rich in places. The gold is coarse and angular, and includes some large nuggets. A flat, oblong, unworn nugget found in No. 7 claim weighed four and one-third ounces.

'Skookum and Magnet gulches, below Eldorado Forks, differ in character from those just described. They cut through the quartz-drift down into the bed-rock beneath, and have so far not been proved productive beyond the edge of the drift. The rich claims near the mouth of both gulches have evidently derived their supply largely, if not altogether, from this older deposit, and not from original sources, as in the cases of Victoria and Ready Bullion gulches. Skookum and Magnet gulches.

Eldorado Creek—

'Eldorado Creek, the most important tributary of Bonanza Creek, is a small stream about seven miles in length and from three to six feet in width at its mouth. It carries, late in the season, barely a sluice-head of water. The valley is flat bottomed for three or four miles above its mouth, but narrow, the flats seldom much exceeding 300 feet in width. The present valley is excavated, like Bonanza valley (of which it is a continuation) in an older and wider one. It shows the same characteristics as Bonanza valley, having a trough-like depression below, 150 feet deep and from 225 to 450 feet in width, above which the slope is continuous and fairly steep to the summit of the ridge on the right limit, but on the left is interrupted by the plain of the old valley, usually about a quarter of a mile in width. At the extremity of the plain the upward slope recommences, but at a lower angle. The Character of Eldorado Creek.

Yukon District—*Cont.*

plain of the old valley extends along the left bank of Eldorado Creek for two miles above its mouth, and also occurs on the right bank for a short distance, about a mile farther up. The upper part of the valley, from Chief Gulch upward, is narrow, steep, and V-shaped. Narrow terraces occur at intervals in the lower part of the valley but do not form a conspicuous feature.

Country rocks.

'*Country-rocks.*—A few narrow trap dikes cross the lower part of Eldorado Creek, and narrow bands of dark graphitic schists were noticed in one or two places, but with these exceptions the valley is cut altogether out of the light-coloured micaceous schists of the Klondike series. Quartz veins are everywhere present, and at one point examined carried specks of free gold.

Gravels.

'*Gravels.*—The Eldorado Creek gravels are precisely similar to those on Bonanza Creek. They consist of from five to nine feet of flat, schistose and angular or rounded quartz pebbles, covering the bottom of the valley in a fairly uniform sheet, overlain by a few feet of frozen muck.

'The old valley-gravels have an elevation above the present valley-bottom, at the mouth of the creek, of 150 feet, and three miles farther up, where they disappear, of 125 feet. They consist, as on Bonanza Creek, of the quartz-drift and an upper series of stratified flat pebbles overlapping the former. Considerable areas of quartz-drift occur at the mouth of Eldorado Creek, forming part of the Gold Hill deposit previously described, and on French Hill immediately below French Gulch, while smaller patches occur about half a mile below French Gulch on the same side, and half a mile below Gay Gulch on the right limit. At the latter point, is the last occurrence of the deposit found in ascending the creek, it is quite narrow and has a thickness of only eighteen feet. It lies in a shallow pitted channel-like depression running parallel to the present valley. At French Hill, a mile and a half further down, when it next appears, it has a thickness including the upper gravel, of over a hundred feet, and a width of half a mile. The occurrences between French Hill and Gold Hill are small and unimportant.

Gold contents.

'*Gold contents of gravels.*—The productive portion of Eldorado Creek extends from the mouth of the valley up to near Gay Gulch, a distance of about three and a half miles. The gravels along this stretch of the valley are of extraordinary richness, and few breaks have been found in the continuity of the pay-streak. Some of the claims will yield more than a million dollars each, or at the rate of $2,000 per running foot, while ground running $1,000 per running foot is common. The pay-gravels extend practically, with varying values, all across the bottom of the valley, and have a thickness of from three to four feet.

The gold also penetrates the bed-rock to a depth of two feet or more. The upper part of Eldorado Creek has so far not proved productive. Yukon District—*Cont.*

'Terrace gravels of moderate richness occur along the valley at intervals from Gay Gulch down to the mouth.

'The quartz-drift is of less importance along Eldorado Creek than on Bonanza Creek, but has yielded good returns from many of the claims on French Hill.

'Eldorado gold is very coarse and is often almost unworn. Nuggets are more plentiful than on the other creeks, and are often found in an imperfectly crystalline condition. The gold is lighter in colour and of a somewhat lower grade than that of Bonanza Creek. Gold.

Hunker Creek—

'Hunker Creek is a tributary of the Klondike into which it empties eight miles above the mouth of Bonanza. It heads close to the Dome, with Dominion Creek, and flows in a north-westerly direction. It has a length of fifteen miles, and is about equal in size to Bonanza Creek. The most important tributaries are Last Chance and Gold Bottom creeks, both of which come in from the left.

'*Valley.*—The valley of Hunker Creek is remarkably similar to that of Bonanza Creek, and like it, its present form is due to a secondary valley sunk in the floor of an older one. The recent valley has a depth in bed-rock, near the mouth, of 300 feet, and including the gravels, of over 400 feet. It is a steep-sided flat-bottomed trough, two to four hundred yards wide near the mouth, gradually narrowing up the stream. Its width is more irregular than the Bonanza valley, and the basins developed at intervals in the lower part are wider. The plain of the old valley is a marked feature from the mouth up to a point half a mile above Gold Bottom Creek, a distance of eight miles. It disappears there but comes in again for a short distance a mile and a-half further up. Hunker valley.

'A few rock-cut terraces occur below the plain of the old valley, but are seldom very conspicuous. Like those on Bonanza Creek, they are narrow, irregular in height, and usually quite short.

'*Country-rocks.*—The rocks along the upper part of Hunker Creek consist of the light-coloured sericite-schists and the greenish chloritic schists of the Klondike series, cut by a few small bosses of rhyolite. From Colorado Creek to the mouth the same rocks also occur, but are associated with wide bands of the lead-coloured and dark graphitic schists of the Hunker series, some green schists and occasional bands of limestone. Country-rock

Yukon District—*Cont.*

Gravels.

'*Gravels.*—The gravels on Hunker Creek, like those on Bonanza Creek, are of four different kinds, viz., the present creek-gravels, the terrace-gravels, the old valley-gravels and a sheet of river-gravel overlying the latter near the mouth of the valley.

'The creek-gravels are all local in origin, and are similar in character to the Bonanza Creek gravels. They consist of flat schistose pebbles, sub-angular quartz pebbles and boulders, and occasional pebbles derived from the newer eruptive rocks. They have a thickness of from four to ten feet, and are overlain by a bed of muck or peaty material ranging in thickness from about twenty feet downwards At Discovery, the thickness of both muck and gravel is less than ten feet for a short distance.

'The terrace-gravels are more rounded than the creek-gravels, but are otherwise very similar. They occur in narrow disconnected strips along both sides of the valley at various elevations up to 100 feet above the present valley-bottom. They have a maximum thickness, in the sections examined, of seventeen feet, and in places are of considerable economic importance.

'The old valley-gravels have a wider distribution along Hunker Creek than on any creek in the district. They commence, in descending the valley, in a comparatively thin narrow band on the right limit opposite No. 4 below Discovery, where they occupy a basin-shaped depression on both sides of No. 6 Gulch. They are absent below this point for some distance, but reappear on the left limit half a mile above Gold Bottom Creek, and continue down on the same side, except when broken through by the valleys of the larger tributaries, to Henry Gulch, near the mouth of the valley. A few small patches also occur on the right limit between Gold Bottom and Hester creeks, and below Last Chance Creek the main deposit crosses Hunker valley and continues through in a wide band to the Klondike valley.

Quartz-drift.

'The character of the quartz-drift on Hunker Creek is similar to that on Bonanza Creek. When typically developed it is a grayish, almost white, compact deposit, consisting mainly of sericite, clear angular quartz grains, quartz pebbles and boulders and a few schist pebbles and boulders. It is also overlain in places, as on Bonanza Creek, by a yellowish loosely stratified deposit of flat pebbles, derived mostly from the Klondike schists. The thickness of the quartz-drift between Gold Bottom and Last Chance creeks ranges, as a rule, from twenty to fifty feet, and the width from 500 to 1,500 feet. Below Last Chance Creek it has a thickness of over 100 feet and a width of nearly a mile.

'The river-gravels are confined to the lower part of the valley, where they cover a flat plateau separating Hunker Creek from the Klondike above their junction, and are also found in a small terrace on the left side. They consist of well rolled and usually small pebbles of slate, quartz, quartzite, schist, granite and sandstone, occasionally interstratified with beds of sand. Yukon District—*Cont*

'*Gold contents of gravels.*—Creek claims of varying richness are being worked along Hunker valley from claim No. 42 above Discovery down nearly to No. 60 below, a distance of about ten miles, and pay-gravels are also reported from several points lower down. A stretch of the creek about three-quarters of a mile in length, about Discovery claim, has proved extremely rich, and in places is stated to yield at the rate of $1,000 per running foot. Terrace-gravels, affording moderate, and in one or two cases high returns, occur scattered along the sides of the valley from the Forks down almost to the mouth. The quartz-drift has not proved so rich as on Bonanza Creek, but numerous claims yielding fair values are being worked for some distance above and below Gold Bottom Creek and on both sides of the valley below Last Chance Creek. Gold contents.

'Hunker Creek gold, like that of most of the other creeks, occurs in coarse, bulky grains, with occasional nuggets in the upper part of the valley, and in flatter and smaller grains lower down. In the rich stretch near Discovery claim nuggets are fairly numerous. The gold from about claim No. 45 below down to No. 59 below is generally superficially darkened by iron. Gold.

'Gold Bottom and Last Chance creeks, the two principal tributaries of Hunker Creek, are both gold-bearing and have been worked to some extent for several miles above their mouths. A band of quartz-drift extends up Last Chance Creek, following the left limit, to No. 15 pup, a distance of two and a half miles, and is fairly rich in places. The gold obtained from the upper part of the band is very angular and is often crystalline. Tributaries.

Dominion Creek—

'Dominion Creek is the largest and one of the most important of the gold-bearing creeks of the district. It heads with Hunker Creek near the Dome, and flows at first in an easterly direction, but gradually bends around to the south and then to the west before uniting with Australia Creek to form Indian River. Its length, following the valley around its semicircular course, is about thirty miles. The principal tributaries are Caribou, Portland, Laura, Hunter, Gold Run and Sulphur creeks from the right, and Lombard, Remington, Champion, Nevada, Jansen, Kentucky and Rob Roy, from the left. Dominion Creek. Tributaries

Yukon District—*Cont.*

'*Valley.*—Dominion Creek valley has the general characteristics of the valleys of the district. At its head is a steep amphitheatrical depression, very regular in form, cut into the 'divide' between Dominion and Hunker creeks. Below this a deep, narrow valley is developed, with steep slopes almost meeting below. Further down, the bottom slowly widens out; small muck-covered flats, increasing gradually in width, border the winding stream, the grade diminishes and the slopes up to the high bounding ridges become easier. In the lower part of Dominion Creek the flats have an extraordinary width compared to the size of the stream. From Jansen Creek to the mouth, they nearly everywhere exceed a third of a mile and in places spread out to half a mile or more. The stream itself, at the mouth, has a width of about twenty-five feet with an average depth on the bars of about a foot.

Valley.

Terraces.

'Terraces have been traced along the left limit of Dominion Creek from a point a short distance below Lombard Creek, down to a point below Jansen Creek, a distance of twelve miles. They occur on the same side just above the mouth of Australia Creek, and probably also at points between Jansen and Australia creeks. They have not been found along the right limit. These terraces evidently mark an old stream-level. They are low, seldom exceeding forty feet in height, and in many places are scarcely twenty feet above the present valley-bottom. The terraces do not form a continuous line down the valley. The deposition seems originally to have been very irregular, and they have since been destroyed in many places, by side streams and by erosion.

Country rocks

'*Country-rocks.*—The rocks on Dominion Creek present greater variety than on the other creeks in the district. The upper part of the valley is cut through the grayish sericitic schists of the Klondike series, alternating with bands of greenish chloritic schist. The latter is fairly massive in places and is often filled with grains of pyrite and magnetite. In the central part of the creek the Klondike schists are largely replaced by biotite-bearing schists, greenish schists and hard quartzose schists. Bands of dark graphitic schists are also present, and limestones were found in the right bank opposite claim No. 136, below Discovery, also in the dump on claim No. 123, below Discovery. These rocks resemble the schists on Indian River and are probably largely of clastic origin, and older than the Klondike schists. They are replaced about midway between Gold Run and Sulphur creeks by the area of grayish granite referred to previously as occurring on Sulphur Creek, and this rock continues on to the mouth of the valley, and down Indian River for a short distance.

Gravels.

'*Gravels*—The gravels on Dominion Creek like those of the other creeks of the district are altogether of local derivation, and consist of a mixture of flat pebbles of greenish and grayish sericitic schists in the

upper part of the creek, the same rocks accompanied by hard quartzose mica-schists below lower Discovery, and with granite in the lower part of the valley. Quartz pebbles and boulders are everywhere fairly abundant as constituents of the gravels and are often of large size. The same passage from angular pebbles in the upper part of the creek to more rounded forms farther down, noticed on the other creeks, also prevails here. Between the two Discovery claims the pebbles are smaller than usual, a fact due to the softness of the country-rock. Yukon District—*Cont.*

'The thickness of the gravel and overlying muck on Dominion Creek is less than on Sulphur Creek and about equal to that on Hunker Creek. At claim No. 20 above Upper Discovery, in the gulch part of the valley, the gravels have a thickness of three feet and are overlain by about fifteen feet of muck and sand. Between the two Discoveries, the most productive part of the creek, the gravels range in thickness from two to seven feet, and the overlying muck and associated sandy clays from about five to fifteen feet. Farther down, near the mouth of Laura Creek, the thickness of muck and gravel increases to about forty feet. The depth to bed-rock in the lower part of the creek was not ascertained as no work was in progress, but is stated to be about thirty feet. Thickness of gravels.

'The gravel in the terraces resembles that in the creeks, and consists of the same material, somewhat more rounded as a rule; but at a couple of points the terrace is built up of a mass of large angular fragments of bed-rock massed confusedly together. The thickness of the bench-gravels ranges from six to fifteen feet. They are not generally overlain by much muck.

'*Gold*—The most productive part of Dominion Creek extends from near the mouth of Lombard Creek down to a point about half a mile below Lower Discovery, a distance of about five and a half miles. The pay-streak is not uniform along this stretch, and the values, according to the present workings, are very variable. In the richer portions the gold-contents of the gravels approximate $500 per running foot, and in the poorer parts the returns have not paid working expenses. A great majority of the claims, however, situated along the portion of the creek mentioned, promise good returns if economically worked. Above Lombard Creek, a number of claims have been worked at intervals, mostly by "laymen," for a distance of over two miles, some of which have proved fairly rich. In the opposite direction, claims have been worked for several miles below Lower Discovery. At Claims No. 73D and 74 below Lower Discovery fair pay is stated to have been found. The total length of the creek along which gold in fair quantities has so far been found exceeds eleven miles. In the wide lower part of the creek considerable prospecting has been done all Distribution of gold.

Yukon District—*Cont.*

along the valley, mostly, however, as representation work, and discoveries of pay-gravel have been reported, but I was unable to verify them.

'The bench-gravels along the left side of Dominion Creek are of great importance. They commence below Upper Discovery and extend, so far as known, in an intermittent manner down to 133 below Lower Discovery, a distance of over thirteen miles. Their distribution along the valley corresponds in a general way with that of the more productive part of the creek-gravels. They extend, however, somewhat farther down the valley, as a claim was being worked during the past season opposite 133 below Lower Discovery which was said to give good returns. The terrace-gravels about Lower Discovery and up the valley to near Upper Discovery have proved extraordinarily rich in places, and some of the claims have yielded large returns for the amount of work done.

Character of gold.

'The gold on Dominion Creek, above Lombard Creek, occurs in large, rough, rounded or angular grains and in small nuggets. Farther down a mixture of heavy grains, some well worn and others quite rough, with a more flaky variety and an occasional large well worn nugget are found. A nugget weighing 8½ ounces was found on claim No. 2 below Upper Discovery. Towards the lower portion of the productive part of the creek, the gold becomes finer and more flaky and large nuggets disappear.

'The bench or terrace gold occurs in fairly large, flattened grains, more uniform in size and smoother and more worn than the creek gold. Large pieces are not plentiful, but occasional nuggets are found, the largest known to me weighing about 4½ ounces.

Mining.

'Mining on Dominion Creek is carried on by the two ordinary methods. The overburden of muck is comparatively thin along the productive portion of the creek, and the conditions are favourable for open work in summer.

'Mining has been greatly hampered by the excessive freight rates and consequent high cost of supplies and machinery, and the net product of the creek during the past season proved somewhat disappointing, notwithstanding the large gross output. A good wagon-road has, however, now been constructed by the Government, and prices will no doubt in future be materially reduced.

Gulches apparently barren.

'No pay-gravels have so far been found on the numerous gulches and streams entering the productive part of Dominion Creek, with the possible exception of some benches on Caribou Creek, reported late in the season. Towards the mouth of the creek, Gold Run and Sulphur creeks, two tributaries from the right, are both gold-bearing; but in the upper part the gold, as at present known, is confined almost entirely to

the main stream-channel. The gold is undoubtedly of local origin, and there is little doubt that discoveries on some of the feeders will eventually be made. Yukon District—*Cont.*

Sulphur Creek—

'Sulphur Creek heads in the Dome and empties into Dominion Creek two and a half miles above Australia Creek. It has a length of about seventeen miles measured along the valley. At its mouth it is a stream about twelve feet wide with an average depth on the bars of about six inches. In the productive part of the creek the water-supply is much smaller, but except near the head, one or more sluice-heads of water are usually available. The principal tributaries are Green, Friday, Meadow, and Brimstone gulches on the left, and Quinn and Black Diamond gulches on the right. Sulphur Creek

'*Valley.*—The valley of Sulphur Creek is sunk from 1,000 to 1,500 feet below the crests of the bordering ridges. The slopes are easy and very uniform, and are somewhat steeper on the right limit than on the left. In the upper part the valley is narrow and gulch-shaped with a steep grade, but it gradually widens toward the mouth, and at the same time the inclination lessens. For some distance above the mouth the grade scarcely exceeds twenty feet to the mile, as measured by the aneroid. The increase in width is fairly uniform, but slight expansions and contractions occur at intervals all the way down. At the mouth of Green Gulch, about five miles from the head of the valley, its bottom is 300 feet wide, and is cut by a narrow muck gorge thirty feet deep, in which the stream, here only about three feet in width, is confined. Seven miles farther down the valley-flat has a width of 750 feet, and near the mouth this increases to nearly a third of a mile. A general cross section of the valley, shows a flat of varying width bordering the stream, from the edges of which the surface rises gently to the bases of the main slopes of the valley; then a sharp ascent of from 700 to 1,000 feet, followed by easier slopes to the crests of the bordering ridges. A marked peculiarity of Sulphur valley is the absence all along its course of well marked terraces. Toward the mouth, breaks in the uniformity of the slope simulating terraces were noticed at several points, but when examined did not carry gravel. Sulphur Creek is singular in this respect, as gold-bearing terraces occur on all the other productive creeks of the district. Small terraces may yet be discovered as the valley has not been fully prospected, but no continuous system exists. Character of the valley.

'A second peculiarity of the valley is the slight continuous rise, referred to above, between the edge of the flat, bordering the creek, and the base of the hills, amounting in some parts to fifty feet or more.

Yukon District—*Cont.*

Bench claims have been staked along this rise, but in the places where shafts have been sunk through it, bed-rock has been found at about the same level as near the creek, and the rise has been shown to be due to a great accumulation of muck. It is possible, however, that in places some terraces may be buried beneath the muck so completely, that no signs of them appear on the surface.

Bed-rock.

'*Bed-rock.*—In the upper part of Sulphur Creek and down to about claim No. 50, below Discovery, the rocks consist principally of the grayish and light-greenish schists of the Klondike series, similar to those found on Upper Bonanza. The schists are cut by numerous quartz veins and by occasional bosses and dykes of rhyolite (?) In the lower part of the valley the schists become coarser, more granular, and appear to change gradually to a granite gneiss, and near the mouth of the creek to a granite. Exposures are scarce along the valley, and the character of the rocks can only be ascertained from specimens obtained from shafts which have been sunk into bed-rock.

Gravels.

'*Gravels.*—In the upper part of Sulphur Creek, where the narrow gulch type of valley obtains, the débris which has accumulated in the bed of the streams consists largely of angular pieces of schists and occasional fragments of little worn quartz that have slipped down the steep hill-sides. Farther down, the flattened schist pebbles become smaller and less angular, are loosely stratified and lie in a matrix of coarse yellowish and grayish sands, and are interstratified in places with beds of sand. In the ower part of the creek the dumps are whitish in colour and resemble at a distance dumps of quartz-drift. The light coloration is due, however, to the decomposed granite rocks into which the lower part of the shafts are sunk. The gravels consist mainly of the greyish and greenish schists of the Klondike series, except on the lower part of the creek, where there is a considerable addition of gneissic and granite pebbles. Quartz pebbles and boulders, angular, sub-angular, or rounded are everywhere fairly abundant, and pebbles of rhyolite, and of a dark coarse augite-porphyrite, the origin of which is unknown, are of occasional occurrence.

Thickness of gravels.

'The gravels vary in thickness from two to eight feet or more. In the productive part of the creek they average about three feet, on the claims examined. The overburden of muck on Sulphur Creek is extraordinary heavy, much more so than on the other creeks of the district. On claim No. 36 above Discovery the gravels run from three to three and a half feet in thickness, are overlain by fifty-five feet of frozen muck, so pure, that a shaft was sunk down to the gravel with pick and shovel, no thawing being required. About Discovery the muck is about forty feet in thickness, and on claim No. 33 below Discovery it is thirty feet thick and rests on three or

four feet of gravel. In the lower part of the creek the muck thins out considerably and the section of both gravel and muck is stated not to exceed twenty to twenty-five feet. No claims were being worked in this part at the time of my visit and I was unable to obtain measurements. Yukon District—*Cont.*

'*Gold contents of gravels.*—Claims were being worked on Sulphur Creek at the time of my visit at varions points from No. 69 above, to 33 below Discovery, a distance of over ten miles. Claims have also been worked at a profit in the forties below and it is stated on good authority that pay-gravels have been obtained at No. 75 below, increasing the productive part of the creek to about fifteen miles. The gold is distributed somewhat irregularly. The best part of the creek, so far developed, extends from about Green Gulch down to a mile or so below Discovery. It is estimated that in parts of this reach the yield will amount to and in places exceed $5,000 per running foot, or at the rate of a quarter of a million dollars per claim. Only a few of the claims promise this amount, but good ground has been proven to exist along the greater part of this stretch and but few blanks have so far been found. Gold contents of gravels.

'In the lower part of the creek the valley is wide, and the location of the pay-streak is a lengthy and expensive undertaking. One or more holes have been sunk on most of the claims, but the prospecting so far done has been insufficient to prove their value.

'Sulphur Creek gold is coarse, angular and nuggety in the upper or gulch part of the valley, but lower down becomes finer, shows more wear, and large nuggets are much less abundant. A sample of gold examined, as far down as No. 33 below, was flaky, but still fairly coarse and rough. It is stated that the grains increase again in weight near the mouth of the creek. Gold.

'The "black sand" associated with the gold, consists mainly of pyrite, magnetite and hæmatite, derived from the green schists of the district. The larger nuggets hold fragments of quartz, and all the evidence obtainable goes to show that the gold is of local origin, and is derived from the veins and silicified schists of the valley. Black sand.

'None of the tributaries of Sulphur Creek have so far proved productive, but it is highly improbable that the gold is confined entirely to the main valley, and it is confidently expected that future prospecting along the side gulches and streams will eventually reveal other sources of supply.

'The deep bed of muck covering the gravels along the productive part of Sulphur Creek, prevents open work, except in one or two favourable spots, and mining is carried on almost entirely by sinking and drifting. A heavy muck roof entails some extra expense in hoisting, but adds to the safety of the workings. Great depth of muck.

Yukon District—*Cont.*

Gold Run Creek—

Gold Run Creek.

'Gold Run Creek was examined only in a hurried manner for a distance of four miles above its mouth. It is one of the principal tributaries of Dominion Creek from the right and enters the latter stream about four miles above Sulphur Creek. It has a length of about eight miles and a course nearly parallel with that of Sulphur Creek. At its mouth it is a stream about six feet in width by six inches deep on the bars, but five miles above its mouth, its size has diminished to about three feet in width by three inches in depth.

Valley.

'The valley of Gold Run conforms to the general type of the country. It is flat bottomed and about a quarter of a mile wide near the mouth, with an easy gradient, but becomes narrower and rises more quickly towards its head. The bordering ridges are uneven and have a height of from 1,200 to 1,500 feet. Low terraces occur near the mouth and at some points farther up, but no continuous system exists.

Country-rocks

'The country-rocks are nearly everywhere concealed, but judging from the material on the dumps appear to be mostly green chloritic schists. At claim No. 36 a band of hard, green, rather massive rock crosses and constricts the valley.

Gravels.

'The gravels are more quartzose than is usually the case, and consist of rounded and angular quartz pebbles and boulders of all sizes up to a foot or more in diameter, and flat pebbles of the green country-rock. They range in thickness from five feet down to a few inches, and are overlain by from fifteen to twenty feet of interstratified sand and muck.

Distribution of gold.

'Gold Run Creek is singular in having its most productive part situated towards its mouth. It is possible, however, that discoveries may still be made higher up, as mining has practically only begun on the creek and it has not yet been thoroughly prospected. Claims were being worked, at the time of my visit, from a point about a mile and a half above the mouth, up the valley for about three miles. The best claims, however, so far developed, occur along a stretch of the valley a mile in length, commencing about two miles above its mouth. The gravels along this stretch have proved to be very rich in places and some of the claims have yielded good returns.

'Gold Run gold is coarse and angular and with the exception of a few smooth grains does not show much wear. Nuggets are not plentiful, and none had been found at the date of my visit over an ounce in weight.

Quartz Creek—

Yukon District—*Cont.*

'Quartz Creek, a tributary of Indian River, is a stream about nine miles in length, and has a width at the mouth of fifteen feet. It forks repeatedly along its course and with its numerous branches has carved out the widest and most conspicuous basin in the district. The principal tributaries are Calder, Little Blanche and Cañon creeks on the right, and Toronto and Mack's Fork on the left. The valleys of the main stream and the larger tributaries have the usual wide, flat bottoms in their lower parts, and are bordered in places by well marked terraces. Quartz Creek.

'Quartz Creek was the first creek on which gold was discovered in the district, but the production up to the present time has been comparatively insignificant, and at the time of my visit very little work was in progress on the creek claims. The comparative leanness of the creek-gravels, so far as known, is remarkable, as this stream with its numerous tributaries cuts nearly everywhere through the Klondike schists, the gold-bearing rocks of the district, and has carried away and presumably concentrated the metallic contents of an enormous amount of material. First discovery of gold.

'Quartz Creek is bordered on the right limit, between Calder and Cañon creeks and for some distance above the latter, by an important terrace built principally of the quartz-drift, the only instance known of the occurrence of this deposit on the Indian River slope. The terrace below Cañon Creek is 110 feet high and in places nearly a third of a mile wide, a shaft sunk on it opposite claim No. 6 below Discovery, 1,100 feet back from the rim, showed about 45 feet of quartz-drift overlain by 55 feet of the upper yellowish gravels. A second deep shaft a short distance lower down, passed through 65 feet of the yellow-drift and six feet of the quartz-drift. Quartz-drift.

'The Quartz Creek quartz-drift resembles that on Bonanza and Hunker creeks, but is rather darker in colour, shows more distinct bedding, and contains a larger proportion of schist pebbles and boulders. It has proved moderately rich in places and a number of claims are being worked along it with varying success.

'The tributaries of Quartz Creek, more especially those on the right side, afford good prospects, but no important strikes have so far been made on them.

Eureka Creek—

'Eureka Creek flows into Indian River from the south, five miles below Australia Creek. It is a small stream, about eight feet in width where it enters Indian River valley, and about ten miles in length It divides three miles above its mouth into two nearly equal Eureka Creek.

Yukon District—*Cont.*

branches, both of which head in a range of high hills that border this part of Indian River valley on the south.

Valley.

'The valley of Eureka Creek conforms to the general type of the district. In the lower part, the muck-covered flat bordering the stream is from 300 to 900 feet wide, but above the forks it soon contracts into a narrow gulch. A well-defined bench fifty feet in height occurs on the left limit opposite the forks and continues up the creek for a couple of miles. At No. 4 above Discovery, the terrace is ninety feet in height.

Rocks.

'*Rocks.*—The rocks on Eureka Creek consist of slates, slaty quartzites, dark micaceous schists and green schists, dipping at high angles and striking in an easterly direction. These are the same rocks that are found on the Yukon River below Indian River and on the lower part of Indian River and referred to as the Indian River series. They are older than the Klondike schists which they border to the north, and are probably of Cambrian age. These rocks belong to an entirely different group from those cut by the principal auriferous creeks, and the fact that they are gold-bearing greatly widens the area of possible discoveries.

Gravels.

'*Gravels.*—The Eureka stream-gravels consist mainly of imperfectly rounded pebbles of dark and greenish schist. Quartz pebbles and boulders, sometimes of large size, are also present, and granite occurs occasionally. In the upper part of the creek, the gravels as usual become coarser and more angular. The bed of stream-gravels is from four to eight feet in thickness and is overlain by from ten to twenty feet of muck. The terrace-gravels consist of the same materials as the stream-gravels but are rounder and more worn. Quartz pebbles also seemed to be rather more abundant.

Yield.

'The yield from Eureka Creek has so far been small, and at the time of my visit very little work was being done. A few prospecting shafts were being sunk, and at No. 17 above Discovery, a crew of miners were engaged in sluicing with satisfactory results. The gold obtained here was rough and fairly coarse and included a number of small nuggets. The valley-bottom at this point is narrow and steep, but the supply of water, except in the spring, is too limited for ground-sluicing, the method by which it could be worked to the greatest advantage, and is barely sufficient to supply a set of small sluice-boxes.

'Good prospects have been obtained at several points from the benches along the left limit of Eureka Creek, on which a good deal of work will be done during the present winter, and also on several claims on the right fork and on a branch of the latter.

'Prospecting on Eureka Creek is an expensive operation. Supplies are packed in by way of the Dome and Sulphur ridge, and are also

brought up the Yukon and Indian rivers in boats, but both routes are long and difficult, and until the rates are greatly reduced only the richer parts of the creek can be worked at a profit. Yukon District—*Cont.*

Other streams.

'The flat bottom-land of the Klondike valley below the mouth of Hunker Creek, and more especially from the mouth of Bonanza valley for some distance down, has afforded very good prospects, ten cents or more to the pan being reported from some of the shafts. The valley above the mouth of Hunker Creek has not, so far, proved valuable. Klondike flats

'Indian River, bordering the southern part of the Klondike region, has yielded small amounts of gold from bars. The valley-gravels are also said to yield fair prospects but are not being worked. A wide gravel terrace, that deserves attention, follows the left limit of the valley from the mouth of Australia Creek down to a point below Quartz Creek. It affords colours of gold, but has not been sufficiently prospected to prove its value. Other terraces, all carrying gold to some extent, also occur in places along the right limit, usually near the mouths of the tributaries. Indian River.

'Australia Creek, which unites with Dominion Creek to form Indian River, has been prospected to a considerable extent, but so far as the creek-gravels are concerned, with little result. A well marked and wide terrace, practically a continuation of that on Indian River, follows the left limit of the valley for a number of miles above its mouth. The terrace-gravels have a thickness of over sixty feet in places, and carry small quantities of fine gold from the surface down. A company was engaged during the past season in an attempt to locate a pay-streak, but the result of the operations is not known. Australia Creek.

'All Gold and Too Much Gold creeks, both of which rise near the Dome and near the sources of Hunker and Dominion creeks and flow outward (the former emptying into Flat Creek and the latter, into the Klondike River a short distance below the mouth of Flat Creek), were the scenes of a rush a couple of years ago, but the result has not justified expectations, and at the present time they are almost deserted. All Gold and other creeks.

'Flat Creek is bordered on the east by a plateau fully 600 feet in height and several miles in width, formed entirely of loose gravels, sand, and sandy clay. This formation is quite recent and is usually regarded by the miners as the wash of an old channel of the Stewart. It was only examined at one point and the evidence obtained there pointed to its deposition in a lake-basin. It covers a considerable area, as it is stated to run through from the Klondike to the Stewart and to extend for some distance past both streams. The deposit has been prospected to some extent and shown to contain a small amount Flat Creek.

ukon District—*Cont.*

of fine gold, but no rich spots have so far been found. It is, however, worth investigation as a possible field for operations on a large scale.

Little general prospecting.

'Very little work was done during the past season in the Yukon district, outside the Klondike gold fields. The Stewart River was further prospected by a few parties and reports of strikes on some of the tributaries were current, but it was impossible to learn anything definite about them. A strike is also reported farther to the north on a couple of tributaries of the south fork of the Salmon, and a small quantity of coarse high-grade gold purporting to come from there, was seen by the writer when on the way out. The creeks at the head of Sixty-mile River, which were almost abandoned after the Klondike discoveries, are also again beginning to attract some attention.

'The outlying districts have been neglected by the old miners since the Klondike discoveries were made, and the work of the many inexperienced men who have overrun a large part of the country during the past two seasons has been mostly wasted. They followed each other in crowds up and down the main waterways, but did little effective work. As a matter of fact, less genuine prospecting has been done since the Klondike discoveries than in the preceding years, notwithstanding the rush. Thousands of streams in the gold belt stretching for hundreds of miles from Atlin to the Klondike and farther to the north, still remain to be explored, and the work of the prospector will not be completed for many years.'

BRITISH COLUMBIA.

British Columbia.

Field-work was in progress in three parts of this province during the past season, the Atlin district, West Kootenay and East Kootenay. Mr. J. C. Gwillim, who was appointed to the staff of the Survey in the early summer, and who was at the time in British Columbia, was entrusted with the execution of a preliminary examination and survey of the Atlin region, to which recent important discoveries of placer gold had attracted much attention. Upon this region and the work done in it Mr. Gwillim makes the following report:—

Work by Mr. Gwillim in Atlin District.

'Under your instructions, I left Vancouver on May 30, for Atlin, to begin a survey and examination of this district, which has lately become prominent as a placer mining camp.

"A. E. Porter was engaged in Vancouver for the season, and along with Mr. McConnell and his party we went north to Skagway, thence over the White Pass to Bennett, which place we reached on June 5. White Pass was nearly clear of snow at this time, but the ice on Summit Lakes was still solid enough to travel on. The upper lakes from Bennett down to Tagish had been open some days, though the spring

British Columbia—*Cont*

was late. Taku Arm and Atlin Lake had broken up about June 1 At Bennett a Peterborough canoe and other necessary articles were bought, and on June 6, with Mr. McConnell, we went on down Lake Bennett. On June 7, with one man, I began a log and compass survey along Taku Arm, travelling southward from Tagish Lake toward Atlin.

Discovery of Atlin.

'The Atlin district became known as a placer field during the summer of 1898, after Fritz Miller and his companions had staked Discovery on Pine Creek. Men went in from many different points; some from Tagish and Log Cabin, and others by way of Taku River and trail to Atlin Lake, so that the principal tributaries of Pine Creek and McKee Creek were staked before winter came.

'During the winter and early spring, many who had gone out in the autumn returned, and others came back by way of Log Cabin and the Fantail route from White Pass, overland from Teslin, by way of the Taku trail, and by Gladys or Sucker and Surprise lakes, with dogs or hand-sleighs. In early spring many horses and sleighs went in over the ice by way of the summer route, over Lake Bennett and Taku Arm. Previous to this discovery of gold there is evidence to show that white men had already been through the district, but apparently without finding gold.

Method of survey.

'The method of survey employed by me was that of log and compass traverses of the lakes with micrometer or paced surveys of the country passed over by land, using mountain stations as checks, together with latitude observations.

Taku Arm.

'For twenty miles up Taku Arm, rough, bare, limestone ranges extend on either side, rising 2,000 to 2,500 feet above the lake. This same belt of limestone passes eastward across Little Atlin Lake, and thence towards Teslin Lake in an easterly direction. No evidence of ores was met with along this course, although, further eastward, some copper is found in the limestone.

Toochi River.

'Toochi River comes in from the west, through a low wide gap, eighteen miles from Tagish Lake. It is a good sized stream, flowing over gravel. No bed-rock was seen. Several terraces of fine material—a sandy clay with very few pebbles—cross this valley, the highest of which, two miles back from the lake, stands 230 feet above it. Such terraces, or portions of them, are common throughout the country to the south-east up to a height of 1,800 feet above the lake system, which is itself approximately 2,190 feet above the sea.

Shore south of Toochi River.

'Two miles south of Toochi River, the white limestone gives place to a different class of rocks and the aspect of the country changes greatly. It has a more worn-down appearance. There are often low foot-hills and broad depressions, characterized by Banksian pine, poplar

British Columbia—*Cont.*

and grassy patches. The mountains are in isolated groups, rounded and grassy above the timber, which rarely runs much higher than 1,000 feet above the lake-level. The rocks underlying this portion of the country are various fine-grained igneous and sedimentary materials, usually called "slates," as distinguished from limestone or granite. Often they are greenstone eruptives, or more or less stratified dark, fine-grained rocks, sometimes of igneous origin also; but, proceeding southward, the rocks become well-defined sandstones, slates proper and conglomerates. The general course of these rocks is south-easterly, running towards Atlin Lake.

'Immediately south of the limestone the rocks just mentioned show signs of mineralization. Much of this country-rock is impregnated with iron-pyrites, iron-stained bands and patches are to be seen on the adjacent mountains, and some quartz bodies have already been staked. Little time was, however, spent here, the main object being to get into the Atlin district proper.

Golden Gate.

'Golden Gate, the narrow passage leading into Taku Inlet and Atlin, was reached on June 11. This place is about forty-two miles southwards from Tagish Lake. From Golden Gate the survey was carried eleven miles southward, up the Arm, sandstones, slates and conglomerates continuing. Thence the Arm turns abruptly westward, entering the belt of coast granites and lying between ranges from 3,000 to 3,500 feet high. This extremity of the lake ends in a deep valley some three miles long, floored with fine sand, down which comes a crooked stream, fed by one of the arms of a glacier from the Coast Ranges.

Southern part of Taku Arm.

'Near this southern end of Taku Arm the first occurrence of gold-bearing quartz was noted. Specimens of free gold, gray copper, copper-pyrites and galena were seen from this district. Concerning the extent of these deposits, however, little can as yet be said with certainty, but several quartz veins were seen. A mineralized area of schists appears to lie in the vicinity of Otter Lake, west of the Arm, and on the old Fantail route from Log Cabin. One of the claims in this locality had been more or less worked since the autumn of 1898, but without developing much of value, as far as I could learn. Further work has been done during the past summer near the Arm itself, especially on what are called the Golden Gate discoveries of free gold. These lie some eight miles south of Golden Gate, on the east shore. Very rich specimens of gold-bearing quartz have been taken from this vicinity, and it is stated a five-ton shipment was made from the Hope claim to a San Fransisco reduction company.

Taku Inlet.

'Returning to Golden Gate, we passed for thirteen miles eastward up Taku Inlet to Taku City and Portage, the surrounding moun-

tains being chiefly composed of slates and the shore low. A portage of a mile and a half leads over a low ridge into Atlin Lake. Aneroid readings make Atlin Lake thirty-eight feet above Taku Arm. The Atlin River flows out of it at this point, and is some two miles long. The water on June 18 was low, but many boats were being tracked up to Atlin Lake. A horse tramway now connects the two lakes. From Taku Portage to Atlin City is four miles across the lake. This place was reached on June 19. British Columbia.—*Cont.*

'Atlin City lies on the east shore of Atlin Lake, a mile north of the mouth of Pine Creek. A broad raised valley lies behind the town. This valley continues eastward for some twenty-five miles. It lies in the drainage basin of Surprise Lake, and of Pine Creek, which flows out of it. The rather low, rounded ranges that flank this wide valley, bound the present productive gold-bearing creeks, all of which, excepting McKee Creek, drain into this central valley. McKee Creek is a parallel stream some seven miles to the south with a basin of its own. Atlin City.

'Atlin Lake is a little over sixty miles long, nearly north-and-south. Atlin City is situated about half way down the east side, but the greater area of the lake lies to the south, amongst many islands and deep bays. The northern portion is a straight reach of water leading up to Mount Minto. The main ranges bordering on the lake are in some places isolated by broad depressions or grassy uplands. Their height reaches from 2,000 to over 4,000 feet above the lake, which is itself approximately 2,190 feet above the sea. The general timber-line lies about 1,500 feet above the lake, but sheltered positions carry trees up to 2,000 feet in some places. Above this is a short deciduous scrub, grass and broken rock. Atlin Lake

'Twenty-five miles northward from Atlin is a conspicuous isolated mountain that rises from the lake-shore to a height of some 4,500 feet above it. This is a well known landmark, often called "Jubilee Mountain" by the people of the district, but named by the boundary surveyors Mount Minto. Jubilee Mountains proper lie a little further north in the limestone belt. Mount Minto is a mass of granite. Mount Minto.

'The Birch Mountains, an equally lofty range, lie ten miles to the south on Goat or Tresa Island. These were climbed and were found to consist of a light-coloured granite porphyry, but are surrounded by low-lying sedimentary rocks. They rise to a height of 4,450 feet above the lake, or 6,640 feet above the sea, this being the greatest altitude reached during the season. Birch Mountains.

'Generally speaking, the more prominent mountain peaks and ranges are granitic while the lower levels and foot-hills are made up of greenstone, serpentine, quartzites and sandstones. Crystalline white limestone also forms conspicuous ranges both north and south of Atlin. Mountain ranges.

British Columbia—*Cont.*

'Looking westward from Birch Mountains on July 30, the rugged snow-clad Coast Ranges cut off the view at about twenty miles. To the north-east and south-east was a very extensive view over rounded grass-grown mountains towards Teslin Lake and river.

Pine Creek.

'Before continuing the survey north of Atlin City, I went up to Discovery, on Pine Creek, the centre of activity in placer mining at that time. As the closed season had been extended until August 1, less work was being done than would otherwise have occurred. Every possible bit of bench or creek ground on the gold creeks was staked, but few men were working. At this time the creek was in flood. Rockers were being used at Willow Creek and along the rocky benches twenty to eighty feet above Pine Creek, with a small supply of water available; from one to two ounces per day per man was reported as the result.

'Productive work was also being carried on at that time on Spruce, McKee, Otter, Wright, Boulder and Birch creeks, whilst many others were being prospected.

Survey north from Atlin City.

'On June 21 I engaged another canoeman (W. H. McIntosh) and continued the log and compass survey northward up Atlin Lake.

'Four miles from Atlin, on the east shore, the rusty magnesian rocks and serpentines give place to a coarse-grained granite. This granite continues for about forty miles north, toward Little Atlin Lake, where the great white limestone belt is again crossed.

'Twenty-nine miles north of Atlin, the British Columbia northern boundary (Lat. 60°) crosses the lake. From Atlin Lake it passes eastward across great swampy flats for twenty miles, thence six miles to the north of Sucker or Gladys Lake to Dawson Peaks or Three Aces, on Teslin Lake.

Little Atlin Lake.

'From the north end of Atlin Lake we ascended the Lubbock River to Little Atlin Lake. This is a swift and crooked stream about fifteen miles long. Little Atlin Lake is fourteen miles long and has a greatest width of a mile and a-half. A sounding taken half a mile from shore gave only forty feet. Boggy ground lies to the westward, then limestone ranges. Limestone also forms the White Mountains close to the east shore. Several parties of prospectors seen here had been through the country between this lake and Teslin. They had found little "slate" formation and no placer deposits, but some traces of copper and quartz veins.

'The height of this lake above Atlin is approximately eighty feet; above Lake Marsh 115 feet. From the northern end an old Indian trail runs to Tagish Houses, near Lake Marsh. A micrometer survey made this distance seven miles and a half. The same trail is said to

pass round the north end of Little Atlin Lake, thence eastward, north of White Mountains and over to Teslin Lake. British Columbia—*Cont.*

'On the way from Little Atlin to Tagish Houses the trail follows a dry pleasant valley containing hay meadows and little prairies with poplar groves. No better looking tract, from an agricultural point of view, was seen during the summer, wild hay being very scarce in Atlin district. From the meadows near the lake, a wagon-road leads to Tagish Police post. This was made by the North-west Mounted Police in order to bring in some 100 tons of hay cut there the previous summer. They also wintered many of the rougher horses in the open, and found them all able to take care of themselves. I am indebted to Inspector Primrose, of the North-west Mounted Police, for courtesy and information, at Tagish post. Trail to Tagish Houses.

'We returned to Atlin on July 4, and continued the lake-survey southward, where the lake widens greatly and has a deeply indented shore-line with many low islands, generally composed of sandstone. A day was spent on McKee Creek, at that time actively worked, and another trip of four days was made up Pike River, along the Taku trail, for twenty-five miles. Only one white man was met on this journey and he had found no good prospects. This river flows along the southern side of a wide depression and empties into Atlin Lake some three miles south of O'Donnell River, which swings in from the north and flows along the north side of the same great valley, the floor of which is chiefly composed of quartzite, grey limestone, conglomerates and soft schistose rocks. Twenty-five miles east the granites appear. Pike River.

'The survey was continued south-westward from Pike River among a labyrinth of islands and deep inlets, showing sandstones and conglomerates, with one small area of basalt.

'Sloco Inlet is the furthest east of the four waterways that lead toward the great glacier which I have called the Llewellyn Glacier. Thirty miles south of Atlin, from Sloco Inlet, a portage one mile long and 320 feet high leads over into Sloco Lake. This lake is 180 feet above Atlin Lake, but drains eastward into the Taku River and thence to Taku Inlet. Its length is seven miles. The water is milky white with suspended mud from the glacier which lies one mile to the west. Sloco Inlet.

'The mountains here rise immediately from the lake. They have a tabular appearance, caused by different bands of volcanic rocks of a basaltic and trachytic character. These mountains rise from 3,000 to 4,000 feet above the lake and are pretty close to the ragged Coast Ranges at this point. Some quartz "float" was seen along the south side of the lake, where a stream flows in near the head of the river

British Columbia—*Cont.*

which drains this lake, known as the Sloco or Clo-cloheen River. Nothing of value was noticed here in the way of ore-bodies. The latitude of this lake is 59° 5′, it being considerably further south than its position on the maps.

'Continuing along the southern shore of Atlin Lake, several deep bays occur. The westerly one leading to a glacial river and reaching to within two miles of the glacier front.

Main glacier.

'The main glacier is a great, gently sloping ice- and snow-field, out of which rise isolated mountains and peaks with wide gaps of sky-line between them. The angle of ascent for the first 2,000 feet is about 7°, after which it becomes much more flat and snow-covered. The ice is much broken where it passes over ridges in the floor beneath, and is not easy to travel on. Indians are said to have crossed over to Taku River and Juneau on this ice, making the distance about sixty miles.

Its apparent recession.

'Many thousands of tons of granitic boulders and mud are lined along the central part of the ice-tongues that reach down into the low lands about Sloco Lake, Atlin Lake and Taku Arm. These glacier-fronts discharge a large supply of muddy water and sand in the later summer, which often colours the lakes for many miles. Apparently they have lately receded, and also sunk somewhat, since about a mile of stone-packed flats lies beyond the present margin of the ice, and lateral moraines of boulders occur on the hill-sides fifty feet above the surface of the ice-field.

'The rocks about this district are chiefly granites, greenstones and a reddish-green stratified rock, partly serpentinized. Large masses of granular quartz were seen, but it was apparently barren.

Second bay leading to glacier.

'Returning north towards Atlin along the west shore, another bay five miles deep swings in toward the glacier and Coast Ranges. Two more muddy rivers enter this bay. The most westerly one being a strong deep stream carrying more water, on July 27, than the Atlin River on June 18. Prospectors seen here spoke of good gold prospects in the vicinity, but nevertheless left the place themselves.

'Granites, greenstones and some thinly banded limestones and slates compose the northern mountains between this western bay and Taku Arm, which lies about ten miles away, to the north-west.

Channel west of Goat Island.

'From this bay the narrow western channel was followed between Goat Island and the west shore, the rocks being chiefly sandstones and conglomerates. A low wide gap leads westward, toward Taku Arm, and this appears to connect the soft slates and sandstones of that lake with similar rocks on the southern part of Atlin Lake. These rocks are probably of Cretaceous age.

'Rocks on Atlin Lake resembling those of the gold-bearing district, were noted between the north end of Goat Island and Taku Portage. There were some greenstones similar to those of McKee Creek and also some hard, jointed, black rocks like those of Birch and Boulder creeks. It is possible that there may be a western extension of these rocks between Atlin Lake and Taku Arm, but none were seen on the Arm itself. British Columbia—*Cont.*

'Atlin River, seen on July 31, before high-water mark had been reached, was carrying out a large body of water. It was estimated at 100 feet wide, six feet deep and flowing swiftly. Atlin River.

'On August 4, the canoe and outfit was sent up to Surprise Lake, eleven miles east from Atlin and about 850 feet above it. This lake is fifteen and a-half miles long. It lies within a group of rugged granite mountains rising from 3,500 to 4,000 feet above Atlin Lake. This granite is chiefly composed of coarse quartz and felspar. It breaks up easily and apparently constituted much of the glacial drift found to the northward toward Sucker or Gladys Lake. Granite mountains.

'The contact-line of this granite with the slates of the gold-bearing creeks, cuts across the western end of Surprise Lake, just east of Ruby Creek on the north and Wright Creek on the south side. East of this contact and in the granite no producing creeks are yet known. The placer mining, at present, stops abruptly within the slates and greenstones of the gold-bearing creeks. Line of contact.

'The granite here appears to be connected with that seen north of Atlin, on the shore of the lake, and was afterwards traced up Fourth July Creek to Surprise Lake. This creek is also a non-producer at present. From Surprise Lake it continues eastward towards Teslin Lake. The "slate" series has here, therefore, been interrupted and has been found to the north-east in the mountains about Gladys Lake, and in the great extent of country south-east of Surprise Lake. These are to a great extent quartzites, but rocks similar to those found at the head of Ruby Creek recur north-east of this interruption.

'A portage-path ten miles long, leads from the north end of Surprise Lake over to Gladys Lake. The height-of-land between the lakes is nearly 300 feet above Surprise Lake. Heavy banks of glacial drift of local origin cover all these upper valleys and low passes to a height of over 2,000 feet above Atlin Lake. Portage to Gladys Lake.

'Gladys Lake is about 110 feet lower than Surprise. Its length is about twenty miles, and it is drained by a river sometimes known as Thirty-mile River or North River. This river enters Teslin Lake a few miles south of Dawson Peaks or Three Aces, and was not traversed by us. Some maps have made it flow directly north Gladys Lake.

British Columbia—*Cont.*

into Teslin Lake opposite Ni-sut-lin River. My information is derived from the boundary surveyors. Boats are said to have come up, but the river is rough.

Rocks of Gladys Lake.

'Very little rock outcrops within the lake-basin. None was seen on its shores and great banks and beds of rather fine drift material cover the depressions. The cherty quartzites commonly seen later along the route to Teslin occur on the hills north of the lake. South of the lake a series of rusty-weathering and black rocks, sometimes nearly a serpentine, was seen. These rocks resemble those found on some of the gold-bearing creeks, especially Boulder and Ruby creeks, and the lower part of Pine Creek.

Streams entering Gladys Lake.

'Consolation, Davenport, Munro and Che-halis creeks flow into Gladys Lake from the south. Several of these creeks were staked in the early spring on good surface prospects. It was found that values did not increase on sinking into the drift, nor was bed-rock reached; so that they are now abandoned. The statement was made that good prospects ceased on going higher up the creeks above the level of the glacial drift; but, as far as I could observe, no stream of likely proportions is found above that level, although on some there is an almost total absence of such material. Much of this drift is composed of the broken up particles of the gray granites about Surprise Lake to the south of it.

'Sucker River comes in by a great valley from the south, near the eastern end of the lake. This valley was afterwards crossed on the way from Surprise to Teslin, and is one of the main depressions of the region.

Streams entering Surprise Lake.

'Returning to Surprise Lake, micrometer surveys were made of Boulder, Birch and Wright creeks, and paced surveys of Ruby and Otter creeks. All these except Ruby were being actively worked for gold.

Journey to Teslin Lake.

'On August 23, a pack outfit was bought, and a trip begun over to Teslin Lake by way of Wright Creek, across the head-waters of Dixie, and down Zenazie Creek to Sucker River. Crossing Sucker River immediately north of a little lake, we continued up Rapid Roy Creek, which flows round the southern base of Guardian Mountain, a conspicous landmark. Thence turning to the north and east, we came out to the upper slopes above Teslin Lake, and about fourteen miles from it. Turning southward fourteen miles along the open flanks of the range facing Teslin Lake, we struck the Taku-Teslin trail on Ptarmigan Flats. These extensive flats are without timber and lie about 2,250 feet above Teslin Lake. A steep trail leads down from them some twelve miles, into the valley and across to Teslin post, which was

reached September 1. The total distance from Atlin to Teslin post by this route is about eighty miles, over easy ground, without bad summits or bog-holes, and with plenty of grass. British Columbia—*Cont*

'The rocks along the route are black "slates" on Wright and Dixie creeks; quartzites and limestones the rest of the way, with a recurrence of black slates at one place on Ptarmigan Flats—the granite being just to the north of the valleys followed. The only evidence of work done was on Rapid Roy Creek, close to Guardian Mountain. Sluicing had been abandoned there. Little evidence of quartz was seen. Rocks noted.

'Prospectors at Teslin had spent the summer about Jennings River, between Teslin Lake and Dease Lake and McDame Creek. They said it showed poor prospects, little bed-rock, and that the country was mostly swamp, granite and volcanic rocks, basalt and scoria. This district is more heavily timbered than Atlin. Jennings River.

'On September 2, we left Teslin post to return to Atlin by way of the Taku trail. Until this date the vegetation in the valley was rank and green; but a quarter of an inch of ice formed the night before we left it. Ptarmigan Flats also had a slight covering of snow. Taku trail from Teslin to Atlin.

'The general direction of Taku trail is south-west. Recrossing Ptarmigan Flats, Hurricane River is reached at twenty-one and a-half miles. Thence rising again, the trail passes over a desolate plateau some 3000 feet above the lakes. This great mountain-mass is composed of a granite, very similar to that of the Coast Ranges. It is strewn with large boulders, and without timber or grass. Seventeen miles west of Hurricane River, a descent is made to Rapid River, thence along a little grassy valley, and along the steep western flanks of a great range of white limestone, down into the valley of the Silver Salmon at its junction with the Nakina River. This point was the furthest south and lowest level reached during the season, and is fourteen miles from Rapid River. The Pike River trail is joined some three miles further back and continues up Silver Salmon valley for seven miles, to the point reached along Pike River on July 12, twenty-two and a-half miles east of Atlin Lake. This trail has little to commend it, and compares unfavourably with the route by way of Surprise Lake. The total length from Teslin post to Atlin is about ninety-four miles.

'We left Silver Salmon, after connecting with the July survey, and crossed northward to the O'Donnell River. This river was followed twelve miles to Atlin Lake. It flows over a well exposed bed of cherty quartzite and through a limestone cañon.

'The rocks seen along the Taku trail are chiefly quartzites and granite, with great mountains of limestone near the Nakina River. At Rapid River, there are slates of possibly Cretaceous age. No signs of placer or quartz mining were seen. Rocks seen.

British Columbia—*Cont.*

'After reaching Atlin on September 11, a micrometer survey was made up McKee Creek to Otter Creek, and then down Spruce to its junction with Pine Creek.

'The remainder of the season, until September 28, was spent in looking over some of the quartz locations, and in a trip up Fourth July Creek to the Sunset basin, twenty-five miles north-east of Atlin.

Earthquake.

'An earthquake movement was felt at 12.45 sun time on Atlin Lake on September 10. This was an undulating motion, lasting about thirty seconds. It was felt as far north as White Horse, and probably further, and was most severe on the coast, where it shook up the glaciers, causing much ice to appear along the steamboat route.

'The gold-bearing creeks are taken up separately, since they will illustrate the geology and economic relations of the productive area. They are confined, so far as known, to a comparatively small area immediately to the eastward of Atlin, being apparently cut off on the east and north by granites, and on the west and south-west by rocks of sedimentary and aqueous origin, none of which have yet proved to be gold-bearing.

Gold output of Atlin.

'The output of Atlin division in placer gold is probably under one million dollars for the season. The number of men actually working on the creeks at the busiest time, in August, was between 1,500 and 2,000.

Ruby Creek.

'*Ruby Creek* lies fourteen and a-half miles east of Atlin. It drains into the north side of Surprise Lake and rises amongst deep valleys seven miles back. The rocks at the head are of a fine-grained black material, probably of igneous origin. They often weather red, and contain patches of a frangible gray limestone, as well as much partly serpentinized rock. These rocks are characteristic of much of the gold-producing district. It will take time to determine them. At present they are called "slates," but they are often very compact and massive or crystalline, forming a smooth bed-rock when not decomposed. The main bed-rock of this creek is basalt. It has been sluiced with little result. A mountain of scoria—an old volcano—lies on the west side; and the Surprise granites lie along the east side. Only one party, G. B. Parsons and others, were working here, at Discovery claim. All the creek is staked and a good deal of work has been done in the basalt cañon.

Boulder Creek.

'*Boulder Creek* is twelve and a-half miles east of Atlin and is the furthest east of the producing creeks on the north side of Pine Creek basin. The source is six miles back from the lake in slate and granite mountains. Most of the creek is staked. About two miles was producing, between the First Forks and a little below Discovery.

'Bed-rock is usually deep, and consists of a rather massive tough black and green material, lower down the stream approaching serpentine. Heavy wash and boulders fill up the narrow gulch, making much work for the individual miner on his 100 feet of ground. Some permanent frost was noted near Discovery on the west side, also a tough clay, beneath which no gold was found. British Columbia—*Cont.*

'Good pay in coarse gold has certainly come out of this creek, from one to two ounces per day per man and nuggets up to an ounce in weight are reported. The gold is usually found on bed-rock and in the loose gravel above it. All the work here is by sluicing and ditching, although water is not abundant, as such short streams are very small during August. This creek falls about 1,400 feet between the Second Forks and Surprise Lake, a distance of three and three-quarter miles.

'*Birch Creek* is nine miles east of Atlin on the same side as Boulder and is of much the same form and character. It heads some five miles back in a great series of dark, fine-grained rocks, apparently stratified. These carry quartz veins, some of which appear to be promising. All this creek is staked, although nothing is being done above the forks three miles and a-half from Pine Creek. From the forks down to Discovery, two miles, active work was going on. Bed-rock is usually deep, and is much the same as on Boulder Creek. A softer magnesian rock, somewhat like that of Pine and Willow creeks, occurs near Discovery. The gold is coarse and is found on or near bed-rock. There is a fall of about 1,000 feet between the forks and Pine Creek. Birch Creek.

'In common with all the creeks on this north side of Pine Creek basin, there is very little or no glacial drift. Since the date of our survey, it is reported that a great part of this creek has been leased for hydraulic mining.

'*Otter Creek.* This creek flows in at the head of Pine Creek from the opposite or southern side, eleven miles from Atlin. It runs in the great drift-covered plateau 1,700 feet above Surprise Lake, and eight miles south-east of it. In common with Wright, Dixie, Spruce and McKee creeks, the upper portions of this stream flow through low grassy ravines or coulées. Little bed-rock is to be seen, all this country being overlain by banks and slopes of clay and boulders, to a great extent above the timber-line. Otter Creek.

'Six miles up, this creek cuts through a ridge of black and grey stratified rocks, forming a little cañon. At this place about twenty men were making 'wages' or better, on August 25. From this point down to a second cañon, near Pine Creek valley, there was nothing being done, bed-rock being heavily covered with drift. The lower cañon is cut through this mixed coarse and fine material to the rocks beneath,

British Columbia—*Cont.*

which are quartzites, limestone and a talcose schist, containing large bodies of a barren-looking quartz. A few men were also sluicing at this place. From the upper cañon to Pine Creek there is a fall of about 900 feet. This creek is a little larger than the preceding ones.

Wright Creek.

'*Wright Creek* flows into Surprise Lake from the south side, fourteen miles east of Atlin. Like Ruby Creek, its basin skirts the western edge of the Surprise granites, and it is the furthest east of the producing creeks. Its upper portions are much like those of Otter Creek, grassy uplands of fine material, with a slate bed-rock in places. The length of Wright Creek is about six miles, its fall from the summit 1,700 feet, and its water supply in August none too large for the work being done.

'The first three miles up from Surprise Lake are rough and boggy. Little or no bed-rock is visible, and no work was being done. Above this, from twenty-eight below up towards Discovery, there is heavy covering on bed-rock; shafts from ten to fifty feet deep were being sunk, and the only Cornish pump seen in the district was at work here in a forty-foot shaft.

'From several claims below Discovery to thirty or thirty-five above, bed-rock is rather near the surface, and this stretch of about a mile is being well worked. Bed-rock is a finely cleaved, black shale or slate, heavily impregnated with iron-pyrites. The adjoining hill-sides slope directly from the mountain down to the creek-bed, which has not the flat-bottomed, filled-up appearance seen on Otter and Upper Spruce creeks. Very few boulders encumber this channel, foreign drift being scarce or absent, while the local rocks are too soft to form boulders of any size.

'The gold is found on bed-rock and in crevices, also along the adjacent banks of broken down slate, quite a large excavation in this having been made near Discovery. It is usually coarse and much mixed with black sand and pyrites, while some native copper is also found, and cinnabar was reported but not seen. The quality of the gold is somewhat finer than Pine Creek gold. Nuggets of several ounces are not uncommon. One, said to be the largest found in the Atlin district, weighed thirty-eight ounces. It was taken from No. 6, below Discovery.

Spruce Creek.

'*Spruce Creek* is the chief tributary of Pine Creek. Its length is about thirteen miles. The upper portion is simply a low grassy coulée leading over into Dixie Creek at 1,500 feet above its junction with Pine Creek, two miles east of Atlin. Fair prospects are said to be found in the banks and little hills of this upper portion, which are made up of boulders and clay of apparently local origin.

'At Eagle Point, eleven miles up, there is a little cañon cutting across gray, ribbed rocks with a slate-like cleavage. Work was going on here in September, with good accounts of values taken out. The bench-rock sixty feet above the cañon had been scraped clear of its thin covering of grass-roots and gravel, yielding, it is said, from 50 cents to $2.50 a pan, coupled with the statement that $2,800 had been taken off an area of 100 feet square. From one to three ounces per day per man was taken out according to one account. There were about twenty men working here in September. British Columbia—*Cont.*

'Below Eagle Point, the creek continues between grassy banks 50 to 100 feet high. This part of the valley-bottom is heavily covered. Much of it has been leased, but no one was working on this stretch of about three miles. Next below is another cañon in greenish-black rocks much like those of Birch and Boulder creeks. A hydraulic company is working here with a single jet. The creek now runs between steep high rock and clay banks, and is practically a gorge where little is being done. Creek below Eagle Point.

'The greatest activity is concentrated for some two or three miles above the junction with Pine Creek. Here are many water-wheels and Chinese pumps, wing-dams and ditches. Several hundred men were working here in September. Tunnels have been driven into the steep side-hills, and are said to reach a gold-bearing gravel at rim-rock, which is wheeled out to the sluices. One eighty-ounce nugget of gold and quartz mixed was taken out below Discovery. The gold is moderately coarse, and is found in bed-rock gravels and on rim-rock. Creek above its mouth.

'*Pine Creek* is the main gold-bearing creek of the Atlin district, and into it ultimately all the other gold creeks drain, excepting McKee Creek. It empties Surprise Lake, eleven miles east of Atlin, flows for five or six miles in a rather flat valley with little or no bed-rock visible; after which it falls more rapidly, cutting down to bed-rock and forming cañons in several places, until it reaches Atlin Lake, more than 800 feet below its source. Terraced flats stretch across the broad valley at intervals. These appear to be composed of pebbles and clay of glacial origin. Pine Creek.

'The chief productive area centres about Discovery or Pine City. Some two miles of the creek is here being worked with wheels, wing-dams and Chinese pumps. A good ditch has been made by the miners of Willow Creek to supply water for this old channel of Pine Creek. Bed-rock is usually a form of serpentine or a soft gray rock with many dykes. Productive area.

'The gold along the creek is found in layers of gravel on or near bed-rock. Many of the little rocky benches ten to sixty feet above

British Columbia—*Cont.*

the stream-bed furnish pay with rockers. There appears to be a concentration of gold in places wherever water has acted on the drift materials of the valley.

Willow Creek.

'*Willow Creek* is a wide filled up channel separated from Pine Creek by a little rocky ridge. Bed-rock is serpentine, overlain by gravels and sometimes by a blue clay and gravel. A section of the overburden here, shows from six inches to a foot of black surface soil, then a coarse gravel with more or less gold, below is a stratum of finer material and then more gravel. Two pay-gravels are said to be found, one below the 'muck' and one on bed-rock, but here as elsewhere values are 'spotty.' Some quartz veins, more or less mineralized, cut across the creek above Discovery. They are said to be associated with richer gravels.

'The gold is moderately coarse, often much like flax seed in size and shape, and is valued at from $16 to $17 an ounce.

McKee Creek.

'*McKee Creek*, is the only producing creek outside the drainage basin of Pine Creek. Its length is seven miles, draining the ranges immediately south of Atlin on the same side of the lake, seven miles to the south. The upper portion of this creek is nearly flat, the valley passing over into the valley of Spruce Creek. It is heavily covered with drift material, with a point of bed-rock here and there. There is a fall of about 1,500 feet between the upper flats and the lake. The bed-rock is often exposed on this lower portion, and is a rather massive greenstone which wears smooth. The creek-bottom is full of rocks and boulders. A bench or terrace runs along the north bank; otherwise this valley resembles that of Boulder and Birch creeks in most respects. Good pay, or one to three ounces per day per man is believed to have been taken out here. The part of the valley above described extends from Little Eldorado Creek to Discovery, less than one mile; below Discovery much of the ground is leased to the Atlin Syndicate Mining Company. Above Little Eldorado not much is now being done. Shafts sunk some twenty feet on the flats passed through a mixture of gravel and clay without gold.

'A fair supply of water and rapid fall are points in favour of this creek. The adjacent mountains are composed of greenstone, quartzite and limestone. Some quartz veins are staked, also some much oxidized rock on Little Eldorado. A spring of carbonated water issues into the bed of the creek above Discovery.

Other gold-bearing localities.

'This completes the description of the worked or producing creeks. The upper portion of Dixie Creek looks favourable for placer gold, and the lower portion, called O'Donnell River, has been very little

prospected, although much of it is staked. Moose Creek, southward of Pike River is also staked, but no work was in progress at the time of our visit. Gold is said to be taken out of it by the Indians. British Columbia—*Cont.*

'The gold-bearing creeks, as far as they are at present productive, lie within the area of certain recognized rocks, consisting to a great extent of serpentines and other magnesian rocks, along the valley of Pine Creek, and of line-grained green and black massive, slates, of probably igneous origin on McKee, Spruce, Boulder and Birch creeks. The only approach to slates proper is found in the black shales or slates of Wright Creek and the gray ribbed rock of upper Spruce and Otter creeks. Rocks characterizing gold-bearing area.

'Little or no gold has been taken from creeks flowing over granite, quartzite or basalt; but the quartzite bed-rock, as well exposed on O'Donnell River, has been very little prospected.

'Most of the valley systems, at their upper levels, show a large amount of drift material of glacial origin. Much of the gold may be the result of a reconcentration of this material, which is usually composed of constituents derived from the adjoining country. Drift deposits.

'On Boulder and Birch creeks there is not much evidence of glacial drift, these valleys were apparently due entirely to erosion by water. The gold appears to be of local origin. It is usually found on the bed-rock of the present or post-glacial streams, whether derived from pre-glacial concentrations or not is yet undetermined. Some of the old channels, benches, and rim-rock deposits, are older water-ways, and some of them appear to have been pre-glacial, more especially in the broad valleys of Pine and Spruce creeks. Relation of gold to these.

'At present profitable work is confined to the flats, bed-rock and benches of the streams cut out since the glacial drift was deposited, together with some adjacent older channels, such as William Creek, wherein boulder-clay and pay-gravels are both found.

'The morainic hills and valley-terraces as a rule are not known to carry gold sufficient for hydraulic working. A certain amount of superficial concentration of gold contained in them, however, appears to have occurred. The definite proof of rich gravels beneath the general burden of glacial drift, would open up large parts of the creeks now lying idle on account of depth of bed-rock. Along the upper portion of the creeks this ground would not be very valuable unless richer than usual, owing to the small amount of water available for mining. Probable importance of pre-glacial gravels.

'Generally speaking the Atlin division still offers considerable inducement in both placer and quartz. In neither case, however, as a "poor

British Columbia—*Cont.*

man's" country, or for individual operation, except in special cases and for short times. An area fifteen miles north-and-south, by twenty miles east-and-west, will include all the creeks described, and, as far as known the productive gold field of this district.

'The extension of the "slate" rocks to the north-east, south, and south-east of the present gold field may promise further placer deposits. The particular series of rocks seen about the gold-bearing creeks, however, was only noticed south of Gladys Lake, and were here heavily covered with glacial drift.

Possible quartz mining.

'The position of quartz mining in the district is at present uncertain, but the geological conditions appear quite favourable for the production of ore-bodies. Some strong veins of quartz and sulphide ores have already been staked, as well as some large outcrops of iron-stained rock, said to carry values, but not much can be said about these without a moderate amount of development and good sampling. As far as the surface indications serve to show, there are large bodies of ore or mineralized rock, but neither the value of the contents of these nor the cost of treatment has been ascertained.

Expense.

'Concerning cost of transportation, the district does not appear to be more inaccessible than West Kootenay was eight years ago. Cost of labour is at present five dollars a day without board. A strong camp capable of furnishing a large tonnage of smelting or milling ore of a value of twenty-five to fifty dollars a ton should bring about cheaper transportation and other facilities which would make such values pay to mine.

Exploration so far accomplished.

'The little work so far done amounts to no more than prospect shafts and cross-cuts, and it is unlikely that much more will be accomplished by the individual miners, owing to the cost of material and living. Companies will probably have to take up undeveloped prospects themselves, and so take most of the risk. In the meantime, the claim owner will be wise to spend some money on sampling and assaying before undertaking costly exploration of the ground. The most favourable quartz districts noticed during the summer were north of Golden Gate some twenty miles, on Taku Arm, south of the same place, and about Otter River and lake, also, along the southern fringes of Atlin Lake, and north and west of Surprise Lake.

'There is a large district of intermixed "slate" and granite south-east of the producing gold field, which is worth prospecting but is somewhat remote for quartz mining at present. So far as could be learned, the granites are practically barren, and, except for small quantities of copper, the limestone ranges have up to the present time, also proved

barren. No district or rock can be condemned as valueless. It is simply stated that appearances favoured the above mentioned localities. The Anaconda, should it turn out favourably, will be an object lesson to miners with preconceived ideas, as its associations are of a peculiar character. British Columbia—*Cont.*

'During July discoveries of native copper were made on the southern shore of Goat Island, nineteen miles south of Atlin. I was not at this place, owing to rough weather on the lake during September, and the claims of other work, and have to acknowledge the courtesy of Mr. A. H. Bramly, a London Mining Engineer, for some account of it and for some specimens of the ore. Native copper.

'Fourteen claims have been staked on the course of this discovery. The country-rock in the vicinity is sandstone, but with dykes and igneous intrusions about the southern flanks of Birch Mountains. The vein-matter consists of calcite seams with flakes and slabs of native copper, one of which was a foot in diameter and an inch thick. Besides these thin seams, there is a zone of greenish rock, impregnated with white and red calcite, and specks of native copper. The main rock itself being a green serpentine, representing an altered dyke passing through the sandstones and conglomerates. Other native copper deposits were reported from near Moore Creek, and the glacier front.

'The Currie Swan is a quartz location made by Joe. Kirkland, on May 21, 1899. It lies three and a-half miles south of Atlin, on the east side, and consists of a number of quartz seams containing galena, lead carbonate and copper stain in a quartzitic country-rock. Metalliferous veins.

'The quartz veins found about the western end of Surprise Lake and one towards Fourth of July Creek are, as usual, confined to the so-called slates. Some of these veins are well mineralized with sulphides, and others show fine gold and silver sulphide resembling some of the Kootenay ore-bodies in this report. The usual course of the veins is north or north-east, true. The dips are usually steep.

'The Pride of Pine Creek and Surprise Mountain Lode, located in August, 1898, by Fritz Miller and other pioneers of the district, on Surprise Mountain, a mile south of the lake and 850 feet above it, are on a strong quartz vein, shown by open-cut to be at least eighteen feet wide, containing galena and some copper-pyrites. This vein is in a band of altered talcose rock, that passes through the usual green and black rocks of this district. Its course is nearly north-and-south. Dip 66° west.

British Columbia—*Cont.*

'The Lake View group consists of Lake View, Grand View and Last Chance, located in September, 1898, by W. H. Brown and others, and situated half-way between Boulder and Birch creeks, 400 feet above the lake. These cover a well-defined vein three feet wide on

Lake View.

the Lake View. Its course is north-northeast; dip 70° westward, It holds galena, zinc blende, silver sulphide and free gold. The country-rock is the same as that of Boulder and Birch creeks. An opening twelve feet deep shows this vein with regular width and good walls. Other parallel veins carrying more sulphides occur in this group.

Little Edna.

'The Little Edna mining claim, situated five miles up Birch Creek on the north-east branch, was located August 15, 1899, by V. C. Spaulding and others. It covers a quartz vein six to eight feet wide containing much pyrrhotite and some copper-pyrites. The vein strikes north-northeast and dips 85° westward through a somewhat stratified series of hard black rocks of fine grain. There is a strong foot-wall with over a foot of selvage matter. Other large outcrops of quartz were seen along Birch and Boulder creeks but nothing has been done to prove them.

Sunset.

'The Sunset group lies twenty miles east of Atlin, over the head of Ruby Creek. Locations were made here on July 15, 1899, by Alex. McDonald and others. This ore-body occurs along with an area of the crumbling gray limestone characteristic of the gold-bearing rocks. Owing to the presence of snow and a cave-in of the open-cut little could be seen of the course and dip of the body of sulphides. As usual, the surface is covered with broken rock, more or less shifted from its original position, The solid sulphide ore-body consists of galena and iron-pyrites; it is over five feet across, while fifteen feet shows more or less impregnation. The course is probably north-east, since other exposures have been found in that direction. Other veins in this vicinity carry copper ores in a quartz gangue.

'The Cañon mining claim is situated on Crater Creek, a tributary of Fourth July Creek, fifteen miles from Atlin. There is said to be a strong vein, seven or eight feet wide, of quartz, containing galena. This was staked in the fall of 1898, by O'Neil.

Anaconda claims.

'Anaconda Group. The claims included in this group lie immediately south and east of Atlin, adjoining the town-site. They were staked by various parties, but have now passed under the control of Lord Hamilton's people, who are developing them this winter. This deposit is very extensive, being in places over 1,000 feet wide, and it cuts across the Pine Creek valley as a distinct band or formation. The rock is a more or less pure magnesiam carbonate or magnesite, much intersected by quartz and calcite stringers and seams of oxidized

material. The rock itself is highly impregnated with pyrites, and some of the little veins carry galena and pyrites, but values in gold are said to be found all through the mass of this altered rock, especially along the oxidized seams and cavities. Of many samples taken by drilling holes all across the outcrop, it is stated that none proved to be barren. During the winter, cross-cuts will be made, under charge of Mr. Featherston, to determine if values continue satisfactory below the surface oxidation. Should this work be satisfactory, there is a great quantity of ore already in sight along the outcrop, and a wide field for operation will be opened. British Columbia—*Cont.*

'This rock, examined microscopically and in the laboratory, proved to be an impure magnesite, containing more or less serpentine, quartz and felspar in different specimens, with iron-pyrites and occasionally galena. It is stained in parts bluish-green (probably by nickel) and also contains a green chromiferous mica. This green mica and the possible nickel stain were first supposed by the locators to indicate copper. Magnesite rock.

'The following mineral specimens were examined in the laboratory of the Survey, besides the ones already mentioned in previous pages :— Specimens examined in laboratory.

'No. 7. Native copper claims, southern shore of Goat Island, Atlin Lake. "An association of green serpentine with white and red calcite. The serpentine is evidently derived from the alteration of pyroxene pseudomorphs after this mineral being plentiful in the mass."

'Magnesite from a vein cutting weathered slates, about one mile and a half north of Pike River, on Atlin Lake. "A white, compact, massive magnesite, through which is distributed a little white quartz, approximately ten per cent."

'No. 4. From half a mile above Discovery, Pine Creek, crossing the bed of the stream as a vein. "A white crystalline ferriferous magnesite, with which is associated a little white translucent quartz and very small quantities of a green chromiferous mica." Free gold was said to have been found in this, and the green mica was mistaken for copper stain.

'A sample of water taken from the warm springs, ten miles south of Atlin, on the east shore of the lake. "This water, when filtered, was clear and bright, and of a faint brownish-yellow colour. It was devoid of odour or any marked taste. Its total dissolved saline matter was 16·53 grains per imperial gallon. A qualitative analysis showed the presence of :— Mineral waters.

Soda, very small quantity.
Lime, small quantity.
Magnesia, very small quantity.

British Columbia—*Cont.*

Sulphuric acid, very small quantity.
Carbonic acid, small quantity.
Chlorine, very small quantity.
Silica, trace.
Organic matter, trace.

'"Boiling produced a slight precipitate, consisting of carbonate of lime with some carbonate of magnesia."

'This spring is luke-warm. It has built up a channel and mounds of calcareous sinter or tufa, and appears to issue from near the contact of the O'Donnell River limestones with quartzites.

'An examination was also made of the so-called "Soda Water" found in the bed of McKee Creek, a little way above Discovery claim. It is described as a clear, bright and colourless water, devoid of odour or any marked taste. The total dissolved saline matter was 103·grains per imperial gallon. A qualitative analysis showed the presence of :—

Soda, very small quantity.
Lime, rather small quantity.
Magnesia, rather small quantity.
Sulphuric acid, trace.
Carbonic acid, somewhat large quantity.
Chlorine, trace.
Silica, trace.
Organic matter, faint trace.

'"Boiling produced a rather small precipitate, consisting of carbonates of lime and magnesia."

'This water, when fresh, is sharp and pleasant to the taste. There appears to be considerable free carbonic acid. The only deposit it leaves on the gravels is a stain of iron.

Magnesite.

'A sample of the white earthy-looking material found immediately behind Atlin town-site in large patches, when examined in the laboratory, was found to consist of "a pure white, more or less firmly compacted, yet readily friable mass of hydromagnesite." The area of these deposits is some two or three acres. They appear to be at least several feet deep. Some pits sunk for six feet show the same white material. The beds themselves are raised two or three feet above the adjacent low land.

'From these notes it appears that magnesian rocks and more or less pure forms of magnesite are common in this district. Serpentine and partially serpentinized rocks occupy much of Pine Creek basin. Magnesite occurs both as beds and in veins. True sedimentary slates or schists are not common in this district.

'Glacial material covers a great portion of the upper valleys and flats to a height of over 2,000 feet above Atlin Lake. Terraces of finer, apparently sorted material, were seen at many different levels from the lake-shores up to a height of 1,800 feet above Atlin Lake. No regular well-defined levels common to more than one valley system were noted, and along the mountain sides above the lake Terrans were usually absent. Across the wide up-land valleys they were common and regular. Some of these banks remote from present streams have been stated to carry colours of gold. British Columbia—*Cont.* Glacial deposits.

'The material which composes the lumpy and less sloping uplands is usually a mixture of sandy clay and partially rounded boulders, the constituents at every place examined being composed of the same rock as the adjacent hills, with an odd boulder of granite or other rock foreign to the locality. Granite boulders were also occasionally seen high up on the mountain sides apart from the general drift material.

'Glacially rounded rock was seen in places on the mountain sides south of Atlin to a height of 600 feet above the lake. The only definite grooves or striations seen were some at the lake-shore, close to Atlin, having a course nearly north-and-south, with the lake trend. Striation.

'The Surprise granite has been carried northwards towards Gladys Lake and Teslin, and the granite of the great plateau on the Taku trail was found in blocks on the opposite range across Hurricane River, ten miles north of its original position. Otherwise there is little evidence of far removed material. The boulders of the lake-shore and creek-beds being of local appearance. This appears to strengthen the opinion that the placer gold had its origin within the drainage basins where it is now found. Transport of boulders.

'True boulder-clay is not so commonly found as more or less assorted material, in the form of gravel and sand beds, little hills of coarse material mixed with sandy clay, and long broad terraces, with steep escarpments.

'The present valley system must have been practically cut out before the advent of this glacial covering, and old stream-beds, other than the ones now flowing, may be hidden beneath the drift. The presence of pay gravel in some places near Spruce and Pine creeks, appears to show the probability of pre-glacial channels more or less undisturbed by later events. Age of valleys.

'The climate of Atlin district is not severe. The vegetation and general dryness point to a small rainfall. The past summer, although unusually wet in southern British Columbia, was not nearly so much so in Atlin, although not so dry as usual. Climate.

British Columbia—*Cont.*

'The lakes *en route* probably break up before or about the 1st of June, and do not completely freeze up again until well on in the winter. No noticeable frost was seen from our arrival on June 7 until the night of September 2 at Teslin, in the lower or lake country. Snow fell on the hills 1,000 feet above the lakes on June 17, and on September 1 at Teslin. On the hills about Atlin it came to stay, in part at least, on September 27.

'Two feet of snow is said to have lain round the lake-shore last winter, and more on the mountains. It is not likely that horses would live without care and feeding, except in favourable winters, although they have done so at Tagish. Cold south-easterly winds continually pour in from the gaps of the Coast Ranges during the early summer and fall, otherwise the climate is, as far as known, very much like that of Kootenay, although considerably cooler. The winter weather is said to be bright and calm. It is not severe as compared with the country further inland as the following average temperatures will show :—

Winter temperatures.

	Fahr.
Last half November	·6
First half December	28·3
Last half December	16·6
First half January	5·9
Last half January	14·5
First half February	16·5

'The coldest periods coincided with those of West Kootenay last winter, being in November, January 1 and of February 1. The lowest recorded was 32° below zero. From Nov. 22 to December 27 the temperature never fell to zero, and on nineteen days was above freezing point.

Forest.

'The forest growth is not heavy. Banksian pine, black spruce and poplar are the common trees. Cottonwood at the mouths of streams grows to a good size. Black spruce furnishes the timber for building, it rarely has a diameter of over two feet. The areas of such timber land are small, and saw-logs are usually about one foot, by twelve or fifteen feet long. Wild hay is very scarce. Bunch grass is abundant east of Atlin Lake. No pine, tamarack, cedar or hemlock trees were seen, and birch only at Nabina River. Thirty-eight species of plants that appeared to be of interest were collected. These are referred to by Professor Macoun in his report on a subsequent page.

Fruits.

'Attempts to grow garden vegetables on the sandy soil near Atlin have not been encouraging, owing principally to raw pine ground and want of rain. There seems no other reason why these should not be

successfully grown. The native fruits are—cranberry, swamp cranberry, blueberries of several kinds, black and red currants, a few gooseberries, raspberries and muskeg berries, also service-berry *(Amalanchier)* of inferior quality. British Columbia—*Cont.*

'Transportation to the creeks is by wagon-road and pack-trail, costing from one to three cents per pound to the different creeks from Atlin City. Pack animals were cheap during last summer, but as they cannot probably be kept through the winter, they will be more expensive next season. Acknowledgments are due to many gentlemen for assistance during the season, especially to Messrs. Frazer and Wheeling of the P. P. Company, Drs. Runnals and Mitchell and Messrs. Brownlee and Lowry of Atlin. Also to Alex. McDonald and Messrs. Murray of Discovery, Pine Creek. Routes to Atlin.

'There are many routes into Atlin, none of which at present are cheaper or better than that by way of Skagway, Bennett and Taku Arm railway and steamboat service, less than twenty-four hours in transit with fair connections, and a total distance of about 140 miles from Skagway. This is both a summer and winter route.

'A probable all-rail route, if such comes to pass, will be via Bennett, Tagish and Little Atlin Lake. From Tagish over to Atlin by this way is fifty-eight miles, with a height-of-land at Little Atlin Lake approximately 115 feet above Tagish and eighty feet above Atlin Lake. The country is open and not rocky until Atlin Lake is reached. This is the route followed by the telegraph. The old Fantail route from Log Cabin is fifty-seven miles; it is a shorter winter trail, for dogs. By way of Telegraph Creek to Teslin and overland to Atlin, is slow and circuitous, but suitable for bringing in stock on foot during summer.'

Mr. R. W. Brock, during the early part of the year, was occupied in working up the field notes and specimens obtained during the previous summer in West Kootenay. In the spring he resumed field-work in this district, accompanied by Mr. W. W. Leach, who devoted special attention to the geographical and topographical part of the work. Work by Mr. R. W. Brock, West Kootenay.

Good progress was made toward the completion of the West Kootenay map-sheet during the summer, although the season proved to be a remarkably unfavourable one in regard to weather. Mr. Brock notes the chief features of the work and the results of interest arrived at, as follows:—

'On May 19 I left Ottawa with instructions to endeavour to complete the field-work necessary for the publication of the West Kootenay Area examined.

British Columbia—*Cont.*

map-sheet. The areas still remaining unsurveyed included all those west of the Columbia River, with the exception of that covered by the Rossland map (already published), a considerable area between Arrow Lake and the Slocan valley (most of the Slocan Slope, including the basin of the Little Slocan, the basin of Cariboo Creek and the country north of this lying in the map-sheet), together with a small triangular area in the lofty mountains east of Kootenay Lake, in the north-east corner of the map-sheet.

Unfavourable weather.

'For field-work, the season was exceptionally unfavourable; the spring was late and snow interfered with the work till well on in July, and from that time on the weather became broken and autumnal. In the early part of August rains set in, and these continued for a month. During this wet weather the mountains were again mantled in snow. The latter half of September was fine, but thereafter the weather again became broken and unsuitable for mountain work. On the other hand, the wetness of the season prevented forest fires and smoke, so that no annoyance was caused from that source.

Surveys made in different districts.

'Nelson was again selected as head-quarters for the season. The first work undertaken was a survey of the west shore of Lower Arrow Lake and the country lying immediately to the westward. As a transit and micrometer survey of the east side of the lake had already been made last season, a log-survey of the west shore-line of the lake was considered sufficient. After completing this work, a portage was made from Christie's ranch, at the head of the lake, into Whatshan Lakes. A couple of weeks were spent in surveying these lakes and the country in the vicinity. Although it was now July, there was still too much snow in the high mountains to allow work to be attempted in the Valhalla Mountains, so camp was moved over into the Slocan valley and the western slope of this basin was examined. About July 24, I returned to Arrow Lake and entered the Valhalla Mountains from Long Creek. After working along the Slocan divide a packing trip was made across the Trout Creek and Little Slocan divide into the mountains to the east. Subsequently, returning to the head of Long Creek, the men were sent back to Burton, and Mr. Leach and I descended the valley of the Little Slocan, following it for its entire length and emerging at Park Siding on the Slocan branch of the Columbia and Kootenay division of the Canadian Pacific Railway.

'Returning to Burton, the area between this place and Slocan Lake, and northward to the edge of the map-sheet, was next surveyed. While this work was being finished, Mr. Leach went over to Kootenay Lakes to try to fill up the blank in the north-east corner of the sheet.

'The next work undertaken was in the district between Shields Landing and Rossland and westward to the watershed between Sheep and McRae creeks on the Rossland-Gladstone trail. British Columbia—*Cont.*

'On October 8 the regular field-party was broken up, but a week or ten days was spent in finishing work at several points on Arrow and Slocan lakes that had been left over till the end of the season.

'Upon leaving Nelson on October 20, I went west along the main line of the Canadian Pacific Railway to examine the Shuswap and Nisconlith rocks in their original and typical localities in the area of the Shuswap map-sheet, and to collect representative specimens for comparison with the similar rocks of the Kootenay district. When this work was stopped by snow, I returned to Ottawa.

'In the Summary Report for last year,* a description has been given of the general character of the country between the Slocan and Columbia valleys. With the exception of the Little Slocan, all the valleys tributary to the Slocan from the west are short and steep. They head for the most part in picturesque cirques, in rugged glacier-bearing mountains. From these cirques, in which lakelets are usually found, the streams descend by leaps and bounds. The smaller streams, such as Falls Creek, opposite Silverton, are exceedingly precipitous, forming an almost unbroken succession of cascades and falls. The streams frequently debouch though cañons, although on Slocan Lake this is not so marked a feature as on Lower Arrow Lake. Topographical features.

'Parallel to Slocan Lake, a few miles to the westward, a high range of mountains extends northward from the Valhalla Mountains, forming the watershed between the Slocan and the Columbia River proper. North of the end of Slocan Lake these monntains decline in height.

'Cahill Creek, the north branch of Evans Creek, which heads with Snow and Trout creeks in the Valhalla Mountains, descends in a succession of steps, on almost each of which a lake is found. Beatrice Lake, the largest, is several miles long. It completely fills the fairly wide valley, mountain-walls rising abruptly on either hand to thousands of feet above it. The discharge from this lake is subterranean for three-quarters of a mile, after which it reaches the surface in a number of large springs. This has given rise to the mistaken idea that Cahill Creek has its origin in the pond fed by these springs, and that Beatrice Lake discharges westward, the rising ground between these two points being the watershed. In reality Beatrice Lake is some miles below the head of the stream. Cahill Lake and two others are found, lower Evans Creek

* Summary Report, Geol. Surv. Can., 1898, pp. 64-65.

British Columbia—*Cont.*

down, before this stream unites with the main fork of Evans Creek about half a mile from Slocan Lake.

Little Slocan River.

'The Little Slocan River is the most important branch of the Slocan from the west. In the centre of one of the most mountainous portions of the district, it occupies a valley remarkable for its depth, size and low gradient; for, except at its head and on the smaller branches where the descent is extremely precipitous, its declivity for a mountain valley is strikingly small. It receives numerous tributaries from all directions. About six miles up from its mouth on Slocan River, a large branch, the East Fork, bends round north-easterly behind Perry Ridge, occupying the low valley that runs through to the main Slocan valley near Slocan City. On this branch, a few miles up, are several small marshy lakes. It receives some large tributaries from the Valhalla Mountains to the north. Between it and Malvey Creek, which flows north-east into the Slocan River, is a low marshy divide.

East Fork.

'The East Fork of Little Slocan might easily be mistaken for the main stream, as its valley is wide and its bend gradually north-eastward, while that of the main branch turns sharply north-west, and, for the first few miles, is contracted into a narrow defile. But above this the main valley widens out, takes a northerly bearing and heads in the Valhalla range with that of Long Creek, which discharges into Lower Arrow Lake, five miles below the Needles, and with that of Trout Creek, which falls into Cariboo Creek near its mouth at Burton City. The two large lakes that are shown on this stream in all the previous maps of West Kootenay, as Little Slocan and Beaver lakes, do not exist. This error has probably originated through a misapprehension of the position of the East Fork with its little lakes, which is parallel to the main Slocan valley, separated from it by the narrow elevation of Perry Ridge, and through mistaking this for the main valley, which, above its contracted neck has been unfrequented even by trappers.

Cariboo Creek.

'The drainage of the whole country behind Burton City is effected by Cariboo Creek and its tributaries, Snow and Trout creeks. Cariboo Creek heads in the lofty mountains, whose eastern waters reach Slocan Lake through Nemo, Sawmill and Mill creeks. For the first seven miles its course is northerly. After receiving the North Fork, which heads with Little Trout and McDonald creeks, it takes a course a little south of west. Several streams enter it from the north, the most important being Blue Grouse, Mineral and Granite creeks. About six miles and a-half from Burton, it bends south for a couple of miles when Goat Cañon Creek, a tributary from the east, flows in. From here it turns westward and discharges into the Columbia at Burton City.

British Columbia—*Cont.*

'The main valley of Snow Creek lies east, and, west, but its chief feeders come in mostly from the south, heading in the Valhallas, with Evans and Nemo creeks, which flow into Slocan Lake. It unites with Trout Creek, a short distance from the mouth of the latter. Trout Creek, as before mentioned, heads with the Little Slocan, and has a northerly course to Cariboo Creek, entering the latter near Burton City.

Character of country west of Lower Arrow Lake.

'The country to the west of Lower Arrow Lake, while still wholly mountainous, has not the wild, rugged aspect of the district to the east. The mountains are much lower, scarcely reaching 6,000 feet, and have rounded, subdued outlines, in striking contrast to the bold lines of the Valhalla range. The ridges are comparatively level, of rather uniform elevation and are of considerable width, so that this portion of the district presents more of the appearance of a plateau country rendered mountainous by extensive erosion, while that east of the lake conforms to the Alpine type.

'Its system of valleys is complicated and suggestive of great changes in the drainage-system of the country. One of the most important valleys is that of the Whatshan River. It leaves the lake at the Needles and extends north, being the continuation in that direction of the north-and-south valley occupied by the main, central portion of Lower Arrow Lake.

Its drainage.

'About three miles and a half from its mouth the Whatshan receives Barnes Creek, which drains a wide valley heading with Fire valley and the Kettle River. About half a mile above the Barnes Creek forks is the outlet of the Whatshan Lakes. These are three in number, connected by short stretches of river. The upper lake is the chief body of water. Their elevation is about 700 feet above that of Arrow Lake. From the outlet to the head of the upper lake is a little over twelve miles in a straight line. Fife Creek enters the lake from the north-west, while east of the main tributary is Stevens Creek.

'A low pass to the east connects the head of Whatshan Lake with Mosquito valley.

'Between the lower end of Whatshan valley and Fire valley on the west and Arrow Lake on the east, the dividing ridges were cut by several low passes.

'A trail, a little under five miles long, runs from Christie's ranch on Lower Arrow Lake to the Whatshan Lakes.

'Fire valley enters the Columbia valley from the north-west, about seven miles below the Needles. It is deep and wide and affords an

British Columbia—*Cont.*

easy pass to the head of Cherry Creek and the Kettle River. For the first few miles it parallels the lake, separated from it by a low ridge. A wagon-road from the lake, about a mile below the Needles, crosses this ridge into Fire valley, where a number of ranchers have located. From here a trail extends up the valley to the head of Kettle River and to Cherry Creek, there connecting with the wagon-road to Vernon. Fire valley is drained by Inonoaklin Creek. Eagle Creek from the west discharges into the lake through the same mouth as Inonoaklin Creek.

'Going south from Eagle Creek are Worthington, Johnston, Cinnamon, Michaud, Bowman, Dog, Pup, Brush, Moberly and McCormick creeks, but of these Johnston, Bowman and Dog creeks are the only ones of any size. They all occupy ordinary transverse valleys, and very often the lower parts of these valleys just before entering the lake are contracted into cañon-like gorges.

'From above Johnson Creek to Dog Creek, a few miles west of the lake and parallel to it, is a clearly defined ancient valley, the present stream-valleys cutting transversely through it.

Sheep Lake Plateau.

'The country south of Arrow Lake and west of the Columbia River has the appearance of a plateau of erosion, and may for convenience be referred to as the Sheep Lake plateau, from the largest of the marshy lakes found in its centre. It is drained by Blueberry Creek, which flows from Sheep Lake into the Columbia about six miles below the mouth of the Kootenay, and by Sheep Creek which flows south across the International boundary and thence eastward into the Columbia. To the west it is separated from McRae Creek by Norway and associated mountains; to the south Old Dominion and other high mountains lie between it and the Rossland country.

Railway and trails.

'A new government trail from Rossland ascends Murphy Creek, crosses into the Sheep Lake plateau and thence over Norway Mountain to Gladstone, on the new Columbia and Western Railway in McRae Creek valley. There is a trail from Shields Landing on Lower Arrow Lake, which ascends Moberly Creek and crosses over to Sheep Lake, there connecting with the Rossland-Gladstone trail. The Columbia and Western Railway, now completed as far as Grand Forks on Kettle River, follows the Columbia River and southern limb of Arrow Lake westward from Robson to Pup Creek, tunnels through from the head of this stream into Dog Creek and crosses the divide from Dog Creek into McRae Creek, which it follows to Christina Lake.

Timber.

'The country west of the Columbia has suffered greatly from forest fires, so that the trees are now mostly small second-growth. Between

the Columbia and Slocan valleys some good timber is to be found, although on account of the mountainous character of the country it is, as a rule, too scattered to be of much importance commercially. Some of the valleys have timber of economic value. That of Evans Creek was taken up last summer. But the valley of most importance in this respect is that of the Little Slocan. For almost its entire length the main valley as well as that of the East Fork is timbered with large well formed pine (*P. monticola*), cedar, hemlock and Douglas fir. Red pine (*P. Ponderosa*) is found at the park-like mouth of the valley. British Columbia—*Cont.*

'The rocks of the district examined during the season are principally eruptives, although, along the northern portion there is an important area of sedimentary rocks and crystalline schists. A short description of the rocks and their distribution between Burton and Robson, east of the Columbia to the Slocan divide, is given in last year's Summary Report.* The rocks west of Slocan Lake from Little Trout Creek south, are granites, with inclusions of mica-gneiss of greater or less extent. Between Mill and Sawmill creeks is a large inclusion of this gneiss. Southward these gneissic areas become smaller, till they finally disappear altogether. Geology

'The granite is principally the gray "Nelson" granite; toward the north end of the lake it is usually isomeric, but at the south end and on Perry Ridge it is strongly porphyritic. In the southern Valhallas and on Mulvey Creek and the east part of the Little Slocan, it is squeezed into a banded mica-augen-gneiss. In the central portion of the district it is cut, or altogether replaced, by the light-coloured acid granite. This is a granite composed mainly of isomeric quartz and light-coloured felspar; the coloured constituents, chiefly biotite, being but sparingly present or entirely wanting, though garnets are not uncommon. Pegmatitic facies are frequently met with, and dykes of this rock cut the parent and the surrounding rocks in great numbers. This rock is largely developed in the Valhallas and along the Slocan divide. Nelson granite.

'At the mouth of the Little Slocan is an area of garnetiferous gneiss. It extends north-westward to a little above the East Forks, north-eastward to the summit of Perry Ridge, and eastward to the summit of Slocan Ridge. It is in part a granite-gneiss, formed from crushed Nelson granite, but is also in part composed of older rocks, which include limestone and perhaps dolomite bands, thus resembling the rocks of the Shuswap Series. From a few miles below the mouth of the Little Slocan to the Kootenay River, the rock is mainly Nelson granite. Garnetiferous gneiss.

*Summary Report, Geol. Surv. Can. 1898, pp. 65-68.

British Columbia—*Cont.*

'The distribution of the rocks west of the Columbia and south of Dominion Mountain is shown on the Trail Creek map.* Along the Middle Fork of Murphy Creek, a band of greenstone extends northward to the Sheep Lake plateau. This greenstone is the more or less altered augite-porphyrite, that is one of the widely distributed West Kootenay rocks. It is much cut up by dykes of various porphyries, lamprophyres, and also by small andesite dykes. At the head of the Middle Fork and in its vicinity, it holds inclusions of a crystalline limestone. Often innumerable reticulating and anastemosing "dykelets" of it have penetrated the inclused limestone with apparently some absorption of material of the latter. When subjected to subsequent crushing, such a complex produces strikingly perfect pseudo-conglomerates. Of these two types may be distinguished, that in which the matrix is of greenstone and the pseudo-pebble is of limestone, and that in which the matrix is of limestone and the pseudo-pebble is of greenstone. Sometimes porphyry "pebbles" occur as well, where a dyke of the latter has also been broken by the flow of the limestone under pressure.

Greenstone area.

'The greenstone is cut off along Dominion Mountain by the Nelson granite, which constitutes the chief rock west of the Columbia to about Shields Landing on Lower Arrow Lake. On Sheep Lake plateau also, from the standpoint of areal distribution, it probably stands first, though westward, at the head of Sheep Creek and Norway Mountain, the greenstone is abundant. This granite is often cut by the same intrusions as the greenstone, particularly by wide dykes of a red, probably syenite-porphyry from the great mass of these rocks to the north. Inclusions of the greenstone are common in this area of granite. Several small areas of Shuswap-like gneisses and crystalline limestones are also included in the mass of granite in the neighbourhood of Dominion Mountain.

Younger eruptives.

'From Moberly Creek north to Fire valley, the rocks belong to the "younger or red granites." The series is younger than and is intruded in the Nelson granite, and consists of a coarse red granite with a number of still younger porphyries. The granite is a coarse-grained rock in which felspar, in two varieties, reddish and grayish, (orthoclase and plagioclase), forms the chief constituent; while the others are quartz and a decomposed bisilicate apparently mostly biotite. The porphyries are generally reddish, and appear to be mostly of the family of syenite-porphyries, although they vary in texture, structure and more or less in composition. The principal constituents are orthoclase,

*Map of part of Trail Creek Mining Division. Geologically surveyed by R. G. McConnell.

plagioclase, biotite, and a diopside-like pyroxene with a little quartz. Felspar is generally the most prominent porphyritic constituent, although in some cases the coloured constituents are also conspicuous. Along their contacts they have usually a well-marked fluxion structure, and trachytic and other effusive facies are common. The eruption of these porphyries has taken place at many successive periods, between which there has been time for the already extruded rock to cool. This is proved by the way in which these dykes cut one another and the distinct salcand along the border of the younger dyke. The greater part of this area consists of a complex of these dykes. They also frequently cut the surrounding older rocks. The white dykes that are found associated with the ore bodies of the district would appear to be an acid facies assumed by these dykes at some distance from the parent mass.

British Columbia—*Cont.*

'Near the borders of the main area are numerous inclusions of the older rocks. Often when these are basic, the acid eruptive in innumerable vein-like stringers has eaten into them, leaving reniform nuclei of the original rock. The result is a conglomerate-like mass. Frequently the peripheries of the nuclei are partially altered. These rocks are well seen in the cutting of the Columbia and Western Railway along Arrow Lake. A little north of Fire valley, the red granite is replaced by the white acid granite, that is in all probability merely an acid varient of the former; although the precise nature of the relationship between these two rocks was not proved. The acid granite extends to about Whatshan River, where the older Nelson granite is the country rock. This extends almost to the head of Whatshan Lake and to the bend of the Columbia, just below Mosquito Creek. At Whatshan River it is cut by a gray fine-grained somewhat prophyritic rock consisting mainly of a gray felspar and a bisilicate which has decomposed to biotite and iron-oxide. While younger than the Nelson granite, this rock is older than the acid and red granites. North of Whatshan Lake through to Mosquito Creek, and along the north slope of the mountain south of the Columbia, between Mosquito and McDonald creeks, the rocks are Shuswap-like mica-schists, gneisses and crystalline limestones. Along Cariboo Creek from Mineral Creek to the North Fork and also on the Ruby Mountains, north-east of the divide between McDonald and Little Trout creeks, is a dark grayish-green porphyritic rock. Occasionally this rock is brecciated and fragments apparently of the augite-porphyritic are included in it. Macroscopically it resembles some of the rocks found in the Columbia volcanic group in the southern portion of the West Kootenay sheet. It cuts the sedimentary rocks, but its relationship to the other eruptive rocks

Inclusions of the older rock.

Crystalline schists.

British Columbia—*Cont.*

in this neighbourhood was not clearly ascertained. Besides the porphyry dykes which traverse all the country-rock of the district, there is a series of green and black lamprophyres, which cut all the other rocks. They are to be met with in all parts of the district, but they appear to be particularly abundant in the regions most cut up by the porphyries.

Sedimentary rocks.

'From Little Trout Creek, near the head of Slocan Lake, to the mouth of McDonald Creek on the Columbia, is a band of dark carbonaceous limestone, calcareous quartzite and slate-like rocks, similar to the Slocan series of the Sandon region, and of which they form the westward extension. They continue northward along the Nakusp and Slocan valley to Summit Lake, where they are cut off by Nelson granite; from McDonald Creek they extend northward along Upper Arrow Lake. Where cut by eruptives, these rocks are often metamorphosed, the carbon being expelled and mica developed, so that instead of presenting a slate-like appearance, they become yellow or gray calcareous mica-schists. Along the south fork of Cariboo Creek, running south from the main band of Slocan rocks and surrounded by granite, is an area of gray mica-schists, that may be the metamorphosed form of the Slocan rocks. No definite information has so far been obtained regarding the date of this series, but they are supposed to be of about Carboniferous age. Unfortunately, the only fossil form so far obtained, does not throw much light upon the question. It is a brachiopod, probably a *Chonetes*, which was found this summer in a carbonaceous limestone boulder, in all probability, from the Slocan series. It was picked up in the drift behind Nelson.

Glaciation.

'The region examined this summer, as also that examined last season,* furnished additional evidences of the extent of the great Cordilleran glacier. In all parts of the district (except on the actual summits of the Valhalla range where disintegration and weathering have obliterated any traces of glaciation if such existed) are to be found erratics, perched boulders, well marked fluting and striation and every evidence of heavy glaciation, and the general trend of the ice-movement remains constant throughout.

'A number of the small local glaciers of the Valhalla Mountains were examined; while some show evidences of fluctuations, in general all are retreating.

'Numerous terraces of silts and gravels, similar to those observed last year along the east shore of Lower Arrow Lake*, were found along the west shore of the lake and along the Whatshan and Slocan valleys.

* Summary Report, Geol. Surv. Can.1 898, p. 68.

'Short descriptions of the nature of the West Kootenay ore-bodies have already been published.* The observations of the past season tend to confirm the opinions already expressed. Additional evidence of the probable relationship between the white porphyry dykes, and the deposits of economic minerals, pointed out in last year's Summary Report, seems to be furnished by the fact that in the districts cut through by these rocks mineralization has taken place; whereas where the dykes are wholly absent, this has not occurred. In the greater part of the Valhalla and Little Slocan country, few of the geological conditions and little evidence of mineralization was observed, and almost no claims have been taken up in this portion of the district.

British Columbia—*Cont.* Economic geology.

'In the northern portion of the district, the dark slate-like rocks of the Slocan series, the same rocks that are found in the highly mineralized Sandon region, occur over a wide area, but it is only at certain points (where these rocks are dyked, and are, in this respect also similar to the Sandon rocks) that mineral impregnation to any important extent has taken place. On Cariboo Creek, such conditions are met with. Consequently there are a number of claims, upon which more or less work is being done. On the Chieftain claims, five men were employed prospecting and developing. The ore consists of auriferous and argentiferous pyrite, chalcopyrite, galena and zinc-blende in a quartz gangue. It occurs in small, rudely parallel veins in the dark Slocan rocks. On the Silver Queen, a force of men has resumed work, interrupted in the winter of 1899 by snow slides. Some work was also being done on the Millie Mac. In addition, development-work was being done on a number of private claims. At some points, as on Mountain Meadow claim at the head of Granite Creek, the gray granite is also well mineralized, with veins of argentiferous galena.

Burton City camp.

'At the Big Ledge, west of Upper Arrow Lake and opposite Halcyon Springs, to which attention was called in my report of last year, considerable work has been done. The information gained regarding the tenor of this mass of sulphides is said to be encouraging. A wagon-road to the deposit was being constructed.

'The new government trail from Rossland to Gladstone has given access to the Sheep Lake and Norway Mountain district, and a large number of prospectors were at work opening up various claim situated in this area.

Where prospectors are at work.

'At the close of the season, prospectors who had gone from Fire valley into the country at the head of Kettle River, returned with

* Annual Report, Geol. Surv. Can. (N.S.) vol. IX. 1896, p. 27 A. Summary Report, Geol. Surv. Can. 1898. pp. 68-69.

British Columbia—*Cont.*

reports of valuable discoveries in that district. On account of the lateness of the season, I was unable to go into the district to verify these reports, but it seems not improbable that the country west of the large area of eruptives, that occur in such mass about Lower Arrow Lake, conditions may exist similar to those found to the north, east and south of this area, where the country-rock is so richly mineralized. and so many producing mines have been located.

'In some specimens kindly furnished me from this new locality, is one of a dyke-rock similar to the light-coloured porphyries spoken of as being characteristic of the mineralized portions of West Kootenay. One specimen, said to be from David Whitley's claim at the head of Kettle River, consisted of jamesonite and native gold. Tellurides, platinum and iridium were supposed to occur, but in the specimens obtained, which Dr. Hoffmann examined, none of these minerals were found, the small metallic grains proving to be pyrrhotite and specular iron.

General progress of West Kootenay.

'The mineral output of West Kootenay during the past season has been seriously affected by labour difficulties, arising from a reduction of the wage-scale upon the passing of a provincial eight-hour law. Altogether on this account, a number of the mines have been temporarily closed down. Others are doing a little work on contract labour. Many of the mines continuing active operations have been handicapped by the employment of unskilled labour. While the greater part of this district has been affected, the output of the productive Slocan has suffered most severely from these causes. A great number of the miners who abandoned work owing to the labour troubles, took to prospectting or to work on private claims, but for this the weather was very unfavourable. Thus in spite of the improvement in many of the prospects through increased development, and of the additions to the list of shipping properties, the past season has been somewhat disappointing to those who had held the well founded expectations of immediate great progress in West Kootenay.

Rossland.

'The progress of the Rossland district, however, has been very marked. Although the Le Roy, the greatest producer, cut down its output for some time to enable development work to be pushed ahead, and to execute numerous improvements in the mine, and the War Eagle, the second great producer has been somewhat handicapped in the matter of hoisting, yet in spite of these facts the output for the Rossland district will this year greatly exceed, both in tonnage and value, that of any previous year. There is also every prospect of important additions to the list of shipping mines.'*

Mr. J. McEvoy was engaged during the early part of the year 1899 in completing the work of the previous summer's exploration of the Yellowhead Pass route, from Edmonton to Tête Jaune Cache, and in preparing a report upon the same. British Columbia—*Cont.* Work by Mr. McEvoy.

Mr. McEvoy left Ottawa on the first of June for the purpose of making a preliminary geological and topographical examination of the south-western part of the East Kootenay District, B.C. On the work accomplished he reports as follows:—

'East Kootenay first attracted attention on account of its placer diggings on Wild Horse Creek, Bull River, Perry Creek and Moyie River. It was the objective point of the Dewdney Trail that was built from Hope on the Fraser River, in 1865. More recently, however, this district has come to notice on account of the discovery and development of lode mines. The construction of the Crow's Nest line has given a great impetus to this industry. Mines that were formerly only shipping a small quantity of ore are now making arrangements for operating on a larger scale and fresh capital is coming in and developing new properties. East Kootenay district.

'The part of the district examined is, roughly speaking, seventy miles square. The base of this square is on the International boundary line, extending from the Kootenay River at Tobacco Plains westward to a point opposite the head of Kootenay Lake. A part of the Goat River mining division of West Kootenay is included in this area. It is needless to say that a thorough examination of all this country could not be made in one season's work, but it is hoped that the results, when compiled, will give some information about the geology of a country hitherto practically unknown in that respect, as well as something definite as to its natural resources. egion examined

'The Kootenay River in this district occupies the southern end (in Canadian territory) of the great "inter-montane" valley, whose course has now been traced for over 800 miles in a north-westerly direction from the 49th parallel. The valley attains perhaps its greatest width in this part of its length, being over twenty miles wide a little north of Cranbrook. The greater part of this wide portion of the valley has an elevation of about 300 feet above the river-level, while the low bottom-land of the stream itself, or, as it may be termed, the secondary valley, rarely exceeds a mile in width. Kootenay valley.

'Three or four miles to the east of the Kootenay River, the Rocky Mountains rise abruptly, while on the west after a gentle slope for fifteen miles, the mountains of the Selkirk or Purcell range rise more gradually and are deeply penetrated by tributaries of the Kootenay.

British Columbia—*Cont.*

With the exception of two prairies, the St. Mary prairie on St. Mary River and Josephs Prairie on Josephs Creek, and a few smaller areas, the whole of the Kootenay valley is covered with an open growth of large trees. The mountain-slopes are more thickly clothed, except where too precipitous.

Cranbrook to Wardner.

'Starting from Cranbrook, which was made head-quarters during the summer, the line of the railway was followed eastward as far as Wardner, passing through Isidore Cañon, a narrow gap through the low ridge of hills lying between Josephs Prairie and the Kootenay River. The rocks are well exposed in the cañon and consist of light-gray slightly schistose felsite, dark-coloured impure quartzite, bands of black slate and some dark-blue flaggy limestone, weathering brownish-yellow, but not containing much magnesia.

'The age of these rocks must be considered as somewhat doubtful, but from their lithological character and situation it appears very probable that they are referable to the Carboniferous. They extend westward and northward and occupy a considerable area of the wide portion of the valley before mentioned. A few miles before Wardner Station was reached, the hills to the south-west of the railway showed exposures of limestone

Limestones south of Wardner.

'South of Wardner along the route down the west side of the Kootenay River, this limestone continues as far as Plumbob Creek, a distance of about ten miles. It is generally fine-grained, gray and bluish in colour and sometimes cherty. Some beds occur of a brownish-gray rather crystalline magnesian variety. While no fossils were found to determine the age of these beds, and from their appearance they might belong either to the Carboniferous or Devonian, the fact that Carboniferous rocks are known to occur in many places in the southern interior of British Columbia, and that there is so far no positive information as to the existence of the latter, is perhaps sufficient reason to provisionally class them as Carboniferous. These limestones do not extend very far back from the Kootenay River, for the width of the area does not appear to be more than six miles at any place.

Plumbob Creek to Boundary line

'South of Plumbob Creek, the trail traverses a flat strip of country that extends for several miles back from the river. Near the river are extensive terraces rising from two hundred to three hundred feet above the Kootenay, marked in places by long drift ridges parallel to the valley and some higher ground formed by irregular gravel hills with numerous pot-holes.

British Columbia—*Cont.*
Tertiary rocks on Gold Creek.

'Along the Kootenay River, about twelve miles below the junction of Elk River, a few exposures show light-yellow fine-grained crystalline dolomite interbedded with siliceous shales. Farther down, at a point, two and a-half miles north of the mouth of Gold Creek, the north end of an area of volcanic rocks is reached. It contains a great variety of greenish amygdaloidal rocks, very fresh in appearance, that are evidently not older than Tertiary. This area extends to the Boundary line, increasing to a width of at least four miles at the southern end.

Gold Creek to Yahk River.

'Following up Gold Creek from its mouth, the route crosses first the wide terrace-flat before mentioned and then a series of parallel drift ridges, increasing in elevation as the distance from the river is increased. Only a few exposures are to be found, consisting of thin-bedded quartzites and shaly quartzites, both showing ripple-markings. A mile and a-half above the junction of the South Fork, a trail that leaves the Kootenay River near Plumbob Creek, crosses Gold Creek and leads south-westward to the head of the East Fork of Yahk River. This was one of the exploratory routes for the Canadian Pacific Railway. It joins the present constructed line at Yahk station on the Moyie River. This route was followed to the point where it crosses the Yahk River.

'Near the junction of the South Fork and for some distance below it, Gold Creek occupies a deep narrow valley, with wooded hills rising steeply on each side to a height of 1,500 feet. The valley of the South Fork is of the same character for two or three miles, above that it becomes wider and the stream winds about it in a flat valley with natural meadows and willow swamps. A stony terrace-flat forms the divide between a tributary of the South Fork of Gold Creek and the East Fork of Yahk River. The latter stream has a caon-like valley for nearly its whole length, with steep, almost precipitous sides.

'On the west side of Gold Creek near the crossing, the trail passes over a low hill composed of purplish dolomite thinly bedded and twisted. The remainder of the route shows thin-bedded quartzites and greenish, slightly calcareous flaggy argillaceous shales with some black slate. The quartzites and shales frequently show ripple-marks and rusty spots around cavities that may have been filled with crystals of some mineral, but which are now too indistinct in form to be determined. Mud cracks are preserved in some of the shaly beds. These beds have undergone very little alteration. No signs of schistosity were seen and their attitude is nearly horizontal with occasional low north-easterly dips.

Ascent of Yahk River.

'The East Fork of Yahk River joins the main stream about half a mile north of the Boundary line. The trail then ascends the main stream

British Columbia—*Cont.*

for a distance of five miles, and, crossing there, it runs westward to the Moyie River. Instead of following the trail it was decided to ascend the Yahk River to its head. The general course of the stream is north-and-south, through a heavily wooded country partly overrun by fire. In such a country and without any trail, progress was necessarily slow. Near the head of the river the valley was abandoned and a route was taken along the top of the mountain ridge on the east side. The highest point of the ridge, Yahk Mountain, is about 7,200 feet above the sea. It is the culminating point of all the country south of Cranbrook and between the Moyie and Kootenay rivers. In comparison with the rugged snowy peaks in view both to the east and west beyond its limits, this particular part of the country may be spoken of as rolling and hilly, rather than mountainous.

'Similar quartzites and shales continue up to this point, with the exception of one small exposure of a coarsely crystalline basic intrusive rock on Yahk River.

Head of Gold Creek.

'On the north side of Yahk Mountain, a steep descent leads to the head of the main branch of Gold Creek. An old and rather faint trail was followed down that stream, leading back to the main trail near Plumbob Creek. Quartzites and shales are exposed at intervals all the way, with uniformly low dips to the north-east.

Cranbrook to Moyie Lake.

'Returning directly to Cranbrook, and having secured additional supplies, the next trip taken was southward, to Moyie Lake and thence along the line of the Canadian Pacific Railway as far as Creston, near Kootenay Lake. This was the route followed by the Dewdney trail. Running due south from Cranbrook, it passes over a gently-rising flat-topped hill with an elevation of 350 feet above that place, and descends Peavine Creek, a small tributary of the Moyie River to the Lake.

Basic intrusive rock.

'On the top of this hill there is a considerable area of dark basic intrusive rock, varying in character from place to place. Quartz veins up to two feet and a-half in thickness are found in these rocks, showing a little galena and chalcopyrite (copper-pyrites). Several mining claims have been staked out here. On two of these properties, the Black Bear and the Union Jack, some development work has been done, without so far showing any body of ore that could be profitably worked. Most of the intrusive rocks that were so frequently met with throughout the remainder of the country visited during the season, are of much the same character as these, and are of great significance, being directly connected with the occurrence of mineral veins. They will require to be microscopically examined for determination. Some-

times they occupy extensive areas and in other cases appear only as narrow dykes, but in whatever form they occur, the discovery of deposits of valuable minerals may be hopefully expected in their neighbourhood. British Columbia—*Cont.*

'Moyie Lake, is the name given to two bodies of water, three and a-half, and two and a-half miles long respectively, running southward and connected by a narrows a mile and a quarter in length. The exposures along the lake show greenish argillaceous shales and black slates, with light-gray quartzites. Moyie Lake.

'Moyie is a prosperous new town situated on the lower part of the lake and on the line of the Canadian Pacific Railway. On the mountain to the east of, and just above the town, the St. Eugene and Lake Shore groups of mining claims are located. A good account of the development on these properties is given by Mr. W. F. Robertson, Provincial Mineralogist * and this need not be repeated here. The dyke along which these claims are located and which is associated with the deposit of fine-grained galena constituting the ore-body, is in some places composed almost entirely of an altered pyroxene, but varies considerably from place to place. It is apparently of more recent origin than the basic intrusions previously mentioned.

'Moyie River, leaving the lake, flows south-westward across the Boundary line, a distance of twenty-four miles in a straight line. The railway follows its north-western bank as far as Rainy Creek, between Yahk and Goatfell stations. Along this part of the route several areas of dark-green intrusive rocks break through the country-rock of massively bedded quartzite. Similar rocks continue westward along the line of railway to Goat River and down that stream to the Kootenay River, where grayish-green schists are found interbedded with thin gray quartzites. This is the first instance seen where the rocks have suffered any great amount of squeezing. Moyie River.

'Kitchener is situated on Goat River where the railway first reaches that stream. On the hills to the south several mining claims have been taken up that show good samples of galena and copper ores.

'Goat River was ascended for a distance of twenty miles above Kitchener, to which point a trail had been cut out. This trail is intended to reach the White Grouse mining camp. It was being rapidly pushed forward at the time of our visit. The rocks seen on Goat River consist of thick beds of quartzite with one or two bands of black slate (probably true argillite). Two areas of basic intrusives were seen cutting these near Leadville Creek. Trail to White Grouse camp.

* Annual Report of the Minister of Mines, B.C., 1898.

British Columbia—*Cont.*

'The mountain-ridge running northward from Goatfell station and forming the boundary line between east and west Kootenay, proved to be composed of similar beds of quartzite with one wide band of black slate. The general dip is to the north-west at an angle of 45°. Numerous veinlets of white quartz and specular iron cut these rocks at right angles to the line of strike. Around the head of Kid Creek on this watershed, where the quartzites are somewhat disturbed and folded, larger irregular veins of rusty quartz were seen.

Palmer Bar Creek.

'Returning to the head of Moyie Lake, the railway line was followed northward from there for a distance of about five miles to Palmer Bar. The place so named is where some shallow bench-diggings have been worked for placer gold, and the small tributary of the Moyie River flowing through it is called Palmer Bar Creek. The gold found here does not appear to have been locally derived, but to have been concentrated from the glacial drift coming from the direction of the lower part of Perry Creek. A number of mining claims are located on the north fork of Palmer Bar Creek and on one of them, the Belleville, a good deal of development work has been done, showing a little galena, zinc-blende and iron-pyrites in a gangue of quartz and calcite. The rocks in this vicinity are gray quartzites, in thick beds, and black slate cut by basic intrusives.

'From Palmer Bar a trail runs south-westward through a gap in the hills to Nigger Creek near its junction with the Moyie River. The distance is three and a half miles, and the summit of the gap is 500 feet above the railway line.

Nigger Creek

'The Pay-roll mine is situated a third of a mile north of the crossing of Nigger Creek. A dyke of dark-green intrusive rock, probably a diorite, running northward, cuts the flat-lying massive beds of gray quartzite. A vein of quartz five feet wide follows the contact on the east side of the dyke for some distance and then cuts through the quartzites. This is exposed in a tunnel a hundred feet long and shows good evidence of continuity. It carries galena and iron-pyrites

Telluride.

seams of talc-clay, and is said to assay well. A small vein on another part of this property, cutting across the dyke, showed, in a specimen examined by Dr. Hoffmann, rust-stained quartz, carrying a little telluride of lead (altaite) and some particles of free gold. The specimen is undoubtedly rich in gold, and although there was no gold in the specimen of telluride actually examined, the presence of altaite affords reason to anticipate the discovery of some of the tellurides of gold with which it is frequently associated.

Weaver Creek.

'Moyie River, below the mouth of Nigger Creek, runs for a couple of miles through a cañon that is impracticable for a roadway. Above

that point the valley is wide and deeply drift-covered. The lower terraces and sides of the stream have been extensively worked for gold, and some mining has been done on the upper tributaries. One of these, Weaver Creek, judging from the amount of work done, must have yielded a considerable amount of gold. British Columbia—*Cont.*

'Perry Creek, a tributary of St. Mary River, was next visited. It drains a portion of the Purcell range of mountains lying between the upper part of Moyie River and the St. Mary River. A trail runs north-westward from Cranbrook, following a slight depression in the low hills, to Booth or Six-mile Creek, near the mouth of Perry Creek, a distance of six and a-half miles. It then turns to the south-west and follows up Perry Creek. Old Town, the chief camp on this stream in the placer-mining days, is five miles above Booth Creek. Cranbrook to Perry Creek.

'The first exposures seen along this trail consist of black slaty shale and impure quartzite; both somewhat disturbed. About half way to Booth Creek the effect of pressure becomes apparent in the rocks. Where this was first noticed, in alternating beds of shale and quartzite, the shade has assumed a schistose structure while the quartzite is only partly crushed. Farther on, between Booth Creek and Old Town, the rocks are completely altered to greenish schists. There is very little quartzite in these rocks. They appear to have been originally of the same character as those seen along the upper part of Moyie Lake, but the latter have remained comparatively unaltered. Along Perry Creek, above Old Town, greenish and gray, thinly-foliated sericitic schists are found nearly to the head of the stream. No trace of the original bedding can be seen in these. The pressure exerted upon them has been applied in an east-and-west direction. The rocks on the mountains around the head of the stream do not show the same extreme alteration as those lower down the stream. They consist for the most part of banded gray quartzites and gray quartz-mica-schist. Schistose rocks.

'The lower part of Perry Creek appears to have yielded some placer gold, but the greater part of the gold has been derived from two miles of its length above Old Town. Two miles above Old Town there is a high fall on the stream. At this place, in the erosion subsequent to the filling up of the valley with detritus, the stream sought a new channel across a zone of intrusive rock crossing the creek, leaving the old channel above deeply buried. Farther up the creek, shallow diggings beside the stream have been worked to bed-rock. The surface of the latter is very rough and uneven, and the pay dirt was "pockety". An effort was made to bottom the creek at "Old Shaft," six miles above Old Town, but apparently without success. Placer diggings.

British Columbia—*Cont.* Quartz veins.

'A number of small quartz veins are seen on Perry Creek, cutting the schists at right angles, and three or more large veins, eight to forty feet in width, run for a long distance along the west side of the valley, striking nearly parallel to the creek in the same direction as the schists. The mineral claims on the creek are described in Mr. Robertson's report already referred to, and an account is there also given of the operations of a small stamp-mill testing some of the rock from the large veins. From the report and from what was learned in the field, it seems evident that there was something wrong about the treatment.

Low valley to Palmer Bar Creek.

'On the return journey to Cranbrook, the low valley running from Old Town to Palmer Bar Creek was examined. This was probably a former channel in pre-glacial times, and was possibly the source of the gold at Palmer Bar. It is now blocked up by moraines. About the middle part of its length there is a chain of lakes. The southern one is a mile in length and discharges into Palmer Bar Creek. Gray quartzites, black slates and greenish schists are exposed along the valley, and one zone of light-coloured coarsely crystalline granitic rock crosses it. This seems to be connected with an area of basic intrusive rock exposed for some distance along the railway line south of Cranbrook.

St. Mary River.

'A good wagon-road runs northward from Cranbrook to the St. Eugene mission, a distance of five and a-half miles, where there is a bridge across the St. Mary River, and then continues up that stream. The St. Mary River empties into the Kootenay at Fort Steele. Its sources are forty-five miles to the west, along the watershed opposite Crawford Creek. It is a large stream too deep and swift for fording during the summer months. St. Eugene mission is about eight miles from Fort Steele. Mark Creek flows into the St. Mary from the north, at Marysville, eleven miles above the mission. For the first eighteen miles of its length, the St. Mary has cut out a flat-bottomed valley, two hundred feet and more in depth, through the gravels and white silts forming the gently rolling surrounding country. This was part of the original bottom of the Kootenay valley. Above this the foot-hills begin to close in upon the river, and before St. Mary Lake (twenty-two miles from the mission) is reached, the river is confined between high and steep mountains. St. Mary Lake occupies the bottom of the valley for about two miles. It has been formed by the filling up of the valley at its foot by the delta deposit of Hell-roaring Creek, a tributary from the south. Nine miles above the foot of St. Mary Lake, the South Fork or Baker Creek comes in from the southwest. A trail ascends this branch for eleven miles, then turning up a western tributary called Redding Creek, it crosses the Hooker Pass

and descends Crawford Creek to Pilot Bay. About seven miles above the South Fork, the main stream divides into three branches, the East, North and West forks. All these branches drain high rugged snowy mountains. Another trail to Pilot Bay follows the West Fork and crosses the Sawyer Pass to Crawford Creek. British Columbia—*Cont.*

'Between Cranbrook and the mission, rusty decomposed schist, greenish felspathic schist and dark-blue rather flaggy limestone are exposed. The limestone is somewhat dolomitic and some of the beds in this locality would yield good lime. Another exposure of limestone occurs about two miles east of the road-crossing of Luke Creek. It is here associated with black slates and gray schists, both of which appear to contain more or less volcanic ash. These rocks are like those seen along the railway line between Cranbrook and Fort Steele Junction, and are supposed to be of Carboniferous age. Limestone.

'Around Luke Creek, a small tributary of the St. Mary seven and a-half miles above the mission, rusty black slates with some thin beds of quartzite, are broken through by a number of masses of basic intrusive rock, probably diorite. The latter in some places has a rough appearance of bedding, probably due to its being forced up between the beds of slate. Many mining claims have been taken up in this vicinity, and considerable development work has been done. Several good looking bodies of ore are uncovered, showing galena, tetrahedrite, (grey-copper), copper-pyrites, iron-pyrites and zinc-blende.

'The town of Kimberly is situated four miles up Mark Creek. A railway is under construction at the present time to connect this place with the main line at Cranbrook. The chief object of this line is to carry out the ore from the North Star mine. This property is located on the hill west of the town. It is at a height of 1,560 feet above Kimberly, from which it is about two miles distant in a straight line. The character of the ore-body in the North Star is somewhat peculiar. A description of the property by Mr. W. A. Carlyle,* gives the extent of the deposit as discovered in the shafts and tunnels at the time of his visit. Since that time, the development work has been greatly extended. The country-rock has the appearance of a rather dark, fine-grained quartzite, but a specimen examined by Mr. A. E. Barlow, proved to be a gabbro-diorite. It will be necessary to examine further specimens. It is in thick beds dipping S. 70° E. at an angle of 20.° A zone of this rock running north-and-south, in which the ore-deposit occurs, has been much altered. It is more or less impregnated with iron throughout, North Star mine.

* Report of the Minister of Mines, B. C., 1896.

British Columbia—*Cont.*

weathering rusty where exposed. The ore is solid, fine-grained galena, carrying a small percentage of zinc-blende. In some places a mixture of zinc-blende and iron-oxides is found. Near the surface the ore-body dips with the country-rock, and in some places lines of bedding in this direction can be distinguished. It has a depth of thirty feet and its limits in a lateral direction have not yet been reached. Farther downward and eastward the dip is steeper, and there is evidence of some slipping and displacement of an irregular character. The deposit appears to have resulted from the replacement of the stratified beds by ore. Deposits of this nature are not uncommon, but the replacement is generally confined to the neighbourhood of a line of fracture or vent, so that the deposit has in some degree the form of a vein. In this case, however, the action has extended laterally for a comparatively great distance, and so far no vent has been discovered. As there is little doubt that the mineral forming such deposits comes from below, finding its way upward along a fissure or fractured zone of rock, the discovery of such a passage-way may be looked forward to in this case, with a reasonable hope that it will constitute a valuable ore-body in itself. In the meantime and for the purpose of immediate development, a determination of the lateral rather than the vertical extent appears to be the most important.

Sullivan mine.

'A little over two miles distant, in a direction N. 15° E. from the North Star, across the valley of Mark Creek, the Sullivan mine is situated. The deposit here is similar to that at the North Star, but, as far as the present development shows, it is on a smaller scale. The extent of the deposit over a considerable area is shown by several shafts and open cuts. It seems likely, however, that there are here two or more distinct bodies of ore separated by areas of altered country-rock. The ore is found in the same altered zone of rock that appears to extend all across the valley, and the lines of bedding can be clearly seen in the ore itself. To the north of the mine an exposure shows the country-rock to be a dark-gray quartzite, dipping to the north-east at an angle of 25°, underlain by a bed of brownish, crystalline, arenaceous limestone. Between this exposure and the principle opening on the lode, there is a dyke of dark-green pyroxene-rock, similar to that seen at the St. Eugene mine. It appears likely that this dyke may have relation to the lode, although such relation has not so far been made manifest. There are several other mineral claims in the vicinity of Mark Creek that were not visited.

Rocks around St. Mary Lake.

'Along the St. Mary River there are few exposures to be seen until St. Mary Lake is reached. The quartzite series of rocks, including some beds of black slate and shale, continue, but are broken through by

several areas of basic intrusives. For some distance below and above the lake, the hills on the north side of the valley are composed of a dark, igneous rock, probably diorite, with a band of quartzite near the head of the lake and others showing on the mountains to the north. On the south side, the sedimentary beds seem to be more continuous. Similar conditions prevail to a point about three miles west of the junction of the South Fork. Notwithstanding the great quantity of intrusive rock cutting the sedimentary beds, no great pressure has been exerted upon the latter, as there is no folding nor any appearance of a schistose structure. They are usually rusty and break into angular blocks. The beds are only slightly tilted, and their low dips are fairly uniform, regardless of interruptions. Many mining claims are located in the mountains north of the lake. In Pyramid Basin, seven miles to the north-west, fourteen claims have already been surveyed. British Columbia–*Cont.*

'Farther to the west, on both the South and West forks, extremely altered rocks are found all the way to the summits. These consist chiefly of greenish talcose schist, light-gray and lead-gray sericitic schist, micaceous argillite and some highly quartzose schist. The general attitude of these rocks is vertical, striking north-and-south. The original bedding cannot be clearly distinguished, but there are some indications of an easterly dip at an angle of 25°. This would place them conformably below the rocks previously mentioned to the east, and in the lower part of the Cambrian formation, a position that their character also indicates. Lenticular veins of quartz frequently occur and larger viens are found cutting these rocks in many places. The ore usually occurring in these veins is chalcopyrite, notable deposits of which are found on the upper part of the West Fork. While time would not permit a visit to these properties, an idea of their importance was gathered from seeing a boulder of ore eighteen inches in diameter, carrying a very high percentage of chalcopyrite, that had been brought down by a snow-slide. Schistose rocks.

'In regard to the age of these quartzites, slates, shales and schists, so frequently mentioned and covering such a large tract of country, there is little positive evidence, but they are all, at least provisionally, referred to the Cambrian. The great thickness of these beds can, with some degree of assurance, be separated into three divisions of that age, although there is not sufficient detailed information to draw the actual line of demarcation between them. The great amount of metamorphism that some parts of these rocks have undergone, and the comparatively unaltered state of others, depending as it does upon their situation rather than upon their age, greatly increases the diffi- Age of rocks.

British Columbia—*Cont.*

culty of such division. The upper part of the formation is, however, apparently represented by the rocks occurring on Gold Creek and Yahk River. Some newer beds which are not distinctly separable may be included in the Cambrian. The middle part of the formation consists of the thick beds of quartzite with wide bands of black slate interbedded. These are best seen along the mountain range west of the Moyie River and on Goat River. The rocks of the lower part are most extensively developed on the upper part of the St. Mary River.

East side of Kootenay River.

'On the east side of the Kootenay River there is a strip of country three or four miles wide, composed chiefly of stratified gravels and yellowish-white silt. At the back of this a slight depression runs along the base of the steep slopes of the Rocky Mountains parallel to the Kootenay River. This was clearly distinguished from near the mouth of Bull River to a point beyond the upper part of Lewis Creek, eighteen miles north of Fort Steele, and in an outlook from a mountain, it was seen to extend far beyond to the north-west. This depression or valley probably marks a line of fault, but as there are practically no rock-exposures, it cannot be explained in this way with any certainty. Portions of its length are at present drained by many different streams, but it appears to have been at one time occupied by a continuous stream. A characteristic feature of the valley is that the small streams flowing into it from the mountains, sink in its porous gravel bottom and are lost to sight for long distances, reappearing in springs or lakes.

Bull River.

'Around the mouth of Bull River and Little Bull River there are exposures of bluish-gray limestone, similar to and forming part of the same area as that occurring on the west side of the Kootenay below Wardner. This limestone has been noted by Dr. Dawson in his report on the Rocky Mountains,* where a general description of the eastern side of the Kootenay valley is given. Nothing beyond what is there stated could be learned as to the extent of an igneous intrusion of felspar-porphyry that crops out near Bull River.

'The range called "The Steeples," running north-westward from Bull River, is composed in the lower part, of light-gray quartzites. These are much lighter in colour than any previously met with, but it is probable that, like the thick beds in the western part of the area, they are referable to the middle part of the Cambrian. Overlying the quartzites, near the top of the range, is a great thickness of purple, slightly dolomitic quartzite, gray fine-grained dolomite, slightly crushed, and two bands of rather crystalline, dark calcareous rock containing a

* Annual Report, Geol. Surv. Can., Vol. I (N.S.), Part B, 1895.

good deal of quartz. These beds may represent the Castle Mountain group of Mr. McConnell. Their general dips are to the north-east and north. They come down to the base of the mountains near Lost Creek, half-way between Bull River and Wild Horse Creek, and a couple of miles north of that place, they again recede from the front of the range and become confined to its higher parts. British Columbia—*Cont.*

'At the end of The Steeples range, a few miles up Bull River, the Chicamon-stone mineral claim is located on a dyke of dark-gray porphyritic felspathic rock. The gray slates forming the country-rock are highly altered and the dyke-rock shows a slight schistosity parallel to the cleavage of the slates. The ore, specimens of which have been examined by Dr. Hoffmann, consists chiefly of tetrahedrite (gray copper), with small quantities of intermixed gangue of quartz and a little felspar. In some places copper-pyrites forms an appreciable part of the ore. A coating of erythrite (cobalt-bloom) and small quantities of magnetite are found in some fine fissures. The ore-body, though not very wide as far as yet uncovered, is of a promising character. The dyke on which this claim is located, extends a long distance across the river to the east, and other claims have been staked out upon it. Chicamon-stone mine.

'Wild Horse Creek, flowing in a general direction of S. 25° W., empties into the Kootenay River at Fort Steele. It has a length of about twenty-five miles and drains the greater part of the rugged mountainous country between the upper part of Bull River and the Kootenay. Gold was first discovered on this stream in 1864 * and since that time placer mining has been continuously carried on. Of late years operations have been chiefly confined to hydraulic working. Three hydraulic plants are at work at the present time, two of which are owned by a Chinese and one by an English company. The bottom of the channel on the lower part of the stream has never been gained, although some attempts have been made to reach it. At the present time an effort is being made to discover an old channel, supposed by some miners to exist to the east of the present channel and to be covered up by the steep talus-slope of the mountains. Wild Horse Creek.

'The greater part of the rocks seen on Wild Horse Creek are black slates, striking north-and-south with high dips to east or west. Near the "gap" of the stream, greenish and gray thinly-foliated sericitic schists are found, interbedded with black calcareous schists and dark flaggy limestone. A little to the south, on Maus Creek, greenish chloritic schists occur in great thickness, with bands of black

*See Annual Report Geol. Surv. Can., Vol. I (N.S.), p. 152 B., 1895, for history of earlier workings.

British Columbia—*Cont.*

slate and a few beds of quartzite. The relation of these beds to those found in The Steeples may become clearer when the observations are plotted, but at present it can only be said that from their characteristics they appear to belong to the lower part of the Cambrian. Small quartz veins are numerous in these rocks and during recent years many larger veins have been discovered. Mining claims on some of these veins have been already considerably developed and show rich looking copper ores. High values in gold are reported in some cases. These properties were not visited, but from what could be learned, the veins are in, or in the neighbourhood of, masses of dark intrusive rock. To the west of the hydraulic workings, on the terminating ridge of the Hughes range, in a quartzite dyke, a large vein of rusty quartz is uncovered. It carries a little galena, and it is reported to contain some free gold.

Quartz veins.

Four-mile Creek.

'The first stream from the mountains north of Wild Horse Creek, is called Four-Mile Creek. The head of this stream reaches the valley at the base of the mountains by a short, rapid descent, and turning southward along this valley most, if not all of it, shortly disappears. A mile or so farther down it reappears with increased volume and flows to within a couple of miles of the Kootenay River, where it again sinks, and there is nothing seen below this to indicate its course. Grundy and Tracy creeks come from the mountains at points distant eleven and twelve miles respectively, in a straight line from Fort Steele. They sink in the same manner, but reappear farther down, as a stream called Six-mile Creek, which thence flows continuously to the Kootenay. The little town of Tracy is situated at the "gap" of Tracy Creek, about four miles back from the river. Its existence is explained by the number of mineral claims in the vicinity. These are located principally on Tracy Creek, but there are many others along the edge of the mountains both to the north and south. Some locations on the upper tributaries of Wild Horse Creek are also reached from this place.

Other streams

Tracy Creek.

'The rocks on Tracy Creek consist chiefly of light-gray quartzites and black slates, with some greenish chloritic schist. Near the vein of the Estella mine, in the basin of Tracy Creek, there is a dyke of coarse felspar-porphyry that contains finely disseminated crystals of iron-pyrites. It is similar in character to that seen at Bull River. Other dykes, highly siliceous, are found on the mountains around the basin. In the edge of the mountains south of Tracy Creek there are two areas of dark basic intrusives, similar to those so frequently met with on the other side of the Kootenay. The ores in this locality are

chiefly galena, tetrahedrite and copper-pyrites. On one claim belonging to the Estella group a good deal of ore has already been taken out. British Columbia–*Cont.*

'Near the close of the season, some further work was done to the east and south-east of Cranbrook. Two additional areas of amygdaloidal volcanic rock were found. One of these is on the northern half of Baker Mountain, and the other lies to the south, on the head-waters of Joseph Creek, These rocks are very similar to those found along the Kootenay River near the Boundary line, and are classed with them in the Tertiary. The amygdules in the rock on Baker Mountain frequently contain specular iron, and there are irregular seams of the same mineral seen in several places, up to six inches in width. Some agates were also noticed. The north side of Baker Mountain is composed of thinly-bedded, dark, calcareous and siliceous shales, interbedded with fine-grained bluish limestone and some beds of rather coarsely crystalline dolomitic limestone. These rocks continue westward and join the area of limestone south of Wardner and are included with it in the Carboniferous. Areas of volcanic rocks.

'The wide valley of the Kootenay and the branch valley running past Cranbrook to Moyie Lake, are deeply covered with superficial deposits. There is an extensive development of yellowish-white stratified silt up to an elevation of 3100 feet above sea-level, irregularly interbedded with gravels in some places. Above this, coarse imperfectly stratified gravels are found for a couple of hundred feet, and higher up on the slopes of the hills irregular morainic ridges and hills with numerous pot-holes. Gravels and silts.

'The recent development of lode mining, aided as it has been by the construction of the Crow's Nest Pass Railway, has caused a considerable influx of people to this district. So far the attention of this increased population has been directed chiefly to mining, while the other resources of the country have not been correspondingly developed. Attention may well be drawn to some of these.

'As a source of wealth the timber of this district must be considered as second only to the mines. With the exception of the comparatively small areas of prairie land, before mentioned, the whole of the low country in this district is covered with an open growth of large trees. The absence of underbrush has preserved them from destruction, as fire does not gain sufficient headway in the grass to attack the large trunks. The principal trees suitable for making lumber are Douglas fir and the western larch *(L. occidentalis)*. The latter attains its largest growth in this district. Bull pine (*P. ponderosa*) is also fairly abundant. As yet there has only been sufficient timber taken Timber.

British Columbia—*Cont.*

out to supply immediate local demands. The railway now built, giving easy access to Alberta, should afford a means of reaching a market for an increased output. Although the lack of convenient waterways is some drawback, this is compensated by the facility with which the timber can be hauled out, on account of the open character of the woods. In the higher valleys and on the mountain slopes spruce is abundant.

Agriculture.

'The agricultural industry is still, considering the opportunities, in a backward state. The chief product at the present time is hay. A great part of the Kootenay valley would make rich farming country, but the amount actually available for cultivation is limited by the water supply, as with the exception of bottom-lands along streams and a few favourably situated localities, the ground requires irrigation. On some of the higher grounds there is a danger of summer frosts. Grain and vegetables have, however, been successfully grown at so many widely separated localities, that this industry may be expected to give profitable employment to a great number of people. It is, however, when taken in connection with the raising of cattle that the best

Fruit.

results will be obtained. The rich growth of grasses in the open woods, including the nutritious bunch-grass, together with the shortness of the season during which cattle need to be sheltered and fed, are sufficient reasons to encourage greater efforts in this direction. Apples have been grown for some years at the mission, at Norbury Lakes on Little Bull River, and probably at other places that were not seen. It is worthy of mention that, on Wild Horse Creek, at an elevation of 3,700 feet above sea-level, Mr. Griffith has a small orchard, and some trees, said to have been planted in the year 1874, are still bearing fruit.

Climate.

'A description of the climatic conditions that prevailed during the past season would be very misleading, as they were at variance with the usual conditions, as evidenced by the vegetation and forest growth. These show that the valley of the Kootenay has only a light rainfall during the greater part of the summer months. There is, however, undoubted evidence of an increased precipitation during recent years. The most distinct proof of this is the dead fringe of trees around the borders of lakes having no outlet. In dry countries where thinly scattered trees have attained a large size, the moisture is so taken up by the roots of these, that a young growth cannot usually obtain a foot-hold except where an old one has died. In this country, however, in many places, some young trees are springing up while the old ones are still all alive. This may be considered as further evidence of an increased rainfall. The eastern side of the valley

along the base of the mountains, seems to escape frosts that in the spring and fall are felt at places of the same elevation on the western side. A possible explanation of this is that the unequal temperatures at different elevations in the high mountains so near by, keep the air in motion and prevent excessive cooling by radiation, which, on clear, calm nights results in frost in the comparatively level country on the other side. The most favourable spots, at high elevations, are on the sloping sides of sheltered valleys, some distance above the bottoms. In such places, especially if they have a southern exposure, and there are no snowy mountain-slopes immediately behind, fruit can be successfully grown.' British Columbia–*Cont.*

MACKENZIE DISTRICT.

In the winter of 1898-99, Dr. R. Bell was occupied with office work. In the spring he was directed to explore Great Slave Lake, to which region a number of prospectors had found their way in 1897 and 1898 and from which many specimens of lead and copper ores had been brought out. The discovery of gold in payable quantities had also been reported and special interest in the region was being shown by the people of Edmonton and other adjacent parts of the North-west. Work by Dr. R. Bell.

A specimen of galena brought from the vicinity of the lake and assayed in the laboratory of the Survey in the autumn of 1898, contained silver at the rate of 38·86 ounces to the ton of pure galena. A number of specimens received during the following winter from Mr. W. J. McLean and from Inspector Routledge, N. W. M. P., showed galena, iron-pyrites and copper-pyrites. Thirteen were subjected to assay, and of these five proved to contain traces of gold, and five small quantities of silver.

While Dr. Bell's observations fail to confirm much that had been currently reported, they will be read with interest, and several facts brought to light, appear to the writer to indicate the probability of important discoveries in the future. Dr. Bell's preliminary report on this work is as follows:—

'The object of my field-work in 1899 is stated in your instructions dated 22nd of May as follows: "The late discoveries of metalliferous ores in the vicinity of Great Slave Lake, including gold, silver, copper, lead, &c., appearing to be of importance, it seems desirable that we should obtain some knowledge of that region, which has remained practically unknown geologically and to a great degree geographically." On receipt of these instructions, preparations were made for carrying out the work. Two reliable voyageurs, who had accompanied me on Instructions and preparations.

Mackenzie District–*Cont.*

many previous expeditions, were engaged at Sault Ste. Marie and two other men were subsequently hired at Edmonton. Supplies were ordered from the Hudson's Bay Company at Edmonton, to be immediately forwarded to Fort Resolution on Great Slave Lake, and two wooden canoes were purchased by telegraph at the same place and sent by wagon to Athabasca Landing on the river of the same name.

Assistant.

'It was arranged that Mr. J. M. Bell, M.A., who had been with me in 1896 and 1898 should accompany me as assistant and that if it were found desirable he should remain in the country all winter and continue the exploratory work next spring.

Arrival at Great Slave Lake.

'Having completed our preparations, I left Ottawa with my assistant on the 21st of June and after several unavoidable delays on the way, amounting in all to nine days, reached Fort Resolution, on Great Slave Lake, on the 20th of July, having, therefore, occupied only twenty days in actual travel from Ottawa. At the time of our arrival the ice had not all disappeared from the north-eastern part of the lake, which was our destination, the steamer *Ethel*, as we afterwards learned, having been detained ice-bound in that quarter during the whole of the 21st of July.

'On the way down and at Fort Resolution we met considerable numbers of men returning from prospecting around Great Slave Lake, after having failed to find any indications of the precious metals or of any kind of ores or other minerals of economic value. The exodus continued all summer, several parties of disappointed prospectors ascending the Slave and Athabasca rivers in company with myself at the close of the season.

Plan of work.

'The plan adopted for carrying out the work was for myself to proceed from Fort Resolution north-eastward to the extremity of the lake, surveying Christie and McLeod bays, which form the greater part of the lake in that direction, and also the north-western shore, locating as many of the islands as possible. At the same time, I sent my assistant to make an exploratory survey, geographical and geological, of the Fort Rae arm of the lake, including Yellow-knife Bay. His work connected with my own among the islands about midway across the main lake, opposite this arm. My party consisted of the two men hired at Edmonton and one of the voyageurs from Sault Ste. Marie, while my assistant had with him the other voyageur and a local man named William Brown.

Surveys and observations.

'In making my track-survey of Great Slave Lake to the north-east of Fort Resolution, I used a row-boat, and having been favoured by calm weather most of the time, the distances were determined

principally by the speed of the boat rowed very steadily through the smooth water, but I also used a floating boat-log. The bearings were ascertained by compass. An observation for latitude was taken nearly every day. I frequently ascended hills near the lake to take bearings and to sketch the shore-lines in all directions. When the bays were wide I went up one side and down the other, taking numerous cross-bearings from one shore to the other. All parts of the survey were found to tally very well. Mackenzie District–*Cont*

'My assistant, with one canoe and the two men above mentioned found his distances by the speed of his canoe, paddled at a regular rate in calm water. After these surveys of the above portions of the lake had been successfully accomplished, I made a similar survey for about thirty miles south-west of Fort Resolution and thence paced the distance for eight or nine miles inland to the locality at which galena had been found among the Devonian limestones. While I was engaged in this work, my assistant made a track-survey of the delta of Slave River and examined the rocks of the lake-shore to the north-east of it. When I left Fort Resolution on September 13 he was setting out, according to instructions, to survey topographically and geologically the shore of the bay to the north-east of the mouth of Slave River. I also instr u cted him, ifthe season permitted, to explore and map the details of the shore-line of the north-west side of the lake from near Yellow-knife Bay north-eastward to the beginning of my own detailed work in that direction. I have since received (January 22) news from him of his having successfully completed these surveys, together with his map of the shore-lines. Work by assistant in autumn.

'The southern shore of the south-western part of the lake had been surveyed by Mr. W. Ogilvie, D.L.S., and Mr. R. G. McConnell, of the Geological Survey, and I have obtained from Captain Mills of the steamer *Wrigley* the distances between different points on the opposite shores of this portion of the lake, which he has ascertained by ship's log. Our surveys of the past season, supplemented by the above data, will enable us to construct a fairly good map of the whole of Great Slave Lake. Previous surveys.

'As I found that my assistant would be able to do very valuable work in continuation of that of the present summer, as we anticipated at the outset, if he were to remain in the country till next year, I arranged for him to pass the winter with Mr. F. Gaudet, the Hudson's Bay Company's officer at Fort Resolution. Instructions could be sent there by the winter packet, for his guidance next season. If circumstances permitted, during the winter he was to explore eastward from Assistant left for the winter

Mackenzie District–*Cont.*

Fort Resolution or in the direction of Hudson Bay and to make other explorations if possible, such as one of Buffalo River on the south side of the lake.

Return journey.

'On the morning of September 13, I started up stream from the mouth of Slave River on my return journey in one canoe, with the four men I had brought down with me. On this journey I made a track-survey and a geological examination of Slave River all the way to Athabasca Lake. From this lake we paddled or tracked our canoe up the river of the same name to Athabasca Landing. Thence I came with my party to Edmonton by wagon, and reached Ottawa on November 24.

Animikie rocks.

'The south-western portion of Great Slave Lake, lying between the inlet (Slave River) and the outlet (McKenzie River) is an open sheet of water about 50 miles in width, surrounded by unaltered and nearly horizontal Devonian strata. The north-eastern continuation of the main lake-basin is excavated out of the older Cambrian or Animikie rocks resting in a long physical depression or trough in the Archæan foundation. These strata have a thickness of over 1,000 feet and they are thrown into gentle anticlines and synclines, parallel to the axis of the general trough, in which they lie. They have been deeply eroded along the anticlinal folds and the waters now filling the depressions form the various long and nearly parallel bays into which this portion of the lake is divided. These rocks consist partly of unaltered limestones varying in colour from very light- to dark-gray, drab and red, some times passing into shales, and partly of sandstones, mostly red, coarse conglomerates and red shales, together with thick sheets or overflows of greenstone, generally capping the other strata and presenting long cliffs made up of perpendicular columns or "palisades," overlooking the different bays. We could not ascertain whether all these greenstone cappings belonged to a single extensive overflow or not. Large exposures of greenstone also occur near the level of the lake, which may not form part of any general overflow. A few wide greenstone dykes were seen cutting the nearly horizontal Animikie strata beneath the crowning overflow.

Laurentian.

'The older Laurentian gneiss and granites rise as a sea of half-rounded hummocks to a general height of nearly 1,000 feet all along the north-west side of this part of the lake and also around the north-eastern extremity.

Huronian.

'Huronian rocks, consisting mostly of schists, occur around Yellow-knife Bay and thence to Gros Cap, including some islands in this part of the lake, also on some islands in the vicinity of Fort Rae and

Mackenzie District–*Cont.*

again at the head of Lake Marian, a continuation of the Fort Rae Arm. There is also a hill of schistose rocks which may be classed as Huronian in a channel north eastward of the entrance to this arm. Rocks which may belong to this series were observed on the south-east side, to the north-eastward of the mouth of Slave River.

'Besides the foregoing, certain rocks were met with in the narrows south-east of Big Caribou Island and on the tongue of land separating McLeod Bay from the east bay, which may not belong to any of the foregoing, but may occupy a stratigraphical place intermediate between the Huronian and the Animikie, similar to that occupied by certain rocks of the east coast of Hudson Bay which the writer there called the Intermediate Series. At the above localities they consist of massive light-gray, blue or dove-coloured limestones which weather to various shades of yellow and brown, hard reddish sandstones or quartzites and fine conglomerates, and red and gray "lumpy" jasper or chert-rock. At the east bay, black shale occurs in the vicinity of the massive limestone of this series, and may form part of the same set of rocks.

Border of Devonian.

'The Fort Rae Arm and its continuation in Lake Marian, having a total length of about 180 miles from the centre of Great Slave Lake, lie along the boundary between the Archæan and the Devonian rocks, and the continuation of this line probably runs near the canoe-route, from thence by Lac la Martre all the way to Great Bear Lake.

'In the narrow central part between the two sections of the basin of Great Slave Lake above described, there is a geographical interval of separation between the Devonian and the Animikie strata, in which the Laurentian rocks prevail with only straggling links of the Animikie.

'On the south-east side of the lake, the Devonian beds are first seen at a slight rise in the level ground called Little Stoney Mountain, north of Fort Resolution, and again on Moose Island, near the same place. At these localities and at the "lead mine," about thirty miles further to the south-east (to be described further on), the strata consist of horizontal beds of porous gray limestone, without observed fossils. On the shore about twenty miles south-west of Fort Resolution, these limestones are associated with black highly bituminous shales. Along the south side of Fort Rae Arm coarse and fine light-gray sandstones were found underlying light-gray limestones, the two rocks forming cliffs here and there.

Laurentian rocks barren.

'As to economic minerals, no regular veins were seen in the old Laurentian, which are the prevailing rocks in the reported auriferous

Mackenzie District–*Cont.*

region of the lake. The quartz, in the irregular occurrences of that mineral in these rocks, was always of the glassy "hungry" character which prevails among them elsewhere. In connection with the reported discoveries of gold in the Laurentian rocks along the north-west side of McLeod Bay, it may be here remarked that after very extensive exploration of similar rocks in nearly all parts of the Dominion by numerous geologists and prospectors during the last fifty years or more, no economic minerals of any kind have ever been discovered in workable quantities, so that this was an exceedingly unlikely field in which to search for gold. I discovered a vein of white quartz twenty-five feet in width, among the jaspery rocks of the Intermediate Series in the tongue of land which separates McLeod Bay from the east bay, but it did not look very promising either. Stains of green carbonate of copper were common on the massive yellow-weathering limestone of the same series in the vicinity of this quartz vein.

Copper ores.

'On the north-west side of McLeod Bay, small interrupted gash-veins or stringers of calcspar are found in the primitive gneiss and granite, and some of them contain nuggets of chalcopyrite, but their occurrence is exceptional or accidental, and they have no economic value. At one locality on the north shore of the bay west of the narrows between Christie and McLeod bays, we detected thin plates of chalcopyrite in some of the joints in the greenstone which gave rise to green copper stains and cobalt bloom.

'No iron ore was found, nor could we hear of the occurrence of any around Great Slave Lake, but some layers of the red shales of the south-east side of McLeod Bay contained sufficient oxide of iron to render them perceptibly heavier than the rest of the rock.

'Some of the unfortunate gold prospectors turned their attention to exploring for mica, but they discovered none, nor could they hear of any of a size or quality that might be of value even under more favourable circumstances as to transport, &c.

No veins observed in Animikie.

'The undisturbed and almost horizontal character of the Animikie series around the lake has not been conducive to the formation of mineral veins therein, and none at all were seen in the whole course of our explorations. But in the Thunder Bay region, Lake Superior, silver-bearing veins occur in nearly horizontal rocks of the same age as these.

Occurence of galena and blende.

'The occurrence of galena and blende in the Devonian limestones at some distance inland from the south-east side of Great Slave Lake, appears to have been known to the Indians for a considerable time. About two years ago they were induced to point out the place to some

white men and a large number of claims have been staked. The locality lies at a distance of about eight and a-half miles south-east from a point on the lake-shore twenty-seven miles south-west of Fort Resolution. The intervening country is low and swampy, but for some distance around the spot where the galena and blende occur, the horizontal beds of gray limestone are sufficiently elevated to afford a considerable area of dry ground and to expose a thickness of about twenty feet of the strata in three little ravines. Several dry sink-holes were noticed in the vicinity of the ore. No fossils were observed. The galena occurs as scattered crystals in the limestone over an area of several acres, but at one place where it is largely mixed with blende, it is concentrated in bunches several feet in horizontal diameter. A shot had been put into one of the largest of these bunches, which enabled us to see a thickness of two feet of the ore, but the actual depth of this mass was said to be four or five feet. The results of a large number of trials for silver made by different assayers was to show that this metal was present only in traces. One assay, out of many which I saw made by Mr. N. S. Potter for the Great Slave Lake Mining Company, of a "crust" which had resulted from a concentration in a cavity by the decomposition of the ore, gave a small bead of silver, but the ore in general cannot be said to be economically argentiferous. Mackenzie District–*Cont.*

'In connection with the question of the possibility of carrying on mining operations at Great Slave Lake, it may be remarked that apart from such considerations as the unfavourable climate, &c., the difficulties connected with transportation over such long distances as must be traversed through an uninhabited country and the remoteness of any metal market even when the borders of civilization are reached, to say nothing of the absence of a local supply of labour, would place mining operations out of the question, except in the case of extraordinarily rich deposits of the precious metals, of the existence of which the geological character of the whole region gives little or no hope. Rich deposits only could be worked.

'The evidences of glaciation are well marked around Great Slave Lake. The general course of the striation is south-westward in conformity with the longer diameter of the lake-basin, but it varies locally, the movements of the glaciers having adapted themselves to the trend of each bay or channel which approximated to that of the general course followed by the ice. Glaciation and shore-lines.

'Old shore-lines, showing former higher levels of the water, were distinctly visible in various parts of the lake. These ancient beaches were found at higher levels in the eastern parts than opposite Slave River, indicating a tilting of the lake towards the west or south-west

Mackenzie District–*Cont.*

accompanied by a greater lowering of the water at the north-eastern extremity.

'I wish to acknowledge our indebtedness to almost every one we met for their willingness to assist us to carry out the objects of our journey. Our thanks are due especially to Mr. F. Gaudet, the Hudson's Bay Company's officer in charge of Fort Resolution, for numerous courtesies, and to Messrs. McKinley, Simpson and Camsell for having twice sent us in their steamer *Ethel* over the open traverse from Fort Resolution to near Gros Cap, which was too wide to venture across in our canoes.'

Saskatchewan District.

Work by Mr. D. B. Dowling.

During the early part of the year, Mr. D.B. Dowling completed the compilation of a map of Lake Nipigon on a scale of one mile to the inch, embodying all the surveys of the former season and those of 1894. He was then employed in compiling and editing, from Mr. Tyrrell's notebooks, a general description of the country to the east of Lake Winnipeg. This, with a report on the Cambro-Silurian rocks of the west shore is now ready for printing. The general map accompanying these reports, including Lake Winnipeg and its vicinity is already in press.

Much of Mr. Dowling's time has also been given to revising and correcting proof of the General Index of Reports from 1863 to 1884 inclusive, the printing of which is proceeding slowly.

Saskatchewan District.

The explorations in the valley of the Nelson River and of parts of the Grass River and Burntwood River, carried out by Mr. J. B. Tyrrell in 1896, covered an area roughly triangular in shape. In order to supplement this and obtain information that could be illustrated by a map-sheet, further surveys were deemed necessary, notably toward the north-west in the area between the Grass River and the latitude of the Churchill River, and southward toward the Saskatchewan and the basin of Moose Lake. Mr. Dowling was instructed to undertake this work during the summer. His report on it is as follows :—

'Leaving Ottawa on June 21, I proceeded to Prince Albert and thence by stage to Fort à la Corne. Here a canoe and some camp outfit had been stored since 1896. These were overhauled and the canoe varnished and patched, when, with two men obtained on the spot, the descent of the Saskatchewan River to Cumberland House was accomplished in two days. Here I was fortunate in finding an Indian whose usual hunting ground lay to the north in the district to be explored. The routes from the south into this country were by two

streams, the Cold River, a tributary of the Churchill heading north of Athapapuskow Lake, and the Burntwood River rising in lakes to the north of Reed Lake. The guide knew the Cold River, so we determined to proceed by that route first and chance finding Indians further north to put us on the route by the Burntwood River. Saskatchewan District–*Cont.*

'To reach the Cold River we passed north-eastward from Cumberland House to the mouth of Goose River on the Sturgeon-weir River and thence through Goose Lake to Athapapuskow Lake. From the north shore of this latter lake a small stream leads through a chain of little lakes about directly north to the height-of-land to Cold River. On Athapapuskow Lake the underlying rocks are Huronian, consisting mainly of greenstones and a few beds of conglomerate, though two or three small masses of instrusive granite forming islands, were seen. To the south and west are found horizontal beds of Trenton limestones resting on these rocks, and on some of the islands on the north-west shore isolated areas of the limestone also still remain. Athapapuskow Lake.

'The Huronian area extends north-west to near the height-of-land, the strike of the beds being mainly northward parallel to our course, but turning abruptly to the east on the upper lake of the chain. The north shore of this lake is found to be occupied by light-coloured granitic gneiss striking to the north-east about parallel to its line of contact with the Huronian schists, which also run in nearly the same direction. The exact contact was not noted, being apparently in the bed of the lake and at the extreme ends of deep bays on either side. Huronian and Laurentian.

'Over the height-of-land, where a portage of a mile was made, we entered by a small stream, a long narrow lake lying along the strike of the gneiss. The surrounding hills are poorly wooded and are generally bare rocky ridges. From this lake, the stream we descended to Cold Lake was not large, but in its lower part occupied a wide channel. On its banks the first terrace of stratified material north of Goose Lake was noticed, being here mostly of sand, while the surrounding country, between the rocky ridges, is covered entirely by a thick growth of Banksian pine.

'Cold Lake, through which we passed, is about twenty miles in length and possibly ten miles wide, though it is so full of rocky islands that the main shores are hard to recognize. A well-defined rocky ridge runs along the east side and continues north until it is broken through by the stream draining this basin. The rocks are generally a light-reddish gneiss with a few bands of a more basic character all broken into by intrusions of a light-reddish pegmatite. On one of the islands in the central part of the lake the intrusive mass Rocks of Cold Lake.

Saskatchewan District-*Cont.*

cuts through beds containing disseminated iron-pyrites. This being oxidized in the vicinity of the intrusion colours the surface of the rock in a broad rusty band across the rocky hill.

'The dip of the beds here being at a very low angle and in some places nearly horizontal, the outcrop is deflected to a great extent by the small undulations.

'The river leaving the lake runs to the north-east until it enters a gap in the bold ridge running along the east side of the lake. Here several heavy falls are passed and an abrupt turn is made to the north from a small hill-enclosed lake-basin. Rough hilly country extends to the Churchill River and characterizes the whole of that valley from west of Duck Lake to below Nelson Lake.

Churchill River.

'An excursion up the Churchill River through Duck Lake to Doctor Lake and return by the main river to the north was also made before proceeding toward Burntwood Lake. Finding a guide who knew the Burntwood River well, we proceeded toward Nelson House by a canoe-route to the north of Burntwood Lake, following down the Churchill River to Nelson Lake and eastward by a long arm finally portaging south to Burntwood River some distance below the lake. Nelson House is situated on a small lake on this river at the confluence of two other streams. Two missions, one of the Methodist church and another of the Roman Catholic church, are established here, and at each, as well as at the Hudson's Bay Company's post, are large gardens containing nearly all the ordinary garden vegetables. At the date of our visit (July 27) potatoes could be found about the size of hens' eggs.

Burntwood River.

'The Burntwood River from the lake to this point, descends through a terrace of sand and clay that begins at the lake a foot or two above the lake level. The river gradually cuts down until its banks become about thirty feet high at Nelson House. As the fall in the river estimated at the rapids closely approximates to this amount, the surface of the terrace is evidently nearly level. The underlying rocky surface is very uneven, but generally slopes to the north-east, so that in descending the stream the terrace deposit covers a larger part of the surface and the protruding hills become less conspicuous.

'The prevailing timber is Banksian pine, with a sprinkling of black spruce and poplar in the valley near the stream. On the level surface behind the marginal part drained by the river, muskeg is reported as occupying a large part of the area. This evidently denotes a lack of drainage, and as the soil is very rich where gardens have been made, there is little doubt that larger areas could be farmed. This applies

Saskatchewan District–*Cont.*

only, as far as personal observation goes, to the valley of the Burntwood River and parts of the Churchill River and the vicinity of Reed Lake.

'After obtaining supplies at Nelson House, we ascended the stream again to Burntwood Lake. Traversing its entire length, we crossed the Burntwood portage at its western end to the Churchill River and connected our traverse with that down the Cold River and along the Churchill River.

Rocks of Burntwood Lake and Churchill River.

'The rocks encountered along the Churchill River and on Burntwood Lake are mainly garnetiferous gneiss and dark hornblende-gneiss broken into and often paralleled by large dykes of light salmon-coloured pegmatite. The beds are nearly vertical and show the result of great pressure, producing a beaded or lenticular structure. The strike is generally east-and-west, with of course many local deflections, but on the east end of Burntwood Lake and on the river below, the general strike is about north-west and south-east.

Outcrop of Niagara limestone.

'From near the middle of the lake we entered an arm leading south in the direction of Reed Lake. This gradually narrows to a stream in places. About half way to Reed Lake we were surprised to find in a little lake-expansion a small outlier of Niagara limestone occupying an island and part of a long point. The beds dip to the north-east.

Huronian rocks.

'In Loon-head Lake, north of File Lake, the gneisses, which for some distance north have a uniform strike to the north-west, are succeeded by a broad belt of granite, and immediately southward are found hornblende-schists and a few interbedded bands of granitic gneiss and pegmatite striking north-east, very much contorted and crumpled; but on File Lake these are found to be part of a series of Huronian rocks which, near the contact with the granite, have been to a great extent re-crystallized and bent. The strike of the Huronian rocks of File Lake is about north-north-east and is continued at nearly the same north-and-south direction southward to Reed Lake.

File Lake to Cumberland House.

'The route followed south was through File Lake to Methy Lake and by a long portage from the latter to Reed Lake. This road was through Banksian pine along the edge of a sand terrace or succession of heavy sand ridges lying to the east of an abandoned valley connecting the two lakes. As we were unable to find the southern route from Reed Lake to the Pas, we returned by the Grass River to Athapapuskow Lake and thence to Cumberland House.

'On the Grass River a few miles below Elbow Lake, several localities were examined and specimens collected from beds that seemed highly pyritized; some quartz veins that had been prospected were also seen,

Saskatchewan District–*Cont.*

but apparently there had been insufficient returns obtained from these surface showings, as the claims had been abandoned. From Cumberland House we went down the river to the Pas and from there started to explore a route leading to Reed Lake. On this route we crossed the Pas ridge north of the Indian reserve at Mr. Reeder's trading post and passed by Atikameg Lake to Pelican Lake. These two lie to the east of the ridge and are both large bodies of water. From the western side of Pelican Lake we ascended a small stream, that takes its rise near Reed Lake, but in its upper part is nearly blocked by willows, and is so small and crooked that our small birch canoe was the only one we could force through.

Garden at Reed Lake.

'On reaching Reed Lake, I visited the home of Mr. Cowan, who has settled there, and found that he had cleared a small patch for gardening, in which he was growing a fine crop of potatoes, cabbage, turnips, beets, beans, and had also a small strip of grain that he expected would soon be ripe. Returning to Pelican Lake, we followed the north shore to its outlet at the east end. This is connected by a wide sluggish stream through a muskeg flat, with the north-west arm of Moose Lake. From our survey of this part of Moose Lake we found that fully half of its area had not been shown on any previous map, the eastern part only being outlined.

Niagara outcrops.

'Several outcrops of the Niagara rocks were visited and a few fossils obtained. On our excursion to Reed Lake, the Niagara rocks were found to extend northward to within a short distance of the lake, leaving apparently a thin exposure of Trenton which outcrops along the south shore.

'The chain of lakes reaching from Atikameg Lake near the Pas ridge to Moose Lake occupies a single basin, as the intervening country is very low, being mostly muskeg and marsh.

Delta plain of the Saskatchewan.

'The trading post at Moose Lake, is situated near the outlet on a limestone ridge north of a wide grass-flat which stretches toward the south-west, and through this the several branches of the Saskatchewan River wind. The southern edge of the wooded country forms a rough line running to the west and along the margin is a series of lakes and ponds by which we returned instead of ascending the main river, although we had a long portage of nearly a mile to make through a grass-flat.

Autumn flood.

'On reaching the Saskatchewan, we found it in flood and steadily rising, an unusual occurrence for the autumn season. Above The Pas the whole country was flooded for many miles. The gardens near the river, as well as all the hay crop, was under water. The half-breed

settlement at Birch River was flooded out and the people were camped on a ridge on the old Indian reserve near by. Finding the country in which I had planned to spend a couple of weeks, in the condition of a large lake with very few camping places left, I determined to pay off the men and return by Lake Winnipeg, the ascent of the river to Fort à la Corne being a long tedious journey. Saskatchewan District–*Cont.*

'Returning to the Pas, we crossed the Birch River portage without lifting the canoe and passed through the gardens of the houses there, which are said to be on the banks of a stream, eight or ten feet above the water. They were submerged to the tops of the windows, and the school building, the highest among them, showed only the upper casement of the windows, the whole basin being apparently filled to the level of the tops of the banks of the Saskatchewan River.

'From Selkirk Island on Lake Winnipeg, I was fortunate in securing passage on a steamer to Selkirk, sending the canoe back to Cumberland House with the men brought from that place.

'The northern edges of the Huronian areas were found at two localities, but the western extension runs probably to Beaver Lake and thence beneath the Trenton limestone which is known to outcrop on its western side. Other small areas probably occur farther west, as Mr. A. S. Cochrane notes serpentine on a little lake south of Pelican Narrows. The small finds of gold in the Saskatchewan in this vicinity can be traced no doubt to the boulder-clay which is derived from the north. Huronian areas.

'Although as yet this district has not been prospected, valuable mineral deposits will probably be found in the near future, and with the advent of railway communication, may become important. In regard to railway projects, the district is situated on the line of the projected road to Hudson Bay and a feasible route by the Pas ridge across the Saskatchewan river-flat leads north through fairly level country underlain by limestone to Reed and Herb lakes, the basins of which are excavated in Huronian rocks. Northward to the Burntwood River rougher country would be met, but the plain through which this stream cuts its valley, offers a possibility for agriculture perhaps not expected in this latitude.' Feasible railway route north.

Ontario.

Mr. W. McInnes employed the winter months in working up the surveys and notes of the preceding summer and in completing a report, which was issued in the summer, on the geology of the area covered by the Seine River and Shebandowan map-sheets. The work of the Work by Mr. W. McInnes.

Ontario- *Cont.* summer was directed mainly to extending the explorations of the previous season in the Rainy River District of Ontario, to cover, as nearly as possible, the geological map-sheet adjoining the Seine River on the north, to be known as the "Ignace" sheet. Mr. McInnes' short report of progress is as follows :—

Assistants. 'I left Ottawa on June 28 and was joined at Fort William by Messrs. T. W. Ellis and E. B. Thompson, who had been assigned to the party as assistants for the summer. They continued with the party until surveying work was finished in the autumn and performed their work satisfactorily.

Method of survey. 'Owing to the absence of any reliable map of the area, it was again found necessary to make surveys wherever explorations were carried on. These were made with a Rochon micrometer telescope and a four-inch, free-needle compass, minor details being added with boat-log and compass. Three Peterborough canoes were used, and four Indians, with the two gentlemen just mentioned and myself, made up the party for the season.

English River. 'The English River was first surveyed from English River station on the Canadian Pacific Railway to Bear Lake, the highest point on the river reached last year. For the first twelve miles below the railway, exposures of rock are infrequent, the river lying in a wide, flat valley, and sweeping from side to side in broad curves through wild hay meadows, with but a narrow fringe of low bushes along its immediate bank and occasional clumps of black spruce and tamarack. The few exposures seen were all of well-foliated, biotite-granite-gneiss.

Keewatin band. 'About twelve miles down, a band of hornblende-schists and fine, black biotite-gneiss or mica-shists crosses the river, striking N. 35° W. With the exception of this narrow band, that has a width of only about half a mile and may represent the remnant of a Keewatin band, biotite-gneisses are met with all the way down the river, the strike gradually changing to north-east. Between the railway and Selwyn Lake, six rapids occur, with a total fall of over fifty feet, necessitating portages aggregating a mile and thirty chains.

Selwyn Lake. 'Selwyn Lake is really a shallow river-expansion, showing many exposures of well foliated, biotite-granite-gneiss striking about north-east. Below the lake the river is wide and lake-like, as far as a series of rapids that mark, the entrance to Mattawa Lake, another expansion of the river much larger than the first. The same gneisses occur all about the lake with the same general strike, well glaciated and showing striæ running S. 10° W. They are irregularly interbanded in coarse and fine layers, the coarser invading the finer and inclosing

blocks of it. The main English River flows out of this lake about half-way down its western side. At its extreme north-eastern end the lake receives the waters of Shikag Lake by a short stream, with rapids passed by a portage of five chains in length. Ontario—*Cont.*

'Although about twelve miles long and varying in width from a few chains to three or four miles where it expands into bays, Shikag Lake is generally shallow, with many protruding rocks and shoals. Soundings in its more open part gave depths reaching fifty-five feet. The immediate shores are low, rising very gradually from the water to the general level of about fifty feet a mile back. The extensive brulé that was found to extend down the English River from a little below Selwyn Lake northward to beyond Brulé Lake, does not reach this lake, where second-growth, green forest of fair size covers the hillsides, with an occasional red pine of the original forest still standing. Rock exposures are frequent about the shores and very uniform in character, consisting of fine, biotite-gneisses similar to those already referred to and with the same strike. To the east, a low watershed divides this lake from the waters flowing into Metionga Lake, which empties by the Bright-sand River into the Albany River. Shikag Lake.

'Continuing down English River from Mattawa Lake, two small rapids are passed and then another river-expansion, known as Wigwaskwa Lake, is reached. Gneisses similar to those already spoken of occur all about the lake, the strike varying from north-and-south to east-and-west. Glacial striæ are well marked running S. 16° W. Wigwaskwa Lake.

'Below the lake the river takes an abrupt turn to the south and keeps that direction for eight miles, to Pine Lake, preserving for the greater part of the distance a lake-like character with an average width of about half a mile. Pine Lake is divided by a long point, about a mile wide, running up through its centre, into two lakes each about five miles in length and from one to two miles wide. The rocks exposed about the lake are the same biotite-gneisses with a less marked foliation and generally contorted. Many of them, in addition to orthoclase felspar, show large crystals of albite. At a few places about the shores, the lake washes against cut-banks of sand with faces from fifteen to twenty-five feet high. One of these sand-covered areas on the east shore supports a good growth of red pine and spruce. Pine Lake.

'Leaving Pine Lake the river flows in a direction a little west of north for seven miles and then turns sharply to the west for four miles, through what is really a long narrow arm of Bear Lake. Rock exposures are not frequent along this part of the river's course; they are all of biotite-granite-gneiss in coarse and finer bands, the dips becoming gradually flatter until, along the shores of Bear Lake, they are nearly Building stone.

Ontario—*Cont.* horizontal, with low undulations, the coarse and fine materials alternating in a stratiform way.

Pagutchi Lake.

'A survey was then made of Pagutchi Lake, lying to the east of Sand-point Lake. The area of obscurely foliated gneisses with horizontal, bench-like jointing that extends for a long distance to the north-west of Ignace, was found to include the rocks seen about this lake. Advantage has been taken of the facility with which this stone can be taken out, at the Canadian Pacific Railway quarry near Ignace. Blocks of almost any dimensions can be quarried with little trouble, and all the bridge-piers and culverts along this section of the railway are being built of it. Pagutchi Lake is about nine miles long, running in a general way north-easterly from Niven's meridian line, but is only from a mile to a mile and a-half wide.

'A route was next surveyed leading from Otter Lake up Minomin River and through Hat, Pine, White Rock and Young lakes, occurring along its course, to Sturgeon Lake. From the railway to Sturgeon Lake by this route makes a good two days' journey. There are eight portages, aggregating not quite two miles of carrying.

Keewatin of Sturgeon Lake.

'The southern edge of the Keewatin band of Minnitaki and Sturgeon lakes, was struck just north of the first portage beyond Hut Lake. At the northern end of the portage, fine, biotite-gneiss striking N. 65° E. incloses rounded pieces of green chloritic schist, resembling a Keewatin rock, and the first exposures seen in Pike Lake are typically Keewatin, consisting of hard, felspathic quartzites and various schists striking N. 75° E. The direction of the glaciation is well marked by striæ trending S. 33° W., swinging to S. 26° W. on Young Lake where they occur on a hard felspathic, schistose rock, that has, in certain layers, a conglomerate structure with the pebbles all small and similarly composed of flinty, felspathic quartzite; probably representing harder bands of the schist, that have been broken and surrounded.

'Continuing towards Sturgeon Lake, the portage crosses a low watershed rising perhaps thirty-five feet and descending fifteen feet, the exposures met with varying from quartzites to diorites.

Soundings.

'Sturgeon Lake lies in a belt of Keewatin rocks, but little wider than the lake itself and made up of the usual, widely divergent types. It is a very beautiful sheet of clear water, with a length of about forty miles and varying in width from half a mile to a mile and a-half. The shore-line is broken by a number of bays of irregular shapes, some of which extend back for several miles. These afford to the prospector a ready means of access to all parts of the Keewatin belt. Soundings near the centre of the wider parts of the lake showed depths

of from 100 to 157 feet. The forest about the lake is still unburnt, except in limited patches, and everywhere there is a thick coating of moss covering the surface of the rocks. The lake is drained by Sturgeon River, which flows from it near the north-western end, and, after following a westerly course nearly sixty miles, joins the English River at Abram Lake below Minnitaki Lake. Ontario—*Cont.*

'All along the long, narrow arm that is first reached on the route from Young Lake, the rocks consist of alternations of coarse, hard diabases, felspathic quartzites and green schists, striking about north-east or parallel to the shore-lines. Where the lake widens out suddenly to two miles and a-half, the south shore is just about at the contact, the rocks consisting chiefly of quartz-porphyries that in certain exposures become quite granitoid, with abundant blebs of opalescent quartz; often crushed and sheared to a schist and generally holding iron-pyrites. Along the south shore, past Drunken Island, and to the crossing of Niven's meridian line, quartz-porphyries that vary to quartzites and hydro-micaceous schists trend parallel to the shore. The northern edge of the gneiss area lies about a mile to the south of the lake, keeping about parallel to the shore-line. Principal rocks.

'On the north shore, the first bay of any considerable size lies entirely within the northern gneiss area and the line of contact crosses about half-way up the next bay. Just to the east of this, however, it bends away to the north, as on a long irregular arm, just west of the meridian line, Mr. Ellis, who surveyed it for six miles with the boat-log, did not reach the edge of the gneisses. Line of contact.

'The lake was examined down to the foot of the narrows, about twenty-five miles from its head. With the exception of the gneiss already referred to as occurring on some of the northerly bays, and of some granitic intrusives in small masses, only Keewatin rocks are seen. Just east of the meridian line the north shore and island show high cut-banks of white, quartz sand. Diorites and green schists extend all along the south shore to the west end of the narrows, where there is an intrusive mass of porphyrite with a groundmass of quartz and felspar, abundantly specked with pyrite, and with large crystals of orthoclase. This rock weathers deeply and is rusty from the decomposition of the pyrite, and waterworn surfaces are thickly covered with projecting felspar crystals, often of large size. Along the narrows, Keewatin diorites, quartzites and schists strike about N. 50° E., and at the lower end is a small area of massive crystalline felsite which becomes in places a close-grained or cryptocrystalline rock composed largely of quartz. Keewatin rocks.

Ontario—*Cont.*
Glaciation.

'The rock-surfaces are generally well glaciated, the striation running S. 15° W. A little to the east of Moose-head Point, a very striking pot-hole, about fifteen feet deep by ten in diameter, is plainly seen in the cliff. About half of the encircling rock has been worn away, leaving a hollow that is known to the Indians as Windigo's back.

Mineralized zones.

'Mineralized zones of sericitic quartz-schists with reticulating and bunchy quartz veins were noted along the lake, and, late in the summer, a number of locations were surveyed on which it was claimed that good showings of free gold had been found. Small working parties were sent in to do preliminary development work with a view to proving them.

'This belt affords a practically new and apparently promising field for the prospector, as very little exploratory work has been done on it and the rocks are of a character that would seem to warrant closer examination. The green forest and the deep covering of moss are unfavourable features, but the easy accessibility of the lake and the extent of its shore-line that lies within the Keewatin belt are strongly in favour of the prospector.

Contact.

'At Blackwater Lake, between Sturgeon and Brulé lakes, the southern contact crosses the lake, the gneisses at the edge merging into quartz-porphyries and cutting massive diorites.

Brulé Lake.

'Southward from here Laurentian banded gneisses extend all about Brulé and adjoining lakes. They are interbanded fine, black and coarse, white biotite-gneisses, the latter invading the former and inclosing pieces of them in the form of broken bands. Along the north shore, closely following its general curve, is a band of very fine biotite-gneiss that probably represents an extremely altered tongue of inclosed Keewatin rocks. About the central parts of the lake, the gneisses show but little foliation and several masses of a very tough, anorthosite-like rock form what seem to be intrusive bosses, making up the body of several islands and a small area on the long, central, easterly-projecting point. The strikes curve gradually from N. 35° E. at the south-west end to east along the eastern shore. The same rocks are continuous southerly down through Cut-stone to Mattawa Lake.

English River to Sand-bar Lake.

'Returning towards Ignace, a route was surveyed from the English River below Pine Lake across to Sand-bar Lake. After ascending Moose River and the two long narrow lakes into which it expands, a portage of a quarter of a mile, the first part up a steep hill-side, leads to Down-hill Lake. About Moose Lakes occasional exposures of

gneiss are seen, generally dipping at low angles and well glaciated in a direction S. 22° W., while on Down-hill Lake, particularly all along its south-east side, are banks of sand and gravel five to fifteen feet in height with no exposures of gneiss *in situ* but with an abundance of large gneiss boulders. Ontario—*Cont.*

'The succeeding lakes, Wabuska (White Grass) and Wabikoba (Willow Narrows), have low shores running back in the form of sandy flats to hills of very moderate height behind. The gneisses are not so distinctly foliated here, and the strike is quite indistinct.

'A portage of sixty-seven chains, over a drift-covered, rolling country, leads to a small lake at the head of Stone Brook, about the shores of which, and down stream to Sand-bar Lake, are occasional exposures of obscurely foliated biotite-granite-gneiss.

'Megikons River, which empties into Pine Lake, was surveyed to its source in some small lakes south of the railway near Tamarac station. Few exposures occur along the lower parts of the river; those that were seen being of biotite-gneiss lying nearly flat. Banks of sand varying in height from twenty-five to ten feet are common along the river, the sand-flats apparently extending back from the river for long distances. The sand is made up mainly of very fine grains of quartz, so fine and so well compacted together in certain layers as to hold up the water and form a line of little springs at its upper edge. The country through which the river flows is a great sandy flat with occasional ridges of sand and gravel. Small Otter River.

'The Gull River, from its source in Gull Lake flows through a country for the most part comparatively level, with large areas of marshy land. Occasional exposures of gneiss crop out, but for long distances the river meanders through a broad flat valley. At a point about twelve miles above the crossing of the Canadian Pacific Railway, the hay-belt that borders the river almost continuously, widens out to form a large meadow with an area of probably two square miles. Generally, below the railway, the river is of the same character, broken by occasional rapids and falls, among which one, about a mile from the railway, is of considerable height; it occurs in two successive pitches with a total descent of over thirty feet. Meadows.

'No actual mining work was being done within the limits of the area explored, with the exception of the preliminary work on Sturgeon Lake, already referred to, and the prospectors were just beginning to reach the Sturgeon Lake belt of rocks. Mining.

'After closing up the season's surveying work and sending Mr. Thompson and Mr. Ellis home, a few days were spent, with Port

Ontario–*Cont.* Arthur as headquarters, in accompanying the Director of the Survey in an examination of the Animikie contacts along Thunder Bay, on the Kaministiquia River and at other points in the neighbourhood. Ottawa was reached on October 19.'

Work by Mr. A. E. Barlow.

During the first part of the year, until the beginning of field-work early in June, Mr. A. E. Barlow, with the assistance of Mr. Joseph Keele, was engaged in plotting and compiling the topographical information secured for the Haliburton map-sheet. This includes not only surveys of roads and railways not shown on the township plans available at the Crown Lands Department, Toronto, but also extensive resurveys of many of the more important lakes and streams, which were either incorrectly shown or omitted altogether on these maps. Some time was likewise consumed in examinations under the microscope of a large number of thin sections, taken as representative of the various rock-types exhibited in this district, while considerable progress was made in the preparation of the report on the geology of this portion of Central Ontario.

Joint report of Messrs. Adams and Barlow.

Dr. F. D. Adams and Mr. Barlow were again closely associated in the field-work necessary for the completion of the Haliburton map-sheet. The following account of the progress of the work includes results obtained by both gentlemen :—

'Mr. Barlow left Ottawa on June 7, joining Mr. Keele (who had preceded him) at Oak Lake. The surveys and examinations were extended southward into the township of Belmont, and thence into Marmora and connection made with the work done by Messrs. Coste and White of this survey in 1886, as shown on the map of the Madoc and Marmora mining district. This extension of the work so far to the south, was necessary, not only to establish with greater accuracy the geographical position of the sheet, but also to correlate definitely the geological observations with those made in previous years by other observers in regions where the Hastings' series had been originally described as typically developed.

General geological results.

'One of the important results thus obtained has been that most of the occurrences of conglomerates previously described are found really to be of the nature of autoclastic rocks, evidencing not only the intricate and extensive intrusion of the plutonics through the associated clastic rocks, but also the pronounced dynamic action to which the resulting complex has been subjected. In addition, it seems certain now, from the result of the past summer's work that the Grenville series is merely a more altered form of the Hastings series as was stated to be probable in a former Summary Report.

'Dr. Adams left Montreal for the field on June 13, going by way of Peterborough and Lakefield into the township of Burleigh. Examinations were made of the western portions of the townships of Cavendish and Harvey, which lie within the boundaries of the sheet. This district was found to be occupied by a southward extension of the Anstruther granites and gneisses with the exception of a very considerable development of crystalline limestone, much of it very pure, in the central portion of Cavendish. This was mapped and its relations to the associated gneisses were determined. Ontario--*Cont.* Cavendish and Harvey townships.

'A detailed examination was then made of the township of Methuen. The great granite area that forms the blueberry barrens was mapped and traced northward into the township of Wollaston, where it ends on the rear of the VIth concession. The nepheline-syenite area mentioned in the last Summary Report was also studied in detail, especial attention being paid to the corundum deposits occur in connection with it. Afterwards the great area of crystalline limestone that extends up from Burleigh and occupies the whole of the district around Jacks Lake was studied and mapped. Cutting through this limestone several undoubted dykes altered by later movement were found. These are of great importance, as they now consist of a rock not to be distinguished from many of the amphibolite occurrences in various parts of the area and whose origin it was very difficulty to determine. As a result it is probable that many of these amphibolites are of igneous origin and presumably of the nature of an altered diabasic rock. Methuen.

'The latter part of July was occupied in examining the very complicated district about Apsley in south-eastern Anstruther and south-western Chandos; the true relations of the limestones, amphibolites and granites being determined by a detailed mapping of the area. Anstruther

'The very rough and rugged township of Lake was explored in the early part of August, and a remarkable series of conglomerates, associated with what is apparently a series of ancient volcanic rocks were discovered to the west of Burnt Lake. The strata of the township of Lake are distinctly of the type of the Hastings series of Vennor and many of them are but little altered. Lake.

'The latter part of August was spent in a study of the township of Wollaston. The several areas of granite and diorite occuring in this township were mapped and their relations to the limestones and amphibolites determined. Another remarkable band of conglomeratic rock, almost certainly of autoclastic origin, was found on lots 16 and 17 in con. IX. of this township. The several bodies of iron ore in the township were also examined and found to be portions of limestone- Wollaston.

Ontario—*Cont.* amphibolite series, probably resulting from the replacement of the limestone rock by iron-bearing solutions.

Glamorgan and Monmouth.

'Dr. Adams' work on the sheet was then completed by the examination, in September, of the eastern portion of the township of Glamorgan and the south-western corner of Monmouth. A large area of gabbro, often holding considerable amounts of iron ore was found in the south-east corner of Glamorgan associated with a large development of nepheline syenite. This latter rock was traced across lots 22 to 27 of cons. IV. and V. and on lot 30 in con. IV. it assumes a very coarsely pegmatitic development and is rich in sodalite. Nepheline-syenite, as well as a great development of gabbro with iron ore is also found in the south-western portion of Monmouth. The former rock is well exposed on lot 10 in con. III. and lots 2 and 3 of the same concession, where it is rich in nepheline, while the gabbro is well exposed about Pine Lake.

Course of Mr. Barlow's work.

'About the middle of July, the work was carried northward again by Mr. Barlow from the township of Marmora into the township of Tudor. The north-western part of Tudor as well as the south-western corner is underlain by the limestone-amphibolite series, while the Hole-in-the-wall diorite, extending from near the junction of Otter and Beaver creeks in the township of Lake, cuts across the township of Tudor, forming the central and eastern portions. Thence this mass of basic intrusive material extends into Grimsthorpe, giving place eastward to the granites which extend northward through Cashel to Weslemkom Lake. August was taken up in examinations and surveys in the townships of Cashel and Limerick, while September was devoted to a study of the nepheline-syenite and associated rocks in the townships of Faraday, Dungannon, Wollaston and Carlow.

Mines in Belmont and Marmora.

'During the progress of the surveys and examinations in Belmont and Marmora, a preliminary examination was made of a few of the mines and some of the information then acquired may be here included.

Deloro mine.

'The famous Deloro mine, situated in the township of Marmora, a short distance east of Marmora station on the Central Ontario Railway, is now operated by the Canadian Gold Fields, Limited, of London, England, in succession to the old Canada Consolidated Gold Mining Company. The Deloro property itself contains about 525 acres, consisting of lot 2 in the VIIIth concession of Marmora, 10 in the VIth, the west half of 10 and the north-east quarter of 8 in the IXth. Certain options and rights in Marmora and adjacent townships, however, give an area for exploration and development in excess of the area thus described. Operations were commenced under the present company about the middle of September, 1896, and have continued ever since.

Mr. Kirkegaarde is at present in charge of the works. Extensive works for the proper treatment of the ore were erected by the present company at Marmora station, but these were totally destroyed by fire during last spring, and at present all the operations are carried on in the immediate vicinity of the Deloro mine itself. The extraction of gold from the refractory sulphides is accomplished by means of the Sullman-Tweed or bromo-cyanide process. Ontario—*Cont*

'The mines are situated on a belt of rocks which, according to Mr. E. Coste's map of the Madoc and Marmora mining district, are Archæan and igneous, and designated as granite inclosing fragments of Archæan. As far as could be ascertained during our inspection, the rock is a mixture of a dark-gray quartz-diorite cut by a hornblende-granite which ramifies through the diorite often in the most intricate manner. Although at times certain comparatively large areas of granite are differentiated rather sharply against others which have a dioritic facies, occasional masses may be noticed that seemingly mark a transition from one rock type to the other. Such masses consist of a rock of a grayish colour, weathering reddish, more basic in composition than the granite and more acidic than the prevailing diorite. These rocks are cut through by pegmatite dykes that are evidently later and more acidic secretions from the same magma from which the granite and diorite have solidified. Associated with these are certain irregular areas of allotriomorphic quartz, which fill in all the irregular cracks and fissures in the rock. The pegmatitic origin of these quartz veins seems beyond a doubt, as places may be seen where the walls of the vein are pegmatite passing inward towards the centre into the gray translucent quartz and containing the usual sulphides and carbonates. Country-rocks.

'The rocks themselves may be regarded as forming part of a basic border or mantle surrounding and cut through by the large mass of granite known as the Huckleberry Rocks. Mining operations have disclosed the fact that the rock everywhere in the vicinity has undergone rather profound shearing and dislocation, the irregular cracks and fissures being filled by the quartz. These irregular vein-like masses of quartz contain a considerable amount of arsenopyrite (mispickel), some calcite, dolomite and ankerite, a small amount of pyrite, and a still smaller amount of chalcopyrite. Free gold is only occasionally visible to the unaided eye in the quartz, but so finely is this disseminated through the sulphides, that it requires the greatest vigilance on the part of the manager to prevent undue loss. In a rough sorting of the ore which is usually carried out, only those portions of the vein and neighbouring rock which show the sulphides are selected, while quartz Character of veins.

Ontario-*Cont.* free from such admixture is rejected as barren. By this means the ore taken to the mill is enriched fully 25 per cent.

Gatling vein. 'Although, as has been stated, these quartz or ore-bearing bodies are exceedingly irregular. two main lines of dislocation occur occupied by what are know as the Gatling and Tuttle veins respectively. These are approximately parallel to one another and have a direction of nearly north-and-south with a dip to the west in the case of the Gatling vein of 57°, and the Tuttle of 64°. The main work has been done on the Gatling vein at what is known as No. 1 or the Gatling shaft, and at the time of my visit (July 7) work had reached a depth of about 300 feet. The width of the vein is variable and at the wider portions "horses" of the associated rocks are included. At a depth of 200 feet the vein was lost after passing through fifty-seven feet of shattered and slickensided rock. It rapidly widened to two or three feet, this width being still maintained. Southward as ascertained by two drifts, the Gatling vein pinches out, but is replaced about 300 feet to the east by the Tuttle vein, which it overlaps. Northward it extends into the "Gatling Five Acre," as the property of another company is called. Two drifts have been run connecting the Tuttle and Gatling veins and work is being continued with promising results in both veins.

Smaller veins. 'Besides these comparatively large bodies of quartz, others which are described as feeders, enter them at sharp angles, producing at their junction a local enrichment of the main ore-body. The wider portions of the vein are relatively much poorer in gold than where these are more constricted. Two other shafts were likewise in operation on minor ore-bearing bodies.

Mass of diabase. 'An important area of intrusive rocks, somewhat similar in character to the Huckleberry Rocks, is exposed in the district immediately adjacent to the western and northern shores of Crow Lake in the western part of the township of Marmora and extending westward into the eastern part of Belmont. They appear to represent the truncated base of a very ancient volcanic centre, while certain hills which rise to the south-west, towards Preneveau P. O., are composed of a portion of the ancient lava flood. These hills rise in somewhat bold rounded outline from an otherwise comparatively level plain underlain by Palæozoic strata. They are composed of a dark-green often fine-grained diabase, in many places porphyritic, large phenocrysts of partially saussuritized labradorite being developed in a groundmass which often has macroscopically a distinct ophitic structure. In many places the rock is amygdaloidal, some of the vesicles, which are

Ontario–*Cont.*

Associated mineral deposits.

often arranged in rows, being empty, while others are filled with quartz and other secondary mineral. This mass is important, as being the parent, so to speak, of four noteworthy mines. The once famous Blairton iron mine is at the southern edge on the south side of Crow Lake, while the Belmont or Ledyard iron mine is on the north-west side. The Cordova (formerly the Carscallen) gold mine and the Ledyard gold mine are near the northern edge.

Character of the country-rocks.

'The main mass, or deep seated portion of this centre of volcanic activity, is for the most part a dark greenish-gray diorite. In many places the texture of the rock is exceedingly coarse and its main constituents are readily discernable without the assistance of a lense, while at other times it is exceedingly fine-grained and of a dark-greenish colour. Occasionally the rock shows foliation, though quite massive in structure, and in many cases this foliation is accentuated by the alternation of coarser and finer bands. The rock is evidently largely composed of a basic plagioclase (labradorite) and hornblende, and appears to be a gabbro-diorite with a broad ophitic structure allying it to the diabases. It is intimately associated with and cut by a red granite that ramifies through the more basic irruptive often in the most intricate manner. Pegmatite dykes were likewise noticed, and large, often exceedingly irregular, masses of allotriomorphic quartz. At times a certain indefinite vein-like arrangement may be noticed with what appears to be a tolerably well-defined hanging- and foot-wall, but both in their horizontal extension, and doubtless also in depth these veins exhibit extreme irregularity.

Occurrence of quartz.

Of course by following certain lines of disturbances and other signs learnt by experience by the miners, the ore-bearing body is frequently recovered at no great distance, and with an increase of experience in such work, many of the existing difficulties and disappointments may be overcome. The abundance of the quartz is a favourable factor in the problem, as in case of one body giving out, there is almost invariably another close at hand to work upon. In the vicinity of these masses of quartz, which for the most part fill residual spaces caused by the extensive deformation and fractures, the rocks have undergone considerable alteration, the resulting chloritization and seritization being the result of the combined action of chemical and dynamic forces. Considerable disturbance has in many instances accompanied the injection of the quartz, as horses or masses of the adjacent rock are caught up and altered by the containing silicious material. The quartz is of a very pale-grayish or whitish colour, and translucent. In many cases large masses seem entirely barren of any mineral whatever. At other times the quartz as well as the adjacent

Ontario-*Cont* wall-rock is highly impregnated with pyrite, ankerite, and chalcopyrite, and at the Cordova mine a selection is made of the material containing these sulphides, while the barren quartz and rocky matter are thrown on the dump as useless.

Belmont gold mine. 'The Belmont gold mine is situated on the east halves of lots 20 and 21 in the first concession of Belmont. It was formerly known as the Carscallen mine, and had been lying idle for some time until the Cordova Mining and Development Co. took hold of it in August of 1897. Extensive operations are now in progress, while the equipment seems very thorough and complete. Work is proceeding by means of six shafts, one (No. 6) of which is on lot 21 to the north of the road running towards Marmora, while the five others are to the south. No. 5 is a considerable distance to the south while Nos. 1, 2, 3 and 4 are close to the road and furnished with good shaft-houses. The ore-bearing bodies have in general an east-and-west trend and appear to belong to three distinct dislocations approximately parallel to one another with a dip to the south $< 60°$ to 70°.

Ledyard gold mine. 'The Ledyard gold mine is situated on the east half of lot 19 in the first concession of Belmont township. The country-rock is much the same as at the Belmont gold mine, in fact the lots adjoin one another and the rocks can be traced with practical continuity from one location to the other. Quartz, very similar in appearance and composition to that at the Belmont and elsewhere throughout this mass of intrusive rock, may be seen in a large number of places on the property, the chief places where work has been done being known as shaft No. 1, the Burnt-knoll, the Hogs-back and the Nichol vein. The line of the Ontario, Belmont and Northern Railway runs through the property into the adjacent lot known as the Belmont Iron Mine. This railway, running through the village of Marmora, connects with the Central Ontario Railway near its junction with the Canadian Pacific Railway. Some work has been done on this mine, the main shaft having been sunk a distance of 100 feet, while large open-cuts have been made at the several places already mentioned. Suitable buildings have been erected, but at present the mine is lying idle in charge of Mr. W. C. Youman.

Old Feigle mine. 'The Old Feigle Mine near Malone station on the Central Ontario Railway was re-opened last April by Mr. O. R. Spragge, and a force of seven men was engaged in development work. The name of the mine has now been changed to The Sovereign. The main shaft is down a distance of 35 feet on quartz with a quartz-diorite as the country-rock.

'The Diamond mine situated on lot 14 in the tenth concession of Madoc, was not visited, but extensive operations were reported. Ontario-*Cont.*

'The Craig mine, comprising the south halves of lots 4 and 5 in the third concession of Tudor, may be mentioned as one of the places where a good deal of work has been done. It is on a sulphide-bearing quartz vein, which cuts fine-grained amphibolites.

'The Bannockburn mine is likewise closed down for want of capital to carry on operations.

'The increase in demand and price for iron has again directed attention to the large deposits known to exist in this district and to which attention has been drawn in previous reports. Iron ores.

'The Dufferin mine, near Malone, has been re-opened and has now been running pretty steadily for two years. Under contract with Mr. Lloyd Bulpit of Madoc, Messrs. Thomas Barnes & Co., of Hamilton, have been shipping about five car loads or 100 tons of ore per week to the smelter at Hamilton. Several very large open pits have been made to secure the ore which occurs in the form of large lenticular masses in crystalline limestone. The ore is a rather pure magnetite, although rough sorting is necessary to rid it of the sulphides which it is apt to contain in places. It is as a rule finely granular, although portions are coarsely crystalline and occasional cavities containing calcite exhibit rather perfect octahedral forms. Dufferin mine.

'The Wallbridge hematite mine near Eldorado is being steadily worked, the ore being shipped to the Hamilton smelter. Wallbridge mine.

'At the Belmont iron mine a few men were engaged stripping the covering of soil to ascertain the quantity and quality of the ore beneath. The mineral seems to occur as a differentiation product of the massive basic irruptive with which it is inclosed. The ore is a magnetite seemingly very free from sulphides. Trial shipments have been made of five car-loads each to the Hamilton and Deseronto smelters, while 165 barrels have been sent to Glasgow, Scotland. Belmont mine.

'The Coe Hill also made a trial shipment of some of the ore which has been lying exposed for years on the dumps, while inquiries are being made looking to the opening up of the once famous Blairton iron mines. Coe Hill mine.

'Mining for mica has been carried on in a desultory way for years, the difficulties being either a scarcity of the mineral or too large a percentage of iron to make it marketable at remunerative prices. Mica mining.

'Messrs. Hughes and Colter, of Bancroft, have opened up a deposit of what seems to be a biotite on lot 30, in concession XIII of Cardiff. Many of the crystals are very large and free from checks or inclusions,

Ontario-*Cont.* but they are very dark in colour. The mica occurs in a vein with crystals of albite, orthoclase and pyroxene in a gangue of calcite cutting the fine-grained reddish gneisses. Mr. Dickson, of Cardiff, has also some rather promising showings of mica, some of which were being developed under option during last summer.

Lead mines. 'Several important finds of galena have also been made in this district and a great deal of work has been done in their development, some ore having been shipped. The two most important locations are known as the Hollandia and Katherine mines. The former has been in operation for several years and about 400 tons of cobbed ore has been taken out and shipped to Belgium. The mine itself is situated a short distance north-east of Bannockburn. The galena occurs rather unevenly disseminated in a gangue composed chiefly of calcite, forming an irregular vein along a line of dislocation running in a direction of S. 54° E., cutting the highly inclined amphibolites of which the strike is N. 45° E. From forty-seven to fifty men were put to work, with twelve cobbers, but the mine has now closed down.

Katherine lead. 'The Katherine lead, zinc and silver mine situated in the eastern part of Lake a few miles west of Millbridge was opened last spring under the direction of Mr. Freeman Daniels of Ottawa. Considerable ore has already been secured and is lying on the dumps ready for shipment. The vein and associated rocks are very similar to those occurring at the Hollandia, but a considerable amount of blende is present in addition to the galena.

Corundum deposits. 'Further work was also accomplished in tracing out the relations and distribution of the syenites with which the corundum deposits are associated. In view of the expected early publication of the final report it is unnecessary here to go into many details.

'The Nepheline syenites, with associated red syenites and granites, are now believed to constitute a fairly well-defined belt of varying width that runs with more or less continuity across the Haliburton map-sheet from Glamorgan on the south-east to Brudenell near the north-east corner. Starting from Glamorgan, this band runs through Methuen curving around through the northern parts of Cardiff and Faraday, passes through Bancroft and the central part of the township of Dungannon as far as the York River. Thence north-eastward it follows very closely the depression occupied by the York River through Dungannon, Monteagle and Carlow townships. With perhaps some important breaks it crosses Raglan into Brudenell and thence passes eastward towards Clear Lake and the Opeongo road. While it is believed that many breaks occur to interrupt the continuity of this

band, but the more work that is done tends to make these interruptions less important, so that for all practical purposes it is perhaps expedient to describe and map the occurrence as one unbroken band. Ontario-*Cont.*

'During last summer Mr. T. H. Hodgson of Kingston was engaged prospecting for corundum along the valley of the York River for Messrs. Shenstone and Craig, who have since signed a lease which calls for the energetic development of a new industry in connection with this mineral. Incidentally Mr. Hodgson has done very valuable work in tracing out and correlating the various belts of nepheline-syenite, the information he has thus gained being placed at our disposal through his courtesy and kindness.

'Some of the discoveries made during last summer would seem to lend support to the view that the gem varieties, especially sapphire, may yet be found, in fact some crystals found by Mr. Hodgson and the writer very closely approach this gem in colour and transparency. Prospectors might direct their attention to a careful search along the tract of country in the valley of the York River from the crossing of the Mississippi road in Dungannon as far as the township of Carlow. Special attention should be paid to the crystalline limestones, as despite opposing views which may be held concerning the origin of these, there is a remarkable similarity in their association with the corundum to that occurring in Burma.

ONTARIO.

(With adjacent parts of Quebec.)

Work by Dr. R. W. Ells.

The winter of 1888-89 was spent by Dr. R.W.Ells, in the compilation of the map-sheets along the upper Ottawa and in writing a report on the geology pertaining to map-sheet No. 119.

The work of the summer of 1899 was devoted principally to completing the surveys in connection with map-sheets, Nos. 119, 120, 122 and 123, which have been in course of compilation for several years. Special attention was also given to the study of the formations around Ottawa city, in connection with the publication of the special map of this district on the scale of one mile to the inch, the compilation of which is well advanced. Dr. Ells reports as follows :—

Surveys made during the summer.

'Surveys were carried on continuously during the season, mostly in the area between the Ottawa and St. Lawrence rivers on map-sheet, No. 120, which was commenced some years ago by the late Mr. N. J. Giroux, but which he unfortunately was unable to complete. This

Ontario—*Cont.* work was largely entrusted to my two assistants Mr. R. Hugh Ells, B. A., and Mr. Howells Frechette by whom the necessary surveys for its final completion were conducted. This sheet is an important one, since in this area are found all the Palæozoic formations from the base of the Potsdam to the Medina. Large portions of the district are, however, occupied by deposits of clay and sand, and there are several peat-bogs of large size and possible great value for the manufacture of compressed peat and moss-litter. Ridges of large size, often chiefly composed of boulders of crystalline rocks in which are great prominent masses of labradorite, are frequent. In this district also, some fine farming lands are situated.

Work on upper Ottawa.

'A number of surveys were also made during the summer along the upper Ottawa in the direction of Chalk River in the townships of Petewawa and Buchanan, and in that part of Quebec above Allumette Island; also on Calumet Island and in the township of Litchfield. In association with Mr. James White, surveys were also made in Templeton township, and in Gloucester and Nepean, to complete the details of the Ottawa map, as also in the township of Hull where the geological structure is somewhat complicated.

Time spent with Prof. Osann.

'In the latter half of August, two weeks were spent with Professor Osann, of Mülhausen, in the study of certain portions of the crystalline rocks north of the Ottawa, between Ottawa city and the town of Lachute, in order to obtain materials for a report on certain eruptive masses, that occur more especially in connection with the economic minerals of that area, such as mica, graphite and apatite. The results of this work it is expected will be great value as affording light on the origin and mode of occurrence of these important minerals.

Progress of work on map-sheets.

'The work on the four map-sheets named above, is now sufficiently advanced to render the compilation of the several maps possible. Much difficulty has been experienced in this respect from the fact that many of the old township plans, the Crown Lands Department, are so incomplete as to be in some cases almost worthless for this purpose, and this has necessitated the making of a certain number of special surveys of railway and other lines with the object of furnishing the necessary framework for their construction.

'In the area included in map-sheet No. 119, great difficulty has been found in defining the boundaries of the several Palæozoic formations. Owing to the extensive deposits of clays and sands, rock-exposures are in many cases widely separated; and while advantage has been taken, as far as possible, of wells and borings, the thickness of the recent materials is often so great that in these the underlying rock has not

been reached. In all such cases the tracing of formation-lines has of necessity been effected by connecting the different and widely separated outcrops along their strikes. Valuable information has, however, been obtained from certain wells which have penetrated to underlying strata and from various quarries where the overlying soil has been removed. Ontario-*Cont.*

'In other places, the distribution of the drift, which has been uniformly from the north and north-west, has afforded some information. While therefore, in a country so widely covered with recent material as that between the St. Lawrence and the Ottawa rivers, it has not been possible to accurately define all the boundaries, it is believed that this has been done with a fair amount of success.

'The geological structure about Ottawa and for some miles to the south and east is somewhat complicated. Numerous faults occur, which, while generally rather local, have rendered the mapping difficult. Some of these separate the Calciferous from the Utica, others affect the Trenton and Black River formations, or separate the Trenton from the Calciferous. The tracing of some of these faults has been carried out as well as the overlying surface-deposits permit. To the south of this faulted area near Ottawa, the formations come in regularly, and it has been conclusively established that in the Ottawa and St. Lawrence area, in the counties of Prescott, Grenville, Dundas, Stormont, Russell and Glengarry, these formations occur in the form of a well-defined basin. In this area, although several small faults and low undulations are seen, the formations are fairly regular in their distribution. The highest beds yet recognized are the red shales referred to the Medina, and surrounding this area the grey fossiliferous sandstones and shales of the Lorraine were recognized at a number of points in the townships of Russell, Gloucester and Cumberland. Geology of vicinity of Ottawa.

'The Calciferous formation which first appears on the Rideau River near the Black Rapids rocks, about four miles south of Hogsback, extends without interruption across to the St. Lawrence at Prescott and down the north side of that river for some miles, being seen in the canal excavations at Iroquois. Several well-defined faults are seen at Hogsback, between the Chazy and the Black River formations, which extend for half a mile or more north of that point, following the course of the river. The measures are here broken across by another line of fault between the Trenton and the Black River that extends south-easterly from the north side of the Ottawa, in the village of Tetreauville, the beds of the latter formation being in places inclined at an angle of seventy-five degrees. To the south of Hogsback other faults Calciferous formation.

Ontario-*Cont.* occur, notably at the corner of the roads on lot I, ranges II and III, Gloucester. This faulted area involves the Chazy, Black River and Utica formations. To the south-east a heavy fault, which is probably connected with this disturbance is seen on lot 10, range VI. of the same township, where the tilted beds of the Calciferous are in contact with the Utica shales. To the south-east of this the surface becomes covered with heavy masses of sand and clay, and this dislocation is traced with difficulty, but it presumably extends through the north-east corner of Osgoode into the township of Russell, the regular succession of formations from the Calciferous upward appearing along the south side.

Faults south of Ottawa.

'To the south of Hogsback another fault is seen on lot 3, range II, of the same township, between the Chazy and Black River limestones, but before reaching the Black Rapids the succession of the Chazy shales on the Calciferous is regular.

Trenton basin.

'A long tongue of the Calciferous extends eastward from the main mass on the Rideau River into the northern part of the county of Dundas, continuing along the north line of the county to a point north of the village of Chesterville. This is conformably overlain on both sides by the shales of the base of the Chazy, which, on the north side of the axis, pass upward regularly through Black River, Trenton, Utica and Lorraine. On the south side, the highest beds seen belong to the Trenton formation, and these are well exposed about South Finch, the northern part of the Trenton basin in this direction being near the village of Crysler. The centre of the northern basin is near the middle of the township of Russell close to its eastern border, while the centre of the southern basin is found, apparently, near the middle portion of the townships of Kenyon and Roxborough. The exposures of the Black River formation, seen along the line of the Ottawa and Cornwall Railway, between Cambridge and Embrun, were useful in working out the structure of this part of the basin.

Formations along the St. Lawrence River.

'Along the St. Lawrence River, the construction of the new sections of the canals at Cardinal, Iroquois and at other points have furnished materials for fixing boundaries hitherto lacking, and in this way the approximate divisions between the Calciferous, Chazy and Black River formations have been obtained. Thus the beds of the former were noted in the bottom of the excavation at Cardinal and at Iroquois, where the clay covering is very heavy and where no data could be obtained at the surface. The town of Iroquois is apparently nearly on the eastern limit of the Calciferous on this shore of the river, since at Sheik Island the next recognized outcrop is of the dolomitic limestones at the base of the Chazy formation. Two miles north of this the Mille

Roches quarries are in Black River limestones. These quarries are extensively worked for stone for canal construction, and blocks of very large size and of excellent quality are here obtained, one solid layer having a thickness of nearly ten feet. A short distance north of this the limestones of the Trenton formation come in. Ontario–*Cont.* Mille Roches quarries.

'A re-examination of the quarries at Glen Robertson and at St. Justin was made and the rocks there found to belong to the Black River formation, though from a small collection of fossils made several years ago their age was then assumed to be Trenton. The railway at Glen Robertson is presumably near the line between the Trenton and the Black River, the beds of the former showing to the south and also to the west at Alexandria. The characteristic fossils of the Black River are abundant at the Glen Robertson quarries. Another Black River quarry is seen on the River à la Graisse in the south-eastern portion of Hawkesbury east, where they have a dip to the south-west at an angle of about ten degrees. They are here separated by a heavy fault from the Potsdam sandstone about two miles west of the village of Ste. Anne de Prescott. The latter formation extends thence north-east to Rigaud village and the line of fault continues from its contact noted above with the Black River to the foot of Rigaud Mountain, with which it may be connected. Glen Robertson quarries. Rigaud fault.

'This fault is an important one and has affected the continuity of the several formations over a considerable distance. The course of the fault is nearly north-west and the strata of the Trenton, Black River and Chazy, have been displaced along its course, for a distance of nearly nine miles.

'To the south of the Potsdam area, near Ste. Anne de Prescott, the Calciferous formation comes in in regular sequence, succeeded towards Glen Robertson by the Chazy and the Black River of the latter place already referred to.

'The distance east and west between the two great Calciferous outcrops, viz., that from Rigaud westward and that from the Rideau River eastward, north of Chesterville, is about thirty-six miles. The breadth of the Trenton basin between these points is about twenty miles, and this is overlain near the village of Maxville by Utica shale, which is regarded as another outlier of the great Utica area that extends easterly from the city of Ottawa nearly to the Vankleek Hill and which, in the townships of Cumberland and Russell, has a breadth of not far from eight miles. Utica shale outlier at Maxville.

'Throughout the greater part of this large area the formations lie in a nearly horizontal attitude. Around the margins of the Calciferous Anticlines.

Ontario-*Cont.*

axes there is a divergent dip of five to six degrees, so that the basin shape is well-defined. Several low anticlines are seen in the Calciferous, one of which was noted in the northern part of the township of Osgoode, about lot 15, range V., where the beds have reverse dips, to the north and south, of five degrees. A similar low anticline with a curving outline was observed to extend from the vicinity of Merrickville on the Rideau for several miles past Oxford Mills, the reverse dips being at the same angles. This anticline was traced for about ten miles till the strata became entirely concealed.

Embrun quarry in Black River limestone.

'High dips are, however, rarely seen and then only near lines of fault throughout the Palæozoic basin. The steep dips in the vicinity of Ottawa have been referred to, where they sometimes reach as high as seventy-five degrees. On the line of the Ottawa and Cornwall Railway, about half a mile south of Embrun station, in a quarry of Black River limestone holding an abundance of fossils, the angle of dip is ten degrees to the north-east, but this formation is overlain by the Trenton limestone a short distance east of Embrun village to the north-east of this point.

Quarries south of Ottawa.

'Few mineral substances are found in the area to the south of the Ottawa in economic quantity. Quarries are, however, numerous and are situated generally in the limestones of the Black River formation which has been found to yield the best quality of stone for building purposes. Others have, however, been worked in the limestones of the Calciferous, Chazy and Trenton, as also in the heavier sandy beds at the base of the Chazy, which are especially well suited for foundation work. There is a large quarry of this rock about two miles east of the village of South Mountain on lot 2, range I., Mountain Township. The most important quarries in the Chazy limestones are near the village of Winchester, on the road thence to North Williamsburgh. The rock here is used both for lime-burning and for building stone. On lot 7, range I., Winchester, there is an excellent quarry of flaggy limestone in layers of about six inches thick, from which flags of any required size can be obtained. This is owned by Mr. William Bolton. A similar flaggy limestone is seen in a quarry on lot 39, range VIII., Williamsburgh. These are near the base of the Chazy limestones, while most of the Winchester quarries are in the grayish somewhat nodular limestones belonging to the upper portion of that formation.

Quarries near Winchester.

Quarries near the St. Lawrence.

'The quarries in the Calciferous formation yield stone principally for local use. The stone is largely dolomitic, but the quarries are not extensive. Along the St. Lawrence east of Prescott, where this formation is extensive, several large quarries are however, found, and are

worked somewhat extensively. The principal quarries in the Black River limestone at Mille Roches, Glen Robertson, &c., have already been referred to. Ontario–*Cont.*

'Large and important deposits of peat are found at a number of points. Most of these are near railway lines, and could be easily operated for the manufacture of moss-litter or compressed peat-fuel. The Mer Bleue bog to the south of Ottawa, lying between the lines of the Canada Atlantic and Canadian Pacific railways, with an extent of several thousand acres, has already been referred to in a former report, and is one of the most important. Among other deposits of value may be mentioned the bog at Newington, through which the Ottawa and Cornwall Railway passes, which is said to be of excellent quality and of large extent. The Moorewood bog, situated about three miles north of Chesterville, is reported to have an area of about 1,000 acres and a depth of twenty feet in places, and can be readily drained. Another bog, with an area of about 400 acres and a reported depth of twenty feet, is found on the town-line between Oxford and Wolford, about three miles east of Merrickville on the Rideau River. Other bogs, some of large size, are found in the township of Osgoode, but these have apparently not yet been proved, though one of them at least is crossed by the railway from Ottawa to Prescott. The importance of these bogs as a possible source of supply of fuel is now being realized and inquiries as to their location are frequent. The large bog near Caledonia Springs has also a good location near the line of the Canadian Pacific Railway, which in fact crosses the western end, but no details as to the thickness of the deposit are to hand. Peat bogs.

'Mineral springs are quite common in this area. The character of the water varies, some of the springs belonging to the sulphur class, while others are saline and gaseous. Those in the more immediate vicinity of Ottawa as at Eastman, and at Borthwick's, and the Victoria springs, near the Montreal road, are already well known locally. The celebrated springs at Caledonia have long been a favourite place of resort. Other springs south of Winchester are very similar in character. The most of those in the central basin appear to derive their water from the Chazy. The Caledonia is found on the Trenton limestone, while those at Eastman are apparently underlain by the Utica or Lorraine shales. At this place there is a heavy body of clay, generally not less than forty feet in depth. Mineral springs.

'The work of the season began on May 4, and ended on October 4.'

QUEBEC.

Work by Prof. J. A. Dresser.

On the work done by him in connection with the special examination of Shefford Mountain, Professor J. A. Dresser sends the following preliminary note :—

Shefford Mountain.

'The examination of Shefford Mountain is now so far advanced that a detailed map and description of it are in course of preparation. It was stated in the Summary Report for the year 1898, that this is a mass of igneous rock about nine square miles in extent with an elevation of rather more than 1,000 feet above the surrounding country; the rocks being intrusive through strata of Cambrian and Cambro-Silurian age; that the intrusion is probably of the nature of a laccolite, uncovered by extensive denudation; and that the igneous rocks are of three, or possibly four, different ages of intrusion.

Areas of different igneous rocks.

'The work of the past summer, continued after a preliminary microscopic examination of the specimens previously collected, confirms these conclusions in their essential features and makes it possible to define the rocks with much greater accuracy and precision. The extent of each of the different classes of igneous rocks has been traced out as carefully as the nature of the locality and the means available permit. These rocks, exclusive of the later dykes, are now found to belong to three periods of intrusion only. The first in order of age is that which forms the extreme eastern part of the mountain, from McCutcheon corner to Morriseau's quarry, and also its most westerly portion about Coupland Lake. It is generally of a rather coarse granitic structure, but varies considerably in different parts. The chief mineral constituents are felspar (largely plagioclase), hornblende, augite and biotite, while apatite, magnetite and sphene are noticeable amongst the accessories. It may be generally classed as an augite-diorite.

First period of intrusion.

'An interesting section through the zone of contact with the sedimentary rocks was exposed for a time in the building of an aqueduct leading to the town of Granby. Here the texture of the rock is variable, hornblende becomes more abundant and very small amounts of nepheline and sodalite appear. Here, as in most parts of the original contact-zone at least, this rock passes into the rarer type essexite.

Second period.

'The second of these rocks is a highly felspathic syenite, the greater part of the area occupied by it consisting almost entirely of the peculiar orthoclase-albite intergrowth, microperthite. The other constituents, augite, hornblende or biotite, seldom constitute more than a very

small proportion of the rock, especially in the central part of the mass. But near the edges there is a considerable increase in the amount of the darker minerals, the character of the felspar is changed and microscopical amounts of nepheline appear, as well as larger sphenes. Quebec-*Cont.*

'This rock forms the central part of the mountain, breaking through the earlier igneous rock, and both on the northern and southern sides has been injected along the previous line of contact of that rock and the sedimentary slates. A marginal modification of it is seen in the rock of Dounan's quarry.

'The rock of the third age of intrusion is holocrystalline, but generally porphyritic in structure. Along its margin and in the numerous dykes given off from it, the groundmass is finely crystalline, chiefly of felspar and the porphyritic crystals, or phenocrysts, are prominent. But near the centre of the mass the texture of the rock becomes much coarser and the porphyritic aspect is less conspicuous. Hornblende is the most abundant bisilicate, although augite is occasionally present. A little sodalite can be seen by the unaided eye. Third period.

'This rock is generally inclosed by the syenite previously described, but for a distance to the south-east of Coupland Lake, it appears to have been intruded along the former line of contact between the two earlier igneous rocks. It forms most of the higher part of the mountain above Notts corner.

'A very brief examination of Brome mountain was also made. This mountain which is only four miles distant from Shefford mountain at the nearest point, occupies about twenty square miles. The exposures along most of the principal roads, that cross the mountain in different directions were visited, and specimens were obtained from other places, quarries, &c., that were not seen. Only one type of igneous rock was found, and this presented little, if any, variation in all the specimens seen. It is syenite which apparently differs from that of the second intrusion at Shefford, only in containing a considerable amount of nepheline.' Brome mountain.

Hudson Bay.

Mr. A. P. Low, during the sumer of 1898, explored the east coast of Hudson Bay from Cape Wolstenholme southward to Great Whale River, where he remained the following winter. An account of his exploration to that place was given in the last Summary Report. In continuation, Mr. Low writes as follows :— Work by Mr. A. P. Low.

'During the months of December and January, the days were too short and cold for extended field-work, and operations were confined to Winter at Great Whale River.

Hudson Bay —*Cont.*

short snowshoe tramps and trips with dog-teams in the vicinity of the Hudson's Bay post at Great Whale River, and to interviews with northern Eskimos, who, at that time, paid their annual visit to the post. A large amount of information was obtained from these people concerning the northern interior and the Belcher and other islands lying off the coast, as well as sketch-maps, which will in a manner fill the blank space on the maps of the north-western portion of the Labrador peninsula.

Journey northward in February and March.

'Early in February preparations for the spring work were begun, and it was decided that Mr. Young, my assistant, should make a micrometer survey of the coast between Richmond Gulf and Fort George at the mouth of Big River, so as to fix the position of Cape Jones. For this work he was provided with two Eskimo guides and a team of nine dogs, while J. Schupe accompanied him as assistant. Having started Mr. Young, I next prepared for my trip northward into the barren grounds, and left on the 23rd with two Eskimo guides and a team of twelve dogs, at the same time Lantz and Ford were sent inland with 800 lbs. of provisions, with instructions to store them at the second forks of Great Whale River, where they would be available on our trip up the river at a later date. We travelled slowly northward over very rough ice piled along the coast, and took three days to reach Little Whale River, when, by the advice of the guides we visited a band of Eskimos living on the ice about ten miles off the land, where they were employed killing seals in a great crack that extended far seaward. The band consisted of about sixty persons living in about a dozen houses made from blocks of the lightly packed snow lodged among the upturned ice along the crack. We borrowed a sleigh and seven dogs from them and continued our journey at a much increased rate.

Tree limit on the coast.

'On our way northward we met many Eskimos travelling to the Hudson's Bay post. They usually travel in small parties of two or three families, each with an overloaded dog-sled; they all greeted us cheerfully and asked for the customary present of tobacco. The northern tree-limit on the coast is just north of Richmond Gulf, beyond which we had to depend for fire on a precarious supply of drift-wood dug from beneath the snow, so that several nights our cotton tent was rather cold and we were obliged to cover up tightly in sleeping bags to keep warm.

Turn inland.

'On March 2, we left the coast, about ten miles north of the mouth of Nastapoka River, and quickly rising about 700 feet from the sea, passed eastward through a number of small lakes surrounded by bare

rocky hills that rose from 300 feet to 600 feet above the lakes, and were almost totally devoid of vegetation. This barren region continued about thirty miles inland from the coast, when the hills become less rugged and the valleys contain some soil on which clumps of spruce and larch grow. At first the trees are not a foot high, but soon increase to eight or ten feet in height, while the trunks are several inches in diameter, and afford a supply of fire-wood. Hudson Bay —*Cont.*

'Ten miles further on, we crossed the water-shed dividing the rivers of Hudson Bay from those flowing eastward into Ungava Bay, and descended slightly to Tasiagaluk or Eskimo Seal Lake. We followed the lake for about forty miles or about one-third of its length, but, being unfortunate in not finding the barren-ground caribou, although the snow on the lake was everywhere beaten with their tracks, we were forced to turn back for lack of food for the dogs. The Eskimos describe the lake as being over 100 miles long with several long narrow bays all having, like the main body, an east-and-west trend. In its widest part it does not exceed fifteen miles across, and towards its eastern end it gradually narrows into the Leaf River, which discharges its water into Ungava Bay. It is reported that there are no direct falls on the river, the natives being able to ascend it to the lake with their umiaks or large skin boats. The small shrub spruce and larch grow along the river-banks to within twenty-five miles of its mouth. Eskimo Seal Lake. Leaf River.

'The country surrounding the lake and along the river is comparatively flat, with low ridges of rocky hills rising from 50 feet to 200 feet above the general level. With the exception of a few small areas of dark basic rock, near the point where we turned back, only red granite was observed between the coast and Tasiagaluk. A track-survey was made of the route followed with considerable difficulty, as the thermometer ranged between–20° and–45° F. We were joined by Mr. Young on March 11 at Richmond Gulf, where he had just completed the survey of the coast, and we returned together reaching Great Whale River on the 13th. The men sent inland with provisions did not return until the 19th and reported great hardships from intense cold and deep snow. Country and rocks.

'We did not start up Great Whale River until April 3, owing to the deep, soft snow. The party consisted of myself, Young and three white men, without guides, and each hauled a sled loaded with about 300 lbs. of outfit and provisions. The work was very difficult and slow for the first week, owing to the deep granulated snow into which the sleds continually sank to the cross-bars. After the 12th the weather became soft with frequent rains, which caused much delay, and on the 30th we were obliged to stop work owing to the breaking up of the ice, Journey up Great Whale River.

Hudson Bay —*Cont.*

which forced us to leave the river and to travel overland to the coast; which we reached near the north end of Manitounuk Sound, returning to Great Whale River post, on the 5th of May.

Course of the river.

'The result of this trip was a survey of the north branch of the river to within a few miles of a large lake, that discharges by this river and also by the Little Whale River. The distance from the mouth of the river to where we left it is nearly 100 miles, which, together with fifteen miles on the Abchigamich Branch, represents the total survey made. The river, for about thirty miles from its mouth flows from the eastward, but then changes its direction, and from the Abchigamich Branch flows southward thirty-five miles. The Abchigamich comes from the north-east, while the valley of the main branch bends to the south-west from the forks, gradually turns west, and then northward parallel to, and about twenty miles inland from the coast.

Rocks.

'The region throughout is formed of rugged granite hills with the river flowing between them in a usually narrow valley. The river is frequently broken by falls and rapids all open when we saw them, and exceedingly difficult to pass with loaded sleds along the narrow margin of snow and ice adhering to the steep rocky walls of the valley. The country is generally wooded with small black spruce and larch.

Unseasonable weather.

'The river was clear of ice from the post to its mouth on May 12, this being the earliest break-up on record in the journals of the post dating back to 1860. The mild weather of the early part of the month was followed by cold stormy weather lasting into June, which greatly retarded our work of preparing the yacht for the summer's use. On June 1, we moved aboard the yacht ready to sail as soon as the ice left the coast. We sailed on the 5th, but had to return owing to an ice-blockade in the Manitounuk Sound, but the next day passed through, as the ice was moving out, and so reached the north end of the sound. The following day we proceeded northward, passing through much ice, and just reached the mouth of Richmond Gulf when the wind changed, jamming the ice tightly on to the coast, and so it remained for the next two weeks. Luckily Richmond Gulf was free from ice, except a few large cakes about its outlet, and we were able to make a survey of that large salt water lake and also to thoroughly examine the rocks about it.

Richmond Gulf.

'Richmond Gulf is a triangular body of salt water, widest at its southern end, where it measures eighteen miles from east to west, while its greatest length is twenty-three miles from north to south. It is separated on the west side from Hudson Bay by a narrow ridge of stratified rocks capped by trap. Facing the gulf, these rocks rise

in cliffs from 500 to 1,500 above the water. The stratified rocks and the traps also form high cliffs along the other shores and on the islands of the gulf, except where arms of intrusive granite come out in a few places along the southern and eastern shores. A deep narrow break in the ridge, near the south-west angle of the gulf affords a connection between the gulf and sea, and through it the water rushes with great velocity with the rise and fall of the tide. The entrance is dangerous for small craft, and is rendered more so from the violent squalls that break down over the cliffs whenever the wind is from the sea. Small trees of black and white spruce and larch grow about the margin of the gulf, and on its east side rise nearly to the summit of the hills, in marked contrast to the barren coast of Hudson Bay outside the gulf. A few clumps of balsam poplar were seen on the islands, proving this species to grow almost to the limit of the spruce. Hudson Bay —*Cont.*

'The rocks about Richmond Gulf, with the exception of large masses of intrusive granite on the south and east sides, are stratified sediments. Everywhere dark, red and green sandstones, with interbedded felsitic shales, are seen overlying a coarse, light-coloured grit or arkose, containing pebbles and fragments of felspar and quartz. These beds are usually greatly disturbed, and are associated with much dark-green trap and diabase, both in sheets parallel to the bedding-planes, and in large, more or less vertical dykes, cutting the bedded rocks. The dark sandstones and shales appear to represent the lower members of the so-called Cambrian of Labrador, and towards their top are probably equivalent to the iron-bearing rocks of the Nastapoka Islands, which lie along the coast outside Richmond Gulf. Although these shales and sandstones are very ferruginous, they were not found to be sufficiently rich in iron to make them commercially valuable. Rocks of shores. Cambrian series.

'The lower part of the high ridge separating the gulf from the sea, is composed of this series, and unconformably upon them rests a series of cherts, black shales and siliceous dolomitic limestone, capped with a great thickness of amygdaloidal trap. This series is thickest to the south, and thins out towards the north end of the gulf, where only about 50 feet of siliceous limestone intervenes between the dark sandstones and the capping of trap. The limestones immediately below the trap form a ledge which may be followed from the north end of Manitounuk Sound to beyond the head of Richmond Gulf, a distance of over seventy-five miles. The limestone contains many old cavities, now partly filled with quartz and usually containing much pyrite, and in a number of places galena has been found associated with the Galena.

Hudson Bay —*Cont.*

minerals. These lumps of galena vary from one inch to fifteen inches in diameter, and may be found in some places, in sufficient quantity to be profitably worked. Such a locality has been reported to have been found last summer between the Little Whale and Second rivers, but I did not see it, having left the locality previous to its discovery.

Return to Great Whale River.

'On June 22 the ice along the coast opened sufficiently to allow us to reach the mouth of Little Whale River, eight miles south of the outlet of Richmond Gulf. Here we were again ice-bound until July 1, when an off-shore wind opened a channel and enabled us to reach Great Whale River the following morning. The coast between the rivers is high and rocky, without any harbours, until Manitounuk Sound is reached, where good shelter is found behind the islands. From Boat Harbour, seven miles north of Great Whale River, to the head of the sound, the shore is occupied by a narrow strip of cherty limestone resting unconformably upon gneiss and granite. The Manitounuk Islands are made up of stratified cherts, dolomites and shales, capped with trap, and these also occur along the shore to the northward of the sound, as far as the head of Richmond Gulf. The coast and islands are partly wooded with clumps of black spruce that grow in the valleys and protected portions of the cliffs.

Impossible to reach outer islands.

'We were blocked by ice at Great Whale River until the 7th, when we sailed southward, and for the next three days were hazardously employed in working through the heavy ice until we reached Long Island, after which we had no trouble with ice. I had intended to visit the Belcher and other islands lying from 60 to 100 miles off the mainland, and forming a chain extending northward from opposite Great Whale River to the neighbourhood of Portland Promontory, but was advised not to attempt it by the Eskimos, on account of the ice. They predicted that the ice would not leave the bay until late in August, and would prove very dangerous to the yacht, owing to the strong tidal currents among the outer islands. Their predictions proved correct, for although the ice left the coast shortly after we proceeded south, the Hudson's Bay Company's ship *Lady Head*, reported that ice was encountered all the way down Hudson Bay to Bear Island in James Bay, where open water was reached on the 20th of August.

Great Whale River to Cape Jones.

'The distance from Great Whale River to Cape Jones at the entrance to James Bay is ninety miles, and the trend of the coast is about south-west. Southward of Great Whale River the land slowly decreases in elevation, and with the exception of the White Bear Hills, which reach the coast about thirty miles north of Cape Jones, the shore is comparatively low, and the country inland is covered with

rounded hills never more than 400 feet in elevation. For about forty miles from the river a narrow strip of cherty limestone appears to have been shoved up over the underlying gneisses. It is broken transversely in several places, and then affords fine boat-harbours. The remainder of the coast is occupied by gneisses and granites. Long Island and the smaller islands lying off this part of the coast are all formed of limestone, cherts and shale, similar to the rocks met with along the coast farther north. On Long Island these rocks are capped with trap, on the west side. The limestones and cherts are usually highly charged with pyrites, and on Long Island a vein of anthraxolite twelve inches wide was discovered by prospectors, who describe it as cutting the black shales. Hudson Bay —*Cont.*

'Leaving Cape Jones, we sailed down the east coast of James Bay, passing by crooked channels between numerous low islands, usually formed of coarse drift and shingle, with occasional groups of rocky islets, in which low ridges from the mainland were continued seaward. It would be very dangerous and almost impossible to follow the inner channels between the islands without a competent native pilot, as the channel is often very narrow and crooked, with submerged reefs and boulder ridges everywhere. We arrived at Fort George, at the mouth of Big River on July 13.

'The country between Cape Jones and Fort George is very flat, and the rocks are hidden beneath a mantle of drift, except where low ridges of granite hills rise a few feet above the level of the plain. Wastikyn, a peninsula a few miles north of Fort George, although only about 200 feet high, forms a prominent land-mark owing to the flatness of the surrounding country. The tree-line, along this part of the coast, extends almost to the ends of the points, leaving only the outer islands barren. The rocks met with are crystalline schists, and intermixed masses of granite. A number of large dykes of diabase cut all the rocks, and are evidently much newer than them. No deposits of minerals of economic value were found in this area. Cape Jones to Fort George.

'From Fort George we continued the survey southward along a coast very similar to that just described, but somewhat more broken and rocky, while a majority of the islands are also rocky. At Comb Hills, a low ridge of granite on the mainland terminates in a string of islands rising about 100 feet above the sea. At Paint Hills, a band of dark-green trap, about four miles wide, forms a chain of high islands running north-east and south-west, which extends about eight miles beyond the general line of the coast. This band also forms a small group of islands, called Solomon's Temples, which lies about six miles outside the Paint Islands. The highest summits on the Paint Coast south of Fort George. Paint Hills.

Hudson Bay —*Cont.*

Islands are about 300 feet above the sea-level. The trap forming these islands has been squeezed by the intrusion of syenite, which cuts it in large dykes and masses. The result of this squeezing is that in many places the trap has become foliated vertically, and now appears as well banded chloritic and hornblendic schists, while in other places it retains its massive character and often shows its original diabasic structure. These rocks usually contain much pyrite, especially where most schistose, and some of the bands appear to be sufficiently large and rich for working. In several of the syenite dykes cutting the trap,

Cape Hope.

plates of molybdenite were found. At Cape Hope, a similar band of trap forms one large and several small islands. This trap does not contain a large amount of pyrites, and no important economic masses were seen. The large island is about 300 feet high, and wooded to its summit.

Rupert House.

'The mouth of East Main River was reached on August 1, and we again changed pilots, sending the old one back to Fort George. We finished the survey at Rupert House, at the mouth of Rupert River, on the 19th, and then crossed the south end of James Bay to Moose Factory, where we arrived on the 21st.

'The coast between the East Main and Rupert rivers is very low, with wide mud-flats bare at low-tide. The water deepens very slowly, and it was dangerous to approach within a mile of the shore. In Rupert Bay the bottom has been filled up by the sand brought down by the Rupert and Nottaway rivers, and outside the narrow channel leading up the middle of the bay, not more than a fathom of water covers the wide flats at low-tide.

'Sherrick Mountain, situated on a peninsula at the mouth of Rupert Bay, is a very prominent landmark, rising as a granite hill about 400 feet above the water. The rocks met with along this portion of the coast are largely mica-gneisses, usually carrying much garnet, and probably including metamorphosed bedded rocks. They are frequently cut by dykes and masses of granite-gneiss, the irruption of which probably caused the alteration of the rocks cut by them.

Reach Moose Factory.

'At Moose Factory the yacht was stripped, and arrangements were made with the Hudson's Bay Company to have it hauled out and safely housed, so that it might be available for future use. The specimens collected were packed and shipped to Ottawa, via London in the *Lady Head*, and preparations were made for our canoe trip up the Moose River to the Canadian Pacific Railway. While the rest of the party were so engaged, Mr. Young made a micrometer survey from the factory to where a meridian line of the Ontario Government crossed

the river, some thirty miles up stream, in order to fix the longitude of Moose Factory. Hudson Bay —*Cont.*

'We left Moose Factory on the 29th in a large canoe, with four Indians to assist in poling up stream, and reached the railway at Missinaibie on September 12, having been delayed by the very low water in the river below the Long Portage. The following day we reached Ottawa where the party was disbanded.

'Among the results accomplished by the exploration may be mentioned a survey of the entire east coast of Hudson Bay, from Cape Wolstenholme, at the entrance of Hudson Strait, to Rupert River near the south end of James Bay; together with explorations inland on great Whale River, and to Eskimo Seal Lake. The numerous observations of the rocks show that crystalline schists, gneisses and granite occupy the greater part of the area examined; and that a band of unaltered rocks, belonging to the so-called Cambrian of Labrador, occupy most of the coast and islands from Portland Promontory to Cape Jones, while other areas of these rocks appear to have been inclosed and altered by later intrusions of granite. The unaltered rocks of the Nastapoka Islands contain large beds of iron ore very similar to the valuable ores of the south shore of Lake Superior. Results of the work. Iron ore.

'A pamphlet on the diamond fields of the great lakes, by Prof. W. H. Hobbs, was received at Moose Factory, too late for attention on Hudson Bay; but, in response to the suggestion of the Director, special observations were made while ascending Moose River on the drift and glacial striæ. These in my opinion confirm the view that the ice moved in a south-west direction from Hudson Bay, and therefore tend to show that the source of the diamond-bearing drift of Wisconsin and Michigan may be in the Hudson Bay region, or in the country to the east of the bay, where there are localities favourable to the occurrence of diamonds, notably the trap-capped carbonaceous shales of Long Island and the islands of Manitounuck Sound. Possible source of diamonds.

'The observations of glacial phenomena show that the peninsula of Labrador was completely covered with ice; that the centre of dispersion of the ice was first in the southern interior, and that it moved northward, finishing in the northern interior. The evidence of raised beaches and terraces show that the land has risen at least 700 feet since glacial times, but there is no evidence of an appreciable rise going on at present.

'Attention may be directed to the valuable fisheries of the east coast of Hudson Bay—Arctic salmon are plentiful in the northern waters as far south as Cape Jones, while trout and whitefish may be taken Fisheries

Hudson Bay —*Cont.*

abundantly along the entire coast. The existence of cod in Hudson Bay may prove of great value, but requires further investigation.

'A complete series of weather observations was kept throughout the entire trip and collections of plants, eggs, birds and other natural history specimens were made.'

NEW BRUNSWICK.

Work by Mr. R. Chalmers.

In the early part of the winter of 1898-99 some time was spent by Mr. Chalmers in revising proofs of his report on the surface geology and gold-bearing deposits of south-eastern Quebec. The remaining winter months were occupied chiefly in compiling the information obtained in the field during the previous summer and in laying it down on the map, No. 1, N. W., of the New Brunswick series—the Fredericton sheet.

Surface geology.

During the past summer, Mr. Chalmers continued the mapping of the surface geology of New Brunswick, as detailed by him below :—

'On the 30th of May I received your instructions to proceed again to New Brunswick and continue investigation on the surface geology of the area of sheet No. 2, S. W. (the Andover sheet) which lies immediately to the north of the Fredericton sheet, and if possible, complete the work on it at an early date. This has been accomplished, and the two sheets (No. 1, N. W. and No. 2, S.W.) will now be prepared for publication, accompanied by a report on the surface geology, forest growth, economic minerals, &c., of the district embraced therein.

'My assistants in the field were Mr. L. P. Silver, and, for some weeks in the autumn, Mr. W. J. Wilson of the Survey.

Special points investigated.

'The surface geology of the area embraced in the Andover sheet and adjacent districts is of a very interesting character. Some of the more important matters pertaining thereto, which have been investigated and studied during the season, are,—(1) the occurrence of alluvial gold in the eastern branches of the Tobique River, more especially the Right Hand Branch and the Serpentine ; (2) the physiography and elevation of the region ; (3) the character of the surface deposits and their relation to the soils and subsoils, and (4) the forest growth and the distribution of the various species of trees found growing within the area.

Deposits of St. John valley.

'In June and July a detailed examination of the deposits in the St. John valley and along its tributaries throughout the counties of Carleton and Victoria was made, partly from the roads and partly by

canoe. The glaciation was studied in every detail. No boulders referable to the Laurentian region to the north of the St. Lawrence, were observed within the area of the two map-sheets under examination. Heavy beds of boulder-clay occupy the valley of the St. John, but no interstratified materials were found in them, such as occur on the south side of the St. Lawrence valley in south-eastern Quebec, though in some places these beds attain a thickness of 50 to 100 feet. Great banks or moraines have been thrown down in the valley by the ice of the glacial period, partially filling it in places and forming drift-dams after the ice withdrew. These held up the river to a high level at the latter stage of the Pleistocene, and appear to have been the cause of the formation of the higher terraces now found along both slopes of the valley. New Brunswick—*Cont.*

'In a previous report these terraces have been described in some detail. The highest are immediately below Grand Falls; but in other places where constrictions or sharp bends occur in the valley, the drift-dams referred to, or glacial dams, which may have existed here at the close of the ice age, caused these terraces to be produced, at levels varying from 50 feet to 200 feet above the present river-bed. The succession in the terraces, like steps on a slope, indicates successive levels at which the river stood as it trenched its channel anew in the valley-drift since the glacial period. The terraces have all a slope down stream, and are seldom more than a half a mile to a mile long, generally much shorter. Terraces.

'During the month of August I took a few days to examine a supposed occurrence of iron, and a copper deposit on the north side of the Restigouche River near Campbellton, N.B. The site of the iron was at Little River, P.Q., on the Oatman farm, about eight miles from the Restigouche. The iron was found in a boring made for water to a depth of fifty-five feet. It was metallic iron, in small grains and pellets, and no other conclusion could be formed than that some iron implement or perhaps a part of the drill itself had dropped into the bore-hole. Examinations near Campbellton.

'The copper deposit is in the valley of the Scaumenac River, five or six miles from the mouth. The ore occurs as green carbonate and native copper in small stringers or grains, associated with calcite and some other minerals resembling zeolites. These occupy cracks and fissures in trap rocks, and appear to be irregularly distributed through them in a thin and scattered condition along a zone or band ten to fifteen feet wide, trending nearly east-and-west. This mineralized zone is near the contact of the trap rocks (felsites, diabases, &c.) with the Silurian limestones and slates. Occurrence of native copper.

New Brunswick—*Cont.*

'The zone crosses the river and apparently extends into the bank on both sides, but how far could not be determined. Some blasting had been done and a small quantity of ore had been taken away, but no work was going on at the time of my visit. The mode of occurrence of the copper as a secondary mineral formed in the fissures and joints of the intrusive rocks, apparently subsequent to their cooling and consolidation, would seem to indicate that it may be more than a mere local deposit in the river-valley. Whether it occurs in paying quantities, however, is not known, no development work having yet been attempted.

Gold in New Brunswick.

'*Alluvial Gold in New Brunswick.*—Reports concerning the occurrence of gold in the alluviums of the Serpentine River having been current in western New Brunswick for some time, it was considered advisable, when we were in that vicinity, to ascertain the facts. In the month of September, therefore, when the rivers were supposed to be lowest, I ascended the Right Hand Branch of the Tobique and the Serpentine with a log canoe and Mr. Manzer Giberson as guide, and explored the last-mentioned river, examining and washing the gravels in its bottom at a number of points. Fortunately Mr. Solomon Perley, of Woodstock, with two men, was there prospecting at the time, and to him I am indebted for much valuable information and assistance. He kindly pointed out to me a number of places where he had obtained alluvial gold, some of which we tested, but other new localities were also examined and a series of trials made which proved the existence of the precious metal in the alluviums, both below and above the Big Falls. Though no rich diggings were discovered, yet a fair showing of gold was found in several places.

Serpentine River.

'The Serpentine River flows in a westerly course into the Right Hand Branch, a tributary of the Tobique, the distance from where the latter joins the St. John River to where gold occurs being from eighty to eighty-five miles. Mountains 2,000 feet or more above the sea bound the Serpentine valley, which is itself in the gold-bearing district, from 1,000 to 1,100 feet in elevation. The country is rugged and broken and heavily wooded, and the river is extremely difficult to navigate with canoes, owing to waterfalls, rapids and the number of large boulders strewn along its bed.

Gold-bearing gravels.

'The character and mode of occurrence of the gold-bearing alluviums here are closely similar to those of other auriferous regions, notably the Chaudière valley, in the province of Quebec; and the succession of the beds, observed in several places, is as follows, in descending order:—(1) Coarse river-gravel, with boulders a foot in diameter and less; (2) fine gravel in deposits of greater or less thick-

ness, lying on bed-rock, sometimes oxidized and containing gold, and (3) rock, often with jagged, broken surfaces, which contains gold in the crevices. New Brunswick—*Cont.*

'In one place about two miles above the Big Falls, however, in what seemed to be an old channel of the river on the north side, the following series was noted in a pit opened by Mr. Perley :—(1) Fine river sand or loam, from one to two feet thick ; (2) sandy clay, with rusty, gravelly layers, about eighteen inches or two feet in thickness. Gold colours were sparingly met with in this. (3) Decomposed, talcose slates, fifteen inches, but the bottom was not reached. Colours of gold were also seen in this material.

'Alluvial gold has been found along the Serpentine from a point about two miles above its junction with the Right Hand Branch nearly as far up as the "dead-waters," which are about twelve miles from the mouth. But it seems to be more plentiful above the Big Falls than below. These falls are about eight miles and a-half up the Serpentine. Coarse gold has been found there in pieces weighing from two to six grains. At the time of my visit, however, but little prospecting had been carried on in the alluviums, except in the bed of the river and at a few places in the banks, and nearly all the washing had been done by the ordinary process of panning. Since then Mr. Perley has extended his examinations as far up as the "dead-waters" mentioned, and reports having found both coarse and fine gold, from three miles and a-half to four miles above the Big Falls. Places where gold is found

'Gold from the alluviums of Silver Brook, a small stream flowing into Nepisiguit River about three miles below Third Nepisiguit Lake, was also shown me ; and I have been informed that gold also occurs in the Little South Branch, the next tributary to the east. In the beds of these streams no exploratory work has been done, however, further than washing with a pan.

'Prof. H. Y. Hind, in 1865*, reported alluvial gold also from Campbell River, Long Lake, the Little South-west Miramichi, and from the ridge between the two last-mentioned waters. It was likewise reported from Blue Mountain Brook.

'Taking all the facts regarding the occurrence of alluvial gold in this part of the province into consideration, it seems probable that the precious metal is to be found in the valleys of a number of the rivers and brooks flowing into the Right Hand Branch of the Tobique, and into the upper part of the Nepisiguit from the south. But the gold in these is extremely scattered, though, so far as can be ascer- General conclusions.

* A Preliminary Report on the Geology of New Brunswick, 1865, pp. 223-4.

New Brunswick—*Cont.*

tained, entirely of local origin. Nor has it yet been discovered in paying quantities. Judging from the specimens obtained, and from the character of the alluviums in which it occurs, however, it does not seem unreasonable to suppose that in some spots, at least, deposits may eventually be found that will be profitably wrought. More systematic exploration is required, not only in the valley of the Serpentine, but in the beds of the small tributaries flowing into it from the north, such exploration being directed more particularly to ascertaining the limits of the auriferous alluviums, and the localities where they contain most gold; also to further, testing the quartz veins at and above the Big Falls. Sluicing should likewise be more generally undertaken, especially at these falls and for two or three miles above them. The flats on either side of the river might also be more thoroughly examined, as in some places they evidently have old filled-in channels beneath, in which gold has probably been more plentifully distributed than in the present river bed.

Source of the gold.

'The original source of the gold has probably been in that portion of the wide band of pre-Cambrian rocks lying between Campbell River on the south and the Nepisiguit River on the north. These consist of schists and slates, often chloritic, or talcose with some quartzites. Intrusives frequently occur among them, and quartz veins are numerous. Gold has not yet been discovered in these quartz veins, but grains, or small nuggets, with quartz attached were met with in the alluviums. A small three-stamp mill has been erected in the Serpentine valley about six miles from the mouth of the river, and some work was done with it in testing the quartz veins in the vicinity; but so far as I could learn the results were uncertain.

'Black sand is abundant in the alluviums of some parts of the Serpentine and contains fine gold, though so far as examined, only in small quantities.

'The average gradient of the Serpentine River for the lower ten miles of its course is from 45 to 50 feet per mile, with two or three waterfalls in that distance. The quantity of water is amply sufficient for sluicing throughout the whole summer, and also for hydraulic work.

Other reported occurrences.

'Later in the autumn a visit was made to the Nashwaak and Cross Creek district, where gold was reported to have been discovered in quartz veins a year ago. In consequence of this report a large number of mining claims were located here in the winter of 1898-99. During the past summer some prospecting was done, but I could not learn that any gold had been found. At the time of my examination of the district I was fortunate in meeting with Mr. Chas. Welch, a

Klondike miner, and we carried out the exploration together. No gold was found by us at Cross Creek, either in the alluviums or in quartz; but in the Nashwaak valley, near Stanley village, a few very fine colours were panned out of the sands and gravels. If this gold belongs to the alluviums of the Nashwaak, it must have been transported a long distance, perhaps from the head of the river, or from the South-west Miramichi, it is so finely comminuted; but it is not unlikely that it may have been dropped by prospectors and others, who appear to have been washing and panning for gold in this valley at various times within the last thirty or forty years. New Brunswick—*Cont.*

'*Physiography and elevation.*—The physiography of that part of New Brunswick lying within the area of the two map-sheets referred to, presents great diversity. The surface, generally speaking, may be characterized as undulating, except on the divide between the St. John and the upper South-west Miramichi, where a rugged mountainous country exists, trenched by numerous rivers and brooks. The higher parts of this watershed attain altitudes of 1,200 or 1,500 feet above the sea. To the north-east, and beyond the limits of the Andover sheet, the region has much the same topographical features as above noted, and increases in height north-eastward as far as the head-waters of the Little South-west Miramichi, where we reach the most elevated portion of the province. Topographical features of country.

'The area referred to forms the south-west part of a wide irregular belt trending north-east and south-west, sometimes called the highlands of New Brunswick, the length of which is over a hundred miles and its width from thirty to forty-five miles. The south-west limit is within the area of the Andover sheet, and near the head of the South-west Miramichi, the north-east is at the sources of the Tête-a-gauche and Upsalquitch rivers. Transversely, it extends from the Little Tobique River and Nictor Lake to the North-west Miramichi waters. Though limited tracts contain arable land, most of it is unfit for settlement, and covered by forest. It is a country of lakes and rivers, with mountains, often bare and precipitous, that rise from 2,000 to 2,700 feet above the sea. Game and fish are plentiful, and it has already acquired a reputation as a sporting ground. It is also one of the principal sources of the rivers and of the water-power of the province. For a forest and game reserve and provincial park it can scarcely be equalled. Though protected to some extent by general provincial regulations, yet forest fires and unlawful destruction of game are not infrequent. A marked increase in the number of moose, deer, caribou and other wild animals has taken place there within the last decade, however, and salmon have likewise become much more Highlands of New Brunswick. Protection of forest and game.

New Brunswick—*Cont.*

plentiful. This shows what can be done by protection. The time will come eventually when all the arable and timber lands of the province, which are accessible will be taken up and deforested. The large central area referred to can scarcely ever be utilized except for its timber, game and water-power. Some further restrictions besides those now in force respecting the fauna of this area, and the products of the forest, especially such as would tend to conserve the younger growth of trees, prevent the spread of forest fires, and check the indiscriminate killing of the wild animals and birds, would be of immense benefit to New Brunswick in the time to come.

Arable lands in Carleton and Victoria.

'*Agricultural character.*—The character of the soil in Carleton and Victoria counties is excellent, more especially in the St. John and Tobique valleys. On the west side of the St. John the whole country between Woodstock and Aroostook westward to the International boundary is thickly settled and under cultivation. On the east side the settlements extend back from the river twenty or twenty-five miles throughout the area of the Andover sheet. The tract of cultivable land referred to in the Tobique valley extends from the Red Rapids settlement to the Blue Mountains, and indeed, as far as Nictau. In the upper part of the valley, however, only the river-flats and terraces are cleared and under cultivation. A third area, which is well settled and contains a large number of good farms was observed along the Nashwaak River, Cross Creek, and crossing the country by the Taxus River to Boiestown on the South-west Miramichi. The district to the east of the Tobique valley, drained by the upper part of south-west Miramichi river, is unsettled and still in a wilderness condition, and is the scene of extensive lumbering operations.

Fertility of Silurian area.

'The Silurian area of north-western New Brunswick is occupied by some of the best land for agricultural purposes to be found in the province, except, perhaps, that resting on the Lower Carboniferous sediments. The excellent character of the soils in the St. John valley between Woodstock and St. Francis is mainly due to the fact that they are derived from the underlying Silurian rocks. The northern portion of the province is also occupied by soils resulting from the decomposition and waste of these Silurian limestones and slates. Large tracts of good land are found in this wide belt throughout. Its general character is shown by the farms in Madawaska and Victoria counties, and by those along the lower settled portions of the Restigouche valley. This large Silurian area is still mostly covered by the original forest growth. There are, however, many stony tracts in these uplands, the rocks being frequently traversed by dykes of intrusives, which, in their disintegration, have yielded boulders and coarse material to the soil. Notwith-

standing this mixture of stony *débris* with the calcareous soil, however, and the prevalence of early frosts in some localities, these uplands will offer an inviting and ample field for settlement when they are made accessible by roads. New Brunswick—*Cont.*

'Towards the close of field-work, Mr. Wilson made an examination of the district along a portion of the South-west Miramichi valley, still wooded, by following some of the lumber roads. He was thus enabled to sketch in the topography and forest-covered areas, and measure the elevation of the country by aneroid.

Professor L. W. Bailey was again employed in New Brunswick during the summer in making some special examinations of the so-called great slate belt of the province, also, for a part of the time, in obtaining specimens of New Brunswick minerals for exhibition at Paris. His report is as follows :— Work by Prof. L. W. Bailey.

'In accordance with your instructions, received in May last, the early portion of the summer was mainly directed to obtaining specimens of economic minerals to form a part of the Canadian exhibit at the Paris Exposition of 1900. With this object in view, in addition to extensive correspondence, personal visits were made to all points which were thought likely to furnish materials suitable for this purpose, and arrangements were entered into for the supply of suitable exhibits. The following list will indicate the nature of the articles obtained :— Specimens for Paris Exhibition

Iron.—Hematite—Jacksontown, Carleton Co.
Limonite—Bog iron—Sunbury Co.
Nickel—Pyrrhotite—(nickeliferous)—St. Stephen.
Antimony—Stibnite—Prince William, York Co.
Manganese—Pyrolusite—Markhamville, Kings Co.
Wad—Dawson Settlement, Albert Co.
Wad—(bricquetted) Dawson Settlement, Albert Co.
Bituminous Coal—Grand Lake, Queens Co.
Albertite—Albert Mines, Albert Co.
Bituminous Shale—Caledonia, Albert Co.
Peat—Kouchibouguac Harbour, Kent Co.
Red Granite—St. George, Charlotte Co.
Black Granite—(mica-diorite)—Bocabec, Charlotte Co.
Gray Granite—Spoon Island, Queens Co.
Freestone, gray—French Fort Quarry, Newcastle, Northumberland.
Freestone, red—Sackville, Westmoreland.
Freestone, brown—Wood Point, Westmoreland.
Freestone, olive—Rockport, "
Limestone—Randolph, St. John Co.
Millstones and Grindstones—Newcastle, Northumberland Co.
Pulp-stone, Scythe-stones, &c. " "
Serpentine marble or Verde antique—St. John.
Marble—White dolomite—Randolph, St. John Co.

New Brunswick—*Cont.*

Graphite—Suspension Bridge, St. John Co.
Dolomite, for use in pulp manufacture—St. John
Infusorial Earth—Land's End, Kings Co.
Gypsum—Hillsborough, Albert Co.
Salt and Brine—Penobsquis, Kings Co.

Notes on mineral industries.

'To this enumeration may be added a few notes respecting the present condition of the deposits represented and their mode of presentation :—

Iron.

'*Iron.* Nothing is at present being done in the production of iron. The principal specimen sent to the exhibition was a large block of hematite from the well known deposits near Jacksonville, in Carleton county, formerly worked and still commonly known as "Woodstock ore." The associated specimen of bog-iron represents the large bed of such material found near Burton in Sunbury county, and of which more or less was used in the manufacture of the Woodstock iron.

Nickel.

'*Nickel.*—Since the publication of the report upon the mineral resources of New Brunswick (1898), wherein full particulars are given of the occurrence and composition of the nickeliferous pyrrhotites of St. Stephen, attempts have been made to obtain further information as to the value of the latter. A considerable quantity was in the first instance sent to England to be treated upon a large scale. The result was unsatisfactory, the percentage of nickel being deemed too small for profitable extraction; but as this percentage was also somewhat variable, the belief was entertained that by further exploitation, ores might be found capable of affording a better yield. To test this point, orders were given for the sinking of trial shafts to a considerably greater depth than had previously been reached, and it was from one of these that the block sent for exhibition was obtained.

Antimony.

'*Antimony.*—The deposits of this metal at Prince William, in York county, still remain unworked, though negotiations with a view to the purchase and development of the property have been made. The specimens forwarded for exhibition are pure stibnite, and fairly represent the quality of the ore, of which, no doubt, an abundance exists. Specimens of native antimony, such as were found during the prosecution of the work, cannot now be obtained.

Manganese.

'*Manganese.*—The specimens sent from Markhamville are a good representation of the very rich ores formerly mined in that locality, but in connection with which no recent work has been done.

'The ore from Dawson setttlement, on the other hand, though only bog-ore or wad, is now being extensively removed, its value being found in its adaptibility, when compressed into bricquettes, for the manufacture of ferro-manganese and steel, for which purpose it has during the last

year been sent to the iron works at Bridgeville, N.S. The machinery first erected for the treatment of the ore having proved inadequate in some respects, an enlargement of the latter is in contemplation or has already been introduced. New Brunswick—*Cont.*

'*Bituminous coal.*—No important change in the conditions or amount of output has occurred during the last year, the vicinity of Grand Lake in Queen's county being the sole source of supply. The general question, however, of possible coal-production over other parts of the New Brunswick coal-field has received considerable attention, and will be made the subject of discussion in the report of which this is anticipatory. The facts obtained all emphasize the necessity of systematic borings along the eastern sea-board of the province, or along the line of the Intercolonial Railway, as affording the only possible way of removing all doubt as to the nature and capacity of the coal measures in that region. Coal.

'Borings for coal at Dunsinaine have been continued, but at new locations, and are still in progress. In one of the borings thus made two seams of coal were passed through, one of 24 inches, at a depth at 170 feet, the other of 26 inches, at a depth of 183 feet. The former, on incineration left 19·56 p.c. of ash, the latter 38·59 p.c., as reported by Dr. Hoffmann.

'*Albertite.*—No actual mining of this interesting material has been undertaken during the past year, nor are any facts known which would warrant any considerable expenditure in this direction. In connection, however, with the explorations undertaken by the New Brunswick Mining Association, with a view to determine the presence or otherwise of petroleum, the supposed original condition of the albertite in southern New Brunswick, numerous interesting observations relative to the substance have been made, and, it is hoped, may be available for a later report. They tend to confirm the views previously expressed by the officers of the Geological Survey, as to the origin, condition of occurrence and distribution of the mineral in question. Albertite.

'*Bituminous shale.*—Interest in this substance has also been revived during the past year, and considerable quantities have been removed for export, the company formed for this purpose being known as the Baltimore Coal Mining and Railway Co. It is proposed to test its capacity, not only as an oil-producer, but in connection with the manufacture of cements and in other ways. Bituminous shale.

'The explorations referred to above, in connection with albertite and petroleum include the study of the bituminous shales, which are,

New Brunswick—*Cont.*

as far as known, the source and carriers of both. As, however, albertite is found not only below the shales in pre-Cambrian rocks, but also above them, penetrating Lower Carboniferous gypsums as well as sandstones of the Coal Measures, it is hoped that places may be found where, owing to the non-removal of the sandstone or other cappings originally confining the petroleum, the latter may have escaped oxidation, and thus have been left in its original fluid condition. For the purpose of testing this point, boring operations have been and are now being carried on in the vicinity of Moncton.

Granite.

'*Materials for the purposes of construction.*—The granite industries at St. George have, during the last year, been more than usually active, a fact which made it somewhat difficult to obtain therefrom adequate representation for the Paris Exhibition. It was hoped that as a result of a meeting held in St. George in May, at which representatives of the several companies working in that place were present, a large trophy to which each company should contribute, would be prepared, but owing to the presence of other engagements, this was subsequently found to be impossible, and the desired representation was left to Messrs Milne, Coutts & Co., by whom, however, a very creditable exhibit is made.

'In addition to the special exhibit referred to above, cubical blocks of red granite, six inches to the side, and variously dressed and polished, together with similar exhibits of gray and so-called black granite, were also forwarded. Freestones were represented by dressed blocks of standard size, from the more important quarries in Westmoreland and Northumberland counties. Among them the red freestone from the Wood Point quarries, near Sackville, represents a newly opened deposit, and a rock whose rich colour has already created for it a considerable demand. It was used in 1897 for the construction of the new armoury in Halifax, and more recently for some large buildings in Moncton.

Limestones.

'In this connection reference may be made to the ornamental limestones, &c., found in the neighbourhood of St. John. In addition to ordinary gray limestone, sometimes used for building, they include white and cream-coloured marbles (dolomites) and serpentine-marble or ophiolite.

Dolomites.

' In the preceding remarks reference has several times been made to the occurrence of dolomites in the neighbourhood of St. John. Much interest has, during the last year, been aroused in these from the possibility of their being suited for use in connection with the manufacture of wood-pulp. Some time was therefore devoted to the determi-

nation of whether or not among the limestones occurring in that vicinity, any could be found carrying a sufficient percentage of magnesia to make them suitable for such use. The result was very satisfactory, for while at each of the great quarries which have been so long worked as a source of limestone for calcination, the rock is a nearly pure calcic carbonate—95 to 99 per cent, with only a trace of magnesia, these were found to be associated at several places with considerable beds, usually white or creamy instead of gray, which are decidedly dolomitic. Thus a sample of rock from Randolph and Baker's quarry, in Randolph, gave to A. E. Macintyre, F.C.S.: New Brunswick—*Cont.* Analyses.

Calcium carbonate ($CaCo_3$).....	62·85
Magnesium carbonate ($MgCo_3$).....	35·32
Iron, alumina, silica undetermined.....	1·83
	100·00

'Other specimens from the same locality, examined in the laboratory of the Survey, proved to contain close on 45 per cent of magnesium carbonate; the proportion characteristic of true dolomite. There would therefore seem to be no reason, so far as chemical composition is concerned, why portions of these rocks should not satisfy all the requirements of pulp-making. As, however, in connection with the inauguration of the large pulp mills at Mispec, it was not thought desirable to commence operations with untried materials, and large amounts of dolomite had been imported from Ohio, the practical tests necessary to place their fitness beyond doubt have not yet been made. It is to be hoped that this will soon be done, as there can be no doubt that the amount of such material about St. John is very large, and that if found suitable for use, a very great saving may be effected. Use in wood-pulp industry.

'*Infusorial earth.*—Specimens of this material were obtained during the past summer from one of two small lakes occurring near the south-west extremity of the Kingston peninsula in Kings county. In a visit to one of these, known as Longs Lake, by the writer, the whole bottom of the lake or pond, having a length of about 1,000 feet and an average width of 600 feet, with a depth varying from 2 to 10 feet, was found to be composed of this material, into which a pole could be readily thrust in places to more than 10 feet and almost anywhere to a depth of 6 feet. The material is light-gray when wet, becoming almost white upon drying, and very adhesive. It is not, however, as judged from the samples selected, sufficiently pure to serve the purposes of tripolite, there being a considerable admixture of clay. In Telegraph Lake, near by, is a similar Infusorial earth.

New Brunswick—*Cont.*

deposit, and both are most favourably situated for removal, that first described being within a mile of the shore of the St. John River, and capable of easy drainage.

Gypsum.

'*Gypsum.*—The operations connected with the working of this material have, as in former years, been confined to the vicinity of Hillsborough, in Albert county, and have been upon the usual extended scale. Specimens fully representative of the different grades of rock, including cut blocks of very pure alabaster, as well as of land-plaster, plaster of Paris, terra-alba, &c., have been prepared by Mr. C. J. Osman, M.P.P., manager of the Albert Manufacturing Company, and forwarded for exhibition.

Investigation of age of slate belt.

'After the completion of the work required in connection with the exhibition, the remainder of the season was, devoted to the study of the principal unsolved problem of New Brunswick geology, viz., the age of the great bands of slates and associated rocks lying upon either side of the granites of York county, rocks in which interest had been renewed, first, by the discovery in the previous season, by Mr. Wilson, of the Geological Survey, of fossils indicative of a Silurian horizon in an area previously regarded as Cambro-Silurian, and, secondly, from the reported discovery, in connection with one of these belts, of auriferous veins, in the parish of Stanley.

Discovery of Silurian fossils.

'The first of the questions cannot here be discussed at length, but the general statement may be made that, while much important information has been obtained bearing upon the strategraphy of the region, and the strata in a few instances have been found to be fossiliferous, the question as to how many systems are represented here and their separation, still remains in doubt. To the discovery of Mr. Wilson of

Localities.

brachiopods, &c., in slates a few miles north of Canterbury station on the Canadian Pacific Railway, we have now to add that of crinoids, corals and bryozoa in the limestones of Waterville, in the parish of Southampton, nearly fifteen miles distant from the former, and apparently indicating a similar (Silurian) horizon, but in a so highly metamorphosed condition that nearly all distinctive features of the inclosed organisms have been lost. On Spring Hill brook also, five miles above Fredericton, slates, alternating with quartzites, and in every way similar to those which form the larger portion of the southern slate belt of York county, have been found by Mr. W. T. H. Reed to contain impressions in the form of smooth black surfaces marked with five striations, hexagonal areolations or both; but these again are so obscure as to throw little or no light upon the age of the beds containing them. Dr. Ami, to whom the specimens have been

referred, says of them that they bear certain resemblances to Ostracoderms, which would lead one to suspect that the rocks are Silurian. Should this be the case and this locality be added to those of Canterbury, Waterville and Rocky Brook, on the Nashwaak, in which Silurian or Lower Devonian fossils were found some years ago by Mr. Chas. Robb, we shall have four widely separated localities within the areas under review in which fossils more recent than that of the age to which these have been assigned, are known to occur. Yet every observer who has examined this portion of New Brunswick, including Logan, Hind, Robb, Matthew and Ells, has regarded the slate bands in question as being, upon the whole, distinct from that of the easily recognizable and highly fossiliferous group of Silurian rocks that lies to the northward in Carleton and Victoria counties. It must also be remembered that distinct proof of the existence of Cambro-Silurian rocks along the line of contact of the two contrasted groups is found in the Beccaquimec valley, in the occurrence of strata carrying such fossils as *Trinucleus seticornis*, *Harpes*, *Acrotreta*, &c.

New Brunswick—*Cont.*

Fossils of Cambro-Silurian age.

'Stratigraphically also, the work of the last summer tends strongly to confirm the view, enunciated in the Report of 1885, that not the Beccaquimec limestones only, but the great bulk of the strata stretching westward towards the Maine boundary, lie unconformably beneath the Silurian system. According to this view the fossiliferous slates of Canterbury (found by us to be also fossiliferous at Eel River) and the crinoidal limestones of Waterville represent areas of Silurian included in more or less open folds of older and much more intensely altered strata.

Relations of two series of rocks.

'In connection with the investigation of these questions, some time was spent in the examination of the so-called Cross Creek gold district in the parish of Stanley. In view of the fact that the first discoveries, made in the early spring of 1898, involving the display of numerous fine specimens and the creating of a fever which led to the investment of over $2,000 in the taking out of prospecting licenses, have never been followed by systematic exploration or expenditure and that nearly all interest in the region has now abated, it would seem that but little real foundation and not a little fraud was involved in some of the earlier statements made. The investigations of the writer led him not only to visit the first reported locality at Cross Creek, but also Rocky Brook, McLean Brook and Ryan Brook, tributaries of the Nashwaak above Stanley, as well as the Taxes River, a branch of the Miramichi. The strata, which are very similar upon all of these streams, include massive quartzites, purple and gray slates and black pyritous slates, thus resembling the

Gold reported at Cross Creek.

New Brunswick—*Cont.*

rocks of the auriferous districts of Queens and Lunenburgh counties, Nova Scotia, and contain numerous veins of quartz; but their relations are obscured by excessive folding as well as by an extensive covering of superficial deposits, while the quartz veins are mostly small and irregular, forming no well-defined lodes, and as far as the writer could ascertain, without gold. There would seem to be but little question that some gold has been found here, as over many other portions of northern New Brunswick, but the existence of anything like a true gold district is yet to be proved.

Materials for road making.

'I have only to add that, by your direction, some little attention was paid to the question of the existence and location of materials suitable for the macadamizing of roads. In the case of the city of St. John, extensive deposits of trappean rock, apparently suitable for this purpose, were noted in the vicinity of the Martello tower, in Carleton, as well as near the old penitentiary building east of Courtney Bay, and by the advice of Mr. W. F. Burditt, of the Good Roads Commission, with whom the localities were visited, the crushing plant of the city has been placed at the point last named. Yet here, as elsewhere, present cost rather than future stability seems to be the principal factor in the choice of materials, the necessity in the case of St. John for the removal of so much stone for the excavation of foundations and the grading of streets, constantly affording a very cheap, though often a very unsuitable material for such use. In Fredericton a variety of diabase, found in the vicinity, is now extensively employed, and is giving good results. Offers for the sending up of samples of this rock to be submitted to experimental tests in the physical laboratory of McGill University were made, but those having the matter in charge preferred to be guided by the results of their own experience.'

NOVA SCOTIA.

Work by Mr. H. Fletcher.

Mr. H. Fletcher was engaged during the winter of 1898-99 in plotting the surveys made in Cumberland county referred to in the Summary Report for 1898, pp. 139 to 148, 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.

On June 16 Mr. Fletcher left Ottawa for field-work in Nova Scotia, and did not return to Ottawa until January 8, 1900. On the work done, Mr. Fletcher makes the following report:—

Assistants.

'I was again assisted by Mr. McLeod and also by Mr. Colin McLeod, of Springhill, who were engaged in making surveys necessary

to complete map-sheets 59, 60, 61 and 62 adjoining the Springhill sheet, and who surveyed the various brooks above the Florida road to their heads in the pre-Carboniferous rocks, the northern limit of the latter being a short distance south of that road. Many of the tributaries of the Wallace and Pugwash rivers they also surveyed by pacing, and nearly all the roads of the district by odometer. The general relations of the various groups of rocks have been already pointed out by Dr. Ells. Nova Scotia —*Cont.*

'My own work consisted chiefly of a study of the south side of the Springhill coal-field. I have great pleasure in acknowledging assistance received in this work from Mr. R. Cowans, General Manager of the Cumberland Railway and Coal Company, from Messrs. C. and J. Hargreaves, John Murray, Ben. Parsons, Harvey Howard, A. H. Alloway, E. Laflamme, Geo. Hall, R. H. Cooper, and other officials of that company; from Messrs. William Hall, M.E., mayor, Dan. McLeod, town clerk, and John Anderson, post-master, of Springhill; from Peter Nelson, John E. Bishop, H. H. Card and Blair O'Rourke, of Springhill; from Rufus and Levi Gilroy, Wesley Herrit, Thomas Boss and Alex. Stewart, of Rodney; J. W. Broderick, of Lower Five Islands, Charles E. Day, of Parrsboro, and others. Owing to the untimely death of G. W. McCarthy, on June 7, I lost his invaluable assistance in this field. Acknowledgements.

'Sixty borings, by a hand drill ranging in depth from a few feet to one hundred and forty-six feet, together with several trenches and pits, have been made in an attempt to define the course of the coal-seams known to exist in this vicinity and their relation to the red and purplish strata of the head of the South Branch of Black River and of the north-east fork of the Upper Maccan River and the conglomerate already referred to.* Springhill coal field.

'It has long been a debatable question with the miners whether these red rocks lie above or below the worked coal-seams, and it cannot be said that this relation has been yet satisfactorily defined, although thus far no stratigraphical evidence seems to have been obtained to contradict the assumption that they overlie, except the small disturbance of strata caused by the great faults required to bring the red strata down perhaps more than 1,500 feet into juxtaposition with the large coal-seam supposed to be that of the West Slope. But this difficulty may be lessened by an unconformity, already hinted at as probable, above this horizon, such as is shown by Dr. Ells often to occur between the Permo-Carboniferous and underlying rocks but has not yet Relation of coal-seams to red beds.

*Summary Report, Geol. Surv. Can., 1898, page 146.

Nova Scotia —*Cont.*

been worked out in this vicinity. The red rocks differ only in colour from the strata underlying the coals, the composition and texture being the same ; but this may also be said of most parts of the great section at the Joggins and no red strata have been seen underlying the coal in the sections at Springhill mines or lower down the South Branch, not more than three-quarters of a mile north of the red rocks in question, with the exception of one layer not far below the seam at McCarthy's slope. The red rocks here include a coal-seam* which is perhaps also that of Maccan River near the Leamington Orange hall and that bored into at a depth of 488 feet in the deep bore-hole at Mapleton. The sections may thus be identical. That at Mapleton is not far from strata referred by Messrs. Scott Barlow and Walter McOuat to a horizon above the Coal Measures, and I would suggest tracing it into connection with the latter, with some of the small coal-seams proved to run past the mine levels, or to the great fault that must separate them if the red rocks underlie the Coal Measures.

Coal seams among the red rocks.

Tracing out of large seam.

'The large seam of the bore-hole described at page 145 of the last Summary Report, was traced south-westward by borings and shallow pits for a distance of sixteen chains, crossing the road to Gilroy's sugar camp, at which a pit proved the dip to be N. 75° W. at right angles to the line traced by boring. The seam, although it maintains its thickness, has here greatly deteriorated. On a more westerly course coal *débris* was found for six chains further in the heavy surface, but, a short distance beyond, the seam appears to come against a fault, which, if the same as that proved to the north-westward on the east bank of Sugarwood Brook, has a dip of S. 4° E. $< 52°$, and is therefore, if normal, a downthrow to the south.

'In the red rocks six chains to the south-westward, a coal-seam, lying horizontal, has been traced for about nineteen chains parallel to the fault, at right angles to the large seam and close along the south bank of the South Branch. Red strata occur along this river to the old Rodney road, were bored in 1874 at the watering trough on the main road, and follow the Upper Maccan River through Leamington and Mapleton, as before stated. Near Rodney they are cut in Burton Boss' well and are succeeded by the conglomerate of Rodney and of Polly Brook.

Faults.

'A curious feature of the eastern outcrop of the large seam, is that red strata follow it on the east side so closely to the rise that the bottom of the seam has not room to reach the surface. This apparently indicates a north-east and south-west fault, details of which could not

*Summary Report, Geol. Surv. Can., 1898, p. 146, line 20.

be obtained; for, while the gray beds associated with the coal to a depth of sixty-four feet in No. 15 bore-hole are regular, the red are horizontal and cut by V-shaped joints. Nova Scotia —*Cont.*

'South of the main east-and-west fault and immediately north of the South Branch of Black River, another downthrow to the south shows, on its north side, red strata apparently from beneath the greenish and gray rocks associated with the coal-seam. These faults appear to be parallel to that near the Syndicate slope, which is also a downthrow to the south or a thrust to the eastward on the south side. The Syndicate fault has not been proved to the eastward, but its position may be indicated by the slight discordance of strata immediately west of McCarthy's slope; also north of the pits at the head of Sugarwood Brook.* None of these faults produce much disturbance of the strata adjcining them.

'South-westward down along Sugarwood Brook from these pits, there is apparently no east-and-west fault for twenty-one chains to a branch from the eastward. Here at the foot of the right bank, bore-hole No. 39 was put down 146 feet through gray strata with one seam of coal, which presumably overlies the large seam a considerable distance. From the forks up the most northerly of the two little brooks into which the branch from the eastward breaks, the rocks resemble those bored and trenched in the South Branch and must overlie the gray fine sandstone above the large coal-seam, unless there be faults not yet detected. The horizontal strata pile rapidly up at the falls (where a six-inch band of hard slaty coal is seen) and are well exposed to within sixty feet of the bridge on the sugar-camp road. In the adjoining branch and in other tributaries of the neighbourhood, a thickness of fifty feet of horizontal rocks is in places exposed. About three chains from No. 39 bore-hole down stream, on the left bank, the main fault above referred to was uncovered, the rock on the north side being a gray sandstone with patches of conglomerate, similar to the strata overlying the large coal and also, in the multitude of glistening points of quartz, like the sandstones of Ragged Reef. As already stated, the dip of the well polished face of this sandstone is S. 4° E. < 52, while at fifty feet to the south-westward red and green rocks are greatly shattered into irregular blocks, traversed by veins and films of calcite, ankerite and hematite; some of the planes are curved but without definite direction; the dip seems to be steeply south but is obscure, for a thin lenticular seam of coal dips for a short distance N. 83° W. < 25°, in which direction it breaks into two layers, the uppermost being nearly horizontal. Westward from Sugarwood Brook, this fault seems to pass Rocks on Sugarwood Brook.

*Summary Report, Geol. Surv. Can., 1898, pp. 143, 144.

Nova Scotia —*Cont.*

through the graveyard on the old Rodney road, to follow South Branch and the Rodney road as far as the sharp turn to northward at the slaughter-house (where the dip is steep and a change of strike occurs) and to cross Harrison Brook about ten chains below the Leamington road, where it appears to dislocate the Claremont anticline, or repeat it at two points, one of which is five chains above the road, the other twenty-two chains below it.

Overlying seams.

'From a point on Sugarwood Brook about midway between the outcrop of the large seam and borehole No. 39, the gray sandstone with coarse layers, supposed to overlie this seam, as already stated, was traced northward about fifteen chains to the head of Gilroy Brook and down along the north bank, from which it gradually recedes as if to join the outcrops of similar rock north of Alex. Stewart's (Jos. Herrit of Barlow's map of 1874*), about one mile to the westward. Immediately south of and overlying this sandstone, a small seam of coal was opened on the left bank of Gilroy Brook dipping south $< 12°$. This was sought and bored on the old Rodney road immediately north of Gilroy's house, where the dip apparently indicates an extension of the coal basin still further to the southward. As the outcrop of the sandstone and of the coal both seemed to point to the equivalence of the latter with a bed opened, many years ago, on the road near the slaughter-house above referred to, and said to contain twenty inches of good coal, a boring was made, intermediate between the two outcrops, at the road immediately west of Alex. Stewart's house. In it a coal, probably the same, was again found, underlain by a heavy band of gray fine and coarse sandstone.

'West of the slaughter-house this coal was not followed, but I might suggest the possibility of its being the Golden seam, three feet eight inches of coal and shale where it was opened by us, a year ago, on the Leamington road, fifty chains south-west from Miller's Corner, on the opposite side of the Claremont anticline, the underlying North Slope seam being perhaps that found in a pit at Lemuel McNutt's gate on the Rodney road.

Mr. Barlow's general section.

'In Mr. Scott Barlow's general section of the Springhill district, of which that given in the Report of Progress, 1873-74, page 157, is a part, no red strata are mentioned for 1,849 feet from the bottom up to the West Slope seam. About 680 feet higher, or 330 feet above the North Slope or No. 3 seam, however, red beds, like those of the bore-holes, begin; while about 515 feet above No. 3 is a four-foot coal (the Golden seam), perhaps that bored in the South Branch of Black River.† The seam called on Mr. Barlow's plan the highest (workable?)

*Published in Walker & Miles' Atlas of the Dominion.

†Summary Report, Geol. Surv. Can., 1889, page 146, line 20.

in the field lies 1,000 feet above No. 3, also among red strata, and at 1,235 feet a two-inch coal seam is included in gray sandstone and shale. Nova Scotia —*Cont.*

'It has been stated that the coal of the 48-foot bore-hole near Sugarwood Brook differs in section from that further south; it is, therefore, possible that the latter may be a distinct seam, perhaps No. 3, in which case a smaller fault might bring red strata into immediate proximity with it, as at the bore-holes. To test this a close comparison should be made of the two seams.

'Comparing the borings of 1898 and 1899 with those made before 1874, shown on Barlow's map, the rocks of Harper's bore-hole, 386 feet deep, may be those cut last season, Harper's bore-hole lying apparently far within the outcrop of the highest seam and the red layers, masses of gray sandstone and streaks of coal corresponding closely in both sections. Roberts' bore-hole, 176 feet deep, also cut red strata and two smaller seams of coal. The coal of the top of the bore-hole, 715 feet deep, at the watering-trough north of Captain Mills', suggests the position of Barlow's highest seam; and the seam bored at 488 feet from the surface will then be almost exactly in the position of the four-foot seam, the Golden seam of the Leamington road. The tracing of this latter from that road into the basin of Maccan River might determine this important point. Comparison of results.

'The bore-hole, 320 feet deep, south of Miller's Corner, seems to indicate a block of faulted, steep-dipping rocks among the flat strata adjoining, if the two seams mentioned in the section as cut 210 and 270 feet from the surface be those shown on the plan as cropping out 500 and 600 feet to the rise of the borehole, on the horizon apparently of No. 3 seam.

'From July 9 to July 14, I was in Cape Breton with Dr. G. F. Matthew, who was working on the Cambrian and other old rocks of Long Island, Barachois, Boisdale, East Bay and Mira, the oldest fossiliferous deposits of Cape Breton, similar to those in New Brunswick and Newfoundland, also studied by Dr. Matthew.* Cambrian of Cape Breton.

'At the end of the year, another short visit was paid to Sydney to obtain particulars concerning recent developments of mineral deposits, more especially in relation to the erection on the east side of Muggah Creek of furnaces for the production of iron and steel.

'In August, four days were spent on an examination of the Devonian rocks of Five Islands and Lower Economy. A section was made of 3,928 feet of the fine plant-bearing exposures of Harrington River, so that Five Islands.

*Bull. Nat. Hist. Soc. of New Brunswick, xviii, vol. iv, p. 198.

Nova Scotia —*Cont.*

there need be no question of the stratigraphical horizon of these rocks, which have hitherto been made to include all the geological formations from the Cambro-Silurian to the Coal Measures, and even the Permian. The upper red series is not so well exposed in this river as the lower gray and blackish shales and quartzites, but appears at many points below the bridge on the shore-road, is in cliffs along the adjoining North River and comes upon the shore at Lower Economy, precisely like the red strata of McAra Brook and yielding a small quantity of manganese ore, like the strata of that age at East Mountain of Onslow.'

Work by Mr. E. R. Faribault.

Mr. E. R. Faribault was engaged during the winter months of 1898-99, in preparing for publication the surveys of the preceding summer, including plans of the gold districts of Waverley, Montague, Cow Bay, Lawrencetown, Lake Catcha and Tangier, in the county of Halifax.* Some progress was also made in the compilation of the map-sheets on the scale of one inch to the mile, lying immediately west of Halifax.

At my request, Mr. Faribault also undertook the construction of a series of longitudinal and transverse sections of the Goldenville gold-district, to form the basis of a model of this important district as typical of others in Nova Scotia and for the forthcoming exhibition at Paris. The work has proved to be a somewhat difficult one, but when completed the model will clearly illustrate the "saddle-vein" structure so characteristic of the Nova Scotia deposits, as well as the position and conditions of the portions of special enrichment of the several superposed veins. These zones of enrichment extend probably to great depths in a direction approximately parallel with the axial plane of the fold, and may easily be determined by systematic and well-directed development.

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

'In compliance with your letter of instructions, dated June 2, I left Ottawa on June 13, for Nova Scotia, to resume the surveys of previous years in connection with the mapping and study of the structural geology of the gold-bearing rocks of the Atlantic coast of that province.

Field work.

'I was again accompanied, during the whole season, by Messrs. A. Cameron and J. McG. Cruickshank, who have been my assistants for fifteen and thirteen summers, respectively. I have to thank many

*Summary Report, Geol. Surv. Can., 1898, pp. 148 to 159, for description of the districts.

persons for information and assistance, especially the Hon. Charles E. Church, Commissioner of Public Works and Mines, Dr. Edwin Gilpin, Inspector of Mines, and Mr. F. H. Mason, F.C.S., of Halifax; Professor H.Y. Hind, Mr. Clarence H. Dimock, and Mr. W.H. Blanchard, of Windsor; Mr. Evan Thompson, of Elmsdale, Mr. Matthew Thompson and Mr. Geo. Ralph, of Renfrew; Mr. John J. Withrow, of South Uniacke: Mr. Samuel Mitchell, Mr. T. R. Price, Mr. Wm. Hayes, of Mount Uniacke; Mr. Bernard Macdonald, M.E., Manager Le Roy Mine, Rossland, B.C.; Mr. E. A. Daly, Manager Dufferin Gold Mine; and Mr. T. G. McNulty, Manager Tunnel Gold Mine, Waverley. Nova Scotia —*Cont.*

'A revision has been made of the structural geology of the gold-bearing rocks of that portion of Hants county covered by the Kennetcook sheet, (No. 65,) the Enfield sheet, (No. 66,) and that portion of the Windsor sheet, (No. 73,) surveyed in 1892 and reported on in the Summary Report for that year at pages 37 and 40. All the field-work necessary for the geological mapping of that region has been completed and most of it has been plotted. Gold-bearing rocks of Hants county.

'Mr. A. Cameron was engaged, from September 12 till October 20, surveying with the prismatic compass and odometer most of the roads situated in the gold-mining region of Queens county, with a view to producing complete maps of that district at an early date.

'Special detailed surveys have been made of the gold-mining districts of Renfrew, Mount Uniacke and South Uniacke, situated in Hants county, in the region surveyed for the Windsor sheet, (No. 73,) with a view of preparing large-scale plans of them, similar to those already published for Guysborough and Halifax counties.

'*Renfrew Gold District.*—Three weeks were devoted to a detailed survey of this district, and a plan on the scale of 500 feet to 1 inch has been plotted and compiled in the field. This district occupies the summit of a low watershed that separates the valley of the Shubenacadie from the Bay of Fundy, and it is situated four miles north of Enfield, a station on the Intercolonial Railway, twenty-seven miles distant from Halifax. Renfrew gold district.

'The auriferous quartz veins which have been worked from time to time, since the first discovery of gold in 1861, all belong to the class of segregated, interbedded veins, occupying spaces along the planes of stratification on the dome of a huge anticlinal fold. This anticline is the continuation from the west of the Mount Uniacke anticlinal

Nova Scotia —*Cont.*

fold, and its general course is N. 70° E. (mag.)* It crosses Stinking Lake, which marks the western limit of the district, about the middle, and running eastward it follows Number-eight Brook down to Nine-mile River and reaches Little Nine-mile River where the gold-bearing rocks are covered by Carboniferous strata.

Character of the anticline.

'The form of the fold is that of a slight overturn to the south, and it is the broadest and most flattened elliptical dome that has yet been met with in the eastern part of the province. Extensive erosion has worn away and truncated this fold to a known depth of 13,700 feet, exposing at the present surface a horizontal section of strata of the quartzite division and intercalated veins, which were originally deposited 8700 feet below the base of the slate division of the gold-bearing series.

'The strata lie at low angles for some distance on both the north and south sides of the fold, the dip increasing gradually till it reaches 50° at a distance of 2,500 feet to the south of the axis, and 65° at a distance of 5,000 feet; while on the north leg of the fold, the dip reaches only 30° at a distance of 2,500 feet, and it does not exceed 45° further north, giving to the axis-plane of the fold a dip to the north of 75°. At the western end of the district ridges of thick beds of hard quartzose sandstones stand out in bold relief for many hundred yards; near Stinking Lake they curve around the western extremity of the elliptical dome, describing long undulating and faulted curves, and pitch to the west at angles varying between 18° and 25°. At the eastern extremity of the dome, in the vicinity of the Nine-mile River, the strata curve more abruptly round the anticlinal axis and they pitch to the east at an angle of about 20°. The centre of this broad dome could not be exactly located, the rocks being for the most part covered by drift in the northern part of the district, but it is situated on or near Number-eight Brook and at no great distance to the east or west of lot 833, block 2.

East and west ends of dome.

Mining on south limb.

'All the mining operations have been carried out on the south or steeper limb of the fold and particularly on the south-westerly portion of the elliptical dome. In studying the structure of this anticlinal fold more closely, we find that three gentle undulations radiate from the centre of the dome, two in a westerly and one in a south-easterly direction. The two western undulations run on the general course of the main anticline towards Stinking Lake, with strata dipping westerly at angles under 25°. The numerous rich boulders of auriferous quartz that have been found between Stinking Lake and the Rawdon road, are derived undoubtedly from these two

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

undulations, but all search for the leads from which they came has hitherto been fruitless on account of the great thickness of drift and boulder-clay covering them. However, the low angles at which the veins dip and the many faults affecting the strata will probably prevent important mining operations. Nova Scotia —*Cont.*

'The south-western undulation, which is by far the most important of the three, begins at the centre of the dome and widens out in a south-westerly direction, pitching to the south-west at an angle gradually increasing from 0° at the centre to 50° at the extreme limit, and the axis-plane dips north at an angle probably near 75°.

'On the north-western side of this undulation, the measures have been subjected to enormous strain and shearing, producing a series of right-hand faults roughly parallel with the axis of the undulation and giving horizontal displacements ranging from a few feet up to 200 feet. Numerous veins have been uncovered on this side of the undulation and many have proved auriferous, but they are so discontinuous and cut up by faults that it is very doubtful if they can ever be extensively worked with profit. One very rich streak was discovered in 1897 on a vein called the Jubilee lead, and a shaft sunk to the depth of 65 feet showed the streak to dip west about 50° and to follow the shoulder of a small local undulation in the faulted measures. I was informed that three tons taken from a part of this streak had given $5,000 worth of gold and that the 80 tons of ore extracted and still lying at the pit were valued at about $60 to the ton. There is undoubtedly a zone of special enrichment crossing the veins along the north side of this undulation, and passing probably in the vicinity of the Jubilee and Walker shafts. The rich float of auriferous quartz discovered on Parker Brook and Rawdon road, immediately north of the bridge, originated no doubt from veins situated on this zone. Faulted tract.

'The south side of the south-western undulation contains the most extensively operated veins of the district. On the south side of the dome, opposite the centre, the strata run on a straight course parallel with the axis of the main fold, and they have been tightly compressed in the process of folding by a direct lateral force from the south which has prevented the formation of fissures. But, as they approach the south-western undulation, they curve gradually round, and, coming under the influence of a powerful shearing force, develope in some slate belts numerous fissure-veins. The veins gradually increase in size and in number, until they attain their maximum width on or about the apex of the undulation, forming a zone of fissure-veins which possesses all the characteristic features of a promising field for permanent and South side of south-western undulation.

Nova Scotia —*Cont.*

deep mining. Important streaks of special enrichment have been worked on many leads along this zone. They are generally well-defined and dip to the west at an angle of about 45°, corresponding to the pitch of the crest of the undulation, and, as far as present operations have gone, we find that they crop out at the surface along a well-defined line. This line of special enrichment runs from the centre of the dome, on Number-eight Brook, S. 47 W.° (mag.) to Parker Brook, some 500 feet below the Rawdon road bridge, thence curving to the south it crosses the Renfrew Brook about the Colonial dam and extends to the works on the Andrews lead, which marks about the extreme south limit of the formation of fissures, on lot 1826, block 1, giving a total length of 8,500 feet.

'In the first 4,600 feet, from the centre of the dome to the Phillips lead at Parker Brook, some thirteen leads have been uncovered, most of them recently, all lying at angles under 40°, many of which have proved auriferous and promising, but none have so far been operated.

Section of auriferous veins.

'The next 1,600 feet of the zone, south of Parker Brook, includes a succession of twenty-two known veins, comprised between the Phillips and the McClure leads, most of them included on the property of the Pictou Development Company. Their length varies from 200 to 1,000 feet, and their average thickness is above that of the veins in most districts in the province. Proceeding from north to south, the veins on which most mining has been done come in the following order and at distances stated from the McLeod lead :—

Leads.	Thickness in inches.	Distance from McLeod lead in feet.	Deepest shaft in feet.	Length opened in feet.	Remarks.
McLeod....	9 to 15	0	360	1,350	Two rich streaks, eastern one dips east, western one west.
Preeper	10 to 36	95	125	800	Good strong lead.
Foundation.	5 to 10	150	400	600	Rich lead, traced west a long distance.
Hay	9	210	120	600	
Paper Collar	6	285	150	300	
Kilcup.	10 to 16	380	50	1,000	
Clements...	10 to 24	460	75	600	Good large belt.
Sims.	10 to 48	655	112	1,200	Good large belt of constant value.
Johnson....	8 to 36	960	90	1,000	
North Ophir	12 to 18	1,370	350	1,000	Belt of four leads, rich streak dips west.
South Ophir	8 to 12	1,510	400	800	Rich pay-streak dips west.
McClure....	12 to 15	1,585	185	500	Slate belt with quartz.

'The remaining 2,300 feet of this zone, between the McClure belt and the Andrews lead, contain, as far as the the surface developments have gone, only ten leads and none have proved of special value.

Rich drift has, however, been found in this section, south of Renfrew Brook, but it may come from the leads worked further north. Nova Scotia —*Cont.*

'Outside of the middle section of this zone of special enrichment, the only veins which have been operated to any extent are those situated on the Free-claim property on the north bank of Renfrew Brook, where a local crush of considerable interest occurs on the Free-claim and No. 2 areas, at a distance of some 5,000 feet to the south of the centre of the dome. Some ten veins have been operated which are mere local segregated sheets of auriferous quartz, occupying interbedded fissures limited to 100 or 175 feet in depth and 150 feet along their course. At this limited depth, the formation is thrown to the south about eight feet by a fault, and on the dip the measures assume their regular course. But it has not been ascertained if they still hold payable auriferous veins beyond the fault, and it is very doubtful if they do. Free-claim property.

'A series of some thirty or forty veins has been uncovered on the south-eastern flank of the dome at a distance varying between 2,000 and 5,000 feet directly south of the centre. A few of them have shown gold, but none have been operated. The pay-streaks on this zone probably dip eastward.

'On the eastern pitch of the main anticlinal fold, 4,000 feet east of the centre of the dome and half-way down Number-eight Brook, a few boulders of gold-bearing quartz have been found, but all search for the veins *in situ* has been fruitless, only a few veins of low-grade ore having so far been found. This comparatively sharp fold presents very promising features for the development of large mineralized fissure-veins, and, but for the heavy drift covering the strata, it affords a very good field of search for new veins. Eastern pitch of main anticline.

'On the north limb of the main fold, the strata lie at angles varying between 10° and 35°, rather low for the occurrence of payable veins, considering the fact that they could only be worked at a disadvantage on account of the low angle of the dip. Boulders holding gold have, however, been found in the thick drift covering this limb, and search for the veins was being made by an American company at the time of our visit.

'The total production of the district from 1862 to September 30, 1898, is 33,869 ounces of gold, valued at $660,453, extracted from 48,142 tons, giving an average yield of $13.72 per ton of 2,000 lbs., while the average of the whole province for the same period is $12.12. This average is certainly very satisfactory, if we take into consideration the inadequate appliances used for the saving of gold, especially Gold product.

Nova Scotia —*Cont.*

by the earlier companies; and, it may be further said that the mining operations have proved as a whole remunerative, although often conducted in a very unskilful manner. Operations in the district have, however, practically been suspended for some time, the only work at the time of our visit being the prospecting for new leads in the northern part of the district.

Causes of present stagnation.

'Various reasons may be assigned for the present stagnation at Renfrew and other gold-mining districts. In most of the districts the ground was formerly held in small areas, operated by individuals or small companies with limited capital, and the system of mining consisted in opening up the different veins separately, by means of shafts sunk every fifty feet along their outcrops. In Renfrew no more than 200 feet of cross-cutting have been done. By this mode of working the payable portions of the veins outcropping at the surface have been extracted to very limited depths, and we have reached a stage at which a system more suitable to deep and permanent mining has to be adopted.

Prospects for larger working.

'I may be permitted to quote here the conclusions of the Director of the Geological Survey, embodied in an article which appeared in the *National Review* for October, 1896: "The knowledge now gained of these veins renders it practicable and desirable that they should be worked in a larger way, combining series of parallel and adjacent deposits under a single management, and opening them up by means of one or two principal shafts. Much would be gained by this in economy and in the perfection of milling and concentrating machinery; and under careful management there is little doubt that the gold product of the province might be easily doubled within a few years."

Best part of district for this.

'As far as developments have gone in the Renfrew district, the 1,600 feet of section of twenty-two leads included in the middle portion of the south-western zone between the Phillips and the McClure leads, offer the most promising field for such undertakings. There is little doubt that the gold-streaks outcropping at the surface on the different veins and pitching west at an angle of about 45°, will be found to extend continuously to much greater depths, and if one thin out it will be replaced by another parallel and in close proximity to the first. These streaks extend in depth in a plane probably parallel to the axis of the undulation, dipping north-west at an angle of about 75°, and developments will have to be directed along that axis-plane to keep in the zone of special enrichment.

'The Renfrew Brook running eastward along the southern part of the district, presents several important falls and rapids between

McLellan Lake and Meadow Brook into which it runs, a distance of two miles. Five falls of about 20, 35, 15, 35 and 15 feet respectively have already been utilized for water-powers above the main road. Six lakes are available for reservoirs above these falls, and several important water powers could be established on this brook, both above and below the main road. Nova Scotia —*Cont.*

'*Mount Uniacke Gold District.*—Some three weeks were employed making a detailed survey of this district, and a plan on the scale of 250 feet to 1 inch is now completed and ready for publication. Mount Uniacke gold district.

'The district is situated on the dividing ridge which separates the waters flowing into the Atlantic from those which seek the Bay of Fundy, its elevation being 480 feet above high-tide in Bedford Basin. It is situated three miles north-west of Mount Uniacke station on the Dominion Atlantic Railway, which is distant twenty-seven miles from Halifax. Mining began in 1867 and was conducted with more or less activity for twenty years, but very little work has been done for the last ten years.

'All the auriferous quartz veins developed belong, as in the above district, to the interbedded class, and they occur on the south limb of the denuded crest of a sharp auticlinal fold. This fold is the western prolongation of that passing through the Renfrew district, from which it is distant seventeen miles; its general course in N. 81° E (mag.) and it forms a long, narrow, elliptical dome, pitching east at a comparatively high, and west at a low angle. It dips to the north at an average angle of 60°, and to the south vertically, forming a slight overturn to the south, giving to the axis-plane of the fold a north dip of about 75°. The horizon of the strata brought up on this anticline is estimated to be 12,500 feet below the base of the slate or upper division, giving a total erosion of some 23,000 feet. Interbedded veins.

'Large quartz veins occur on the centre of this dome, on area 678, block 2,250 feet north of the P.C.F. Gold Mining Company's crusher, but none of them have so far been operated, although they show mineralized bands which may prove workable.

'All the veins operated are situated on the south limb of the fold and occur along two well-defined and distinct zones of fissures. In the process of folding, the measures on the south side of the fold have been subjected to a lateral pressure and shearing causing the softer rocks and more yielding beds of slate to separate along the planes of sedimentation, developing a zone of fissure-veins running almost parallel with the anticline and at a distance of 600 feet at the west end and 800 feet at the east end of the dome. This zone is very Fissure veins.

Nova Scotia —*Cont.*

narrow, but it has a total length of some 6,500 feet or more, limited at the east end by the Alpha Brook and extending west to about area 813, block 1. It presents along its whole course only a few veins, three of which have been operated. The two most northerly, the South lead, 3 inches thick, and the Bunker lead, 4 inches, are only fifteen feet apart and have been worked at intervals by many small shafts, seldom reaching 60 feet, and by open-cuts, for a length of 3,400 feet. One pay-streak on the Bunker lead, dipping east and formed by angular veins dipping south-east, has, however, been worked on the Prince of Wales property to the depth of 200 feet.

Nuggetty lead.

'One hundred and ten feet south of the Bunker, the Nuggetty lead, four inches wide, has been extensively worked at places along its course. It was uncovered for 6,000 feet, or nearly the whole length of the district. Four important pay-streaks have been worked on the Nuggetty lead: one at the east end on the P. C. F. property, dipping east at an angle of about 35°, was worked 150 feet deep; 1,000 feet west of it another pay-streak, dipping east at an angle of 26°, was worked to the eastern limit of Mr. Henry Hogan's Montreal property, proved very rich to the depth of 247 feet and is said to be still of good value. 2,700 feet further west, a rich streak, probably dipping west, was worked to the depth of 200 feet on the Prince of Wales property; and, 1,100 feet still further west, the last pay-streak dipping east at an angle of 24°, was worked in connection with some other leads to the vertical depth of 110 feet and found very rich.

Veins south of anticline.

'A few veins have also been uncovered 4,400 feet east of Alpha Brook, immediately south of the anticline. At the western end of the district several veins have been uncovered on the south side of the anticline between the West Lake property and Coxcomb Lake, on blocks 1 and 12, but none have been worked. On what may be called the western extension of the district beyond Coxcomb Lake and west of the 1,085 foot fault described hereafter, Mr. August Michel, has exposed by trenching on the south side of the same anticline, some sixty-five lodes on blocks 11 and 12. He reports that these veins vary in width from one inch to two feet. One of them showed visible gold, and assays proved nineteen of the others to be auriferous, ten of which are considered as of exploitable value. All these auriferous veins are situated north of a band of coarse, quartzose sandstone, 380 feet wide, which is undoubtedly the continuation of that occurring south of the Nuggetty lead, and they are evidently intercalated between strata of the same horizon as those holding the South, Bunker and Nuggetty leads in the central part of the district. None of those veins have yet, however, been operated.

Nova Scotia —*Cont.*

'In the process of the upheaval which has caused the great anticlinal fold, a bulge or broad transverse undulation has been formed on the south side of the dome, extending directly south some 3,000 feet from its centre. The outcrops of the strata on this undulation describe, at the surface, pronounced curvatures, and on either side they assume a comparatively straight course towards the east and west. A very important zone of numerous fissure-veins, has developed between the curved strata along this undulation, in the same manner as along the south-western undulation already described in the Renfrew district. One hundred and thirty distinct veins or belts of veins, have been uncovered or operated to a greater or less extent across the zone, giving a total of 172 feet of quartz or crushing ore, and all of them were surveyed.

Auriferous veins of Mount Uniacke district.

'Proceeding from north to south on a line directly south from area 678, block 2, the most important and extensively worked veins are met with in the following order, at distances stated from the centre of the dome :—

Leads or Belts.	Thickness in inches.	Distance from centre of dome in inches.	Deepest works in feet.	Length opened in feet.	Remarks.
Twenty-foot..	240	100	Not worked	....	Holds mineralized streaks.
Eight-foot... .	96	210	Not worked	.....	
Nichols	14	250	75	200	
Three-foot.....	34	275	Not worked	.....	
Scotch Belt...	48	380	Not worked	.....	Cut by cross-cut at 110 ft. level.
Number Three	10	400	260	400	Rich streak. At 110 ft. level, cross-cut
Cook.	10-96	420	110	800	180 ft. south and 100 ft. north. At 150 ft. level, one 150 ft. south....
Cross Tunnel Belt	18	438	160	.....	
1st P. C. F. Slate Belt...	120	450	150	400	Belt 18 ft. wide; rich streak, 10 ft. ore, dips east, $< 25°$.
Murray. . ..	6	470	160	600	
Cut Lead Belt.	12	500	135	400	Rich streak on Cut lead.
2nd P. C. F. Slate Belt...	60	510	50	300	Belt 18 ft. wide, 5 leads, streak dips east.
.....	...	545	.....	....	Line between the C. P. F. and the
Logan.....	8	600	100	300	Montreal properties.
1st Montreal Slate Belt..	120	622	65	85	Belt 20 ft. wide; rich streak; 10 ft. ore; dips east.
2nd Montreal Slate Belt...	100	660	80	80	Belt 16 ft. wide; rich streak, 9 ft. ore dips east.
Contract.....	4	710	105	1,000	With other leads was also worked in open-cut, 25 ft. wide and 15 ft. deep.
. . . .	.....	875	.....	.....	From 710 to 875 ft. several leads, worked by shallow cuts.

Nova Scotia —*Cont.*

Leads or Belts.	Thickness in inches.	Distance from centre of dome in inches.	Deepest works in feet.	Length opened in feet.	Remarks.
South	3	875	65	1,500	This and the next two leads constitute the east-and-west zone.
Bunker	4	890	200	3,400	Worked to shallow depths for a great length.
Nuggetty	4	1,000	247	6,000	Four streaks worked, 150, 247, 200 and 110 ft. deep.
McPhail	4	1,070	140	600	Streak dips east.
Iron Slate Belt	72	1,115	40	400	Between 1,115 and 1,380 ft., band of
.....	.....	1,380	.....	.....	coarse quartzite with several whin-bound veins of no value; no slate.
Bain.	6-24	1,405	140	1,000	Affected by four faults at east end.
Allen Belt..	15	1,440	50	400	Two leads, 6 and 9 ins., in the belt.
....	....	1,870	.....	.....	Between 1,440 and 1,870 ft. coarse quartzite, several veins of no value, one only worked 45 ft.; no slate.
Howe Belt....	60	1,870	40	50	Belt 6 ft. wide, short streak dips east, 3 ft. ore.
Dimock Belt..	72	1,885	240	400	Belt gives 14 ft. ore on a rich streak (half crushing material) dipping east.
RobertsonBelt	33	1,900	240	400	Belt of three leads, 3, 24 and and 6 ins. wide, on a rich streak dipping east and worked with the above belt for a length of 400 ft. from the surface.
.....	....	1,960	.....	.....	Between 1,900 and 1,960 ft., ten leads cut by cross-cut, averaging 12 ins.; not worked.
Hayes Belt...	36	2,155	80	100	Belt of three leads.
McQuarry Belt	60	2,175	40	150	Large belt.
Galena.....	6	2,235	50	200	
N. McIntosh..	3	2,555	80	250	
Dowell Belt...	12	2,600	40	....	Belt of three leads.
S. McIntosh..	6	2,640	60	.....	
Dimock South Belt.	9	2,660	60	500	Belt of three leads.
Toronto	4	2,925	55	100	
Hayes Slate Belt	8	3,000	25	100	Workings furthest south.

Good prospects for deep mining.

'There is not the slightest doubt that most of the streaks of special enrichment have not been worked-out on the different veins, but extend down to much greater depth; and that, if some of them do run out, further systematic development by means of levels and cross-cuts will show that they are replaced by other parallel streaks of equal value, either in the same or in some adjacent vein. As the veins dip vertically and the pay-streaks are all situated on a line running north-and-south across them and pitch to the east at angles varying between 25° and 35°, the plane or zone containing these pay-streaks will also dip east at the same angle. As depth is attained, the form of the undulation may possibly change, and the extension of the zone will then change slightly in direction and dip, but it is most probable that it will extend beyond the limit of practicable mining. The large belts

of mineralized slate and quartz which have been operated on the P. C. F., the Montreal and the Phœnix properties, have been found to carry regular values on the north-and-south zone of special enrichment, and they still present a very promising field for extensive mining of low-grade ore. Nova Scotia —*Cont.*

'On the north side of the Mount Uniacke anticlinal fold, a few veins have been uncovered, but so far none of them have been worked, and that limb of the fold does not seem to offer a promising field, as the drift covering it has not been found auriferous.

'A great dislocation has affected the anticlinal fold at the west end of the district. It runs north-and-south through Coxcomb Lake, and gives to the anticlinal axis a left-hand displacement of some 1,085 feet at the head of the lake. This fault has already been mentioned as separating the main district from the large group of veins and belts of leads uncovered by Mr. A. Michel, but not yet worked. A series of five small left-hand and right-hand faults has also been made out, affecting the continuity of the Borden, Little, Nuggetty, West Lake and Polkinghorn leads on the Prince of Wales and West Lake properties, at the western end of the district. Two left-hand faults have disturbed the eastern end of the district in the vicinity of the Alpha Brook. The eastern one runs about S. 51° E. (mag.), crosses the Alpha Brook directly east of the Alpha lead and the main road 400 feet west of the Alpha Brook, and it gives a horizontal displacement of some 200 feet at the anticline. The other runs probably S. 27° E. (mag.), and gives a displacement of 40 feet on the Nuggetty lead, between two shafts 130 and 150 feet deep on the eastern pay-streak, worked on the P.C.F. property. Another line of disturbance, probably running north-and-south, occurs some 800 feet west of the south undulation and 300 feet west of the school-house, twisting the measures 80 feet to the north on its western side. Fault.

'In his "Ores of Nova Scotia" Dr. Gilpin states that mining began in this district in 1867, and during the next few years several companies were working; the returns, which rose in 1868 to 3,247 ounces, were maintained for twenty years at figures varying from 100 to 1,700 ounces. The total production of this district and that of South Uniacke from 1862 to Sept. 30, 1898, is given under the same head by the Department of Mines of the province, and it is 38,447 ounces, valued at $749,732, extracted from 54,325 tons; giving an average yield per ton of 2,000 lbs. of $13.80, which is certainly a very satisfactory result. Yield of gold.

'*South Uniacke Gold District.*—This district is situated on the Dominion Atlantic Railway and on the boundary line between Halifax South Uniacke.

Nova Scotia —*Cont.*

and Hants counties. Two weeks were devoted to a survey, with a view of making a large-scale plan of it, but the notes have not yet been plotted, and it would not be judicious to attempt a detailed description of its structure. The following general notes may, however, be given for the present.

'All the veins operated occur here also in slate layers interstratified between heavy beds of quartzite, on the north limb of an anticlinal fold, four miles to the south of the Mount Uniacke and Renfrew anticline.

'The measures on the south side of the anticline lie about horizontal for a distance of over a quarter of a mile, after which they begin to take another dip; while on the north limb, the angle at which they dip gradually increases, till it becomes vertical at a distance of 900 feet, giving to the axis-plane of the fold a dip to the south of about 45°. The fold has a westerly and easterly pitch, forming a very long elliptical dome.

Two veins worked.

'It may be said that only two veins of importance have so far been worked on this dome, the Hard lead and the Slate lead. A rich and wonderfully regular streak, dipping east at an angle of about 28° has been worked on the Hard lead for a total length of some 1,800 feet on that incline, crossing three properties; and it has given the remarkable average yield of ten to twelve ounces to the ton. The Slate lead, lying a short distance to the south of the latter, has also been worked extensively, and was still being operated at the time of our visit.

'These leads are situated at a distance of some 900 feet to the north of the anticline, where the strata begin to assume a vertical and constant dip, after having gradually increased from 0° to 90°, or, in other words, at the limit of the curvature of the truncated fold. This limit constitutes then a narrow zone of special enrichment, which intersects the strata and veins intercalated at a very slight angle, keeping a course more to the north towards the east, and more to the south towards the west. On the leads occurring north of the Hard lead, prospecting should therefore be prosecuted further and further towards the east receding from that lead, and on the leads south of the Slate lead receding further west receding from that lead. In depth the pay-zone dips to the south, like the axis of the fold, at an angle of about 45°.

Other gold Mining districts.

'Besides the above three gold-mining districts actually surveyed last summer, a few other less important mining developments have been examined in the region. The surveys of these have not yet been all plotted, but a few preliminary notes may here be given.

'*Upper Newport Gold District* (McKay Settlement, Ashdale or Meander River).—Five miles north of the Mount Uniacke anticline, the quartzite division of the gold-bearing series is overlain conformably by a great belt of slate of the upper division. The latter, at Upper Newport, is covered on its northern limit by the gypsum, limestone and sandstone of the Windsor series of the Carboniferous. It constitutes the high ridge of the Rawdon and Ardoise hills, and stretches to the south-west to within one mile of Ponhook Lake, on the St. Croix River, where it is cut by granite. The measures of this belt have been plicated into one main synclinal fold, followed to the north by a main anticlinal fold. Nova Scotia —*Cont.* Upper Newport gold district.

'The anticline, which is the most northern one met with to the east of Windsor, runs N. 63° E. (mag.) and follows the escarpment marking the northern limit of the Rawdon and Ardoise hills, but to the east of Herbert River and to the west of Martin Brook, it is covered over by the Carboniferous rocks, which limit its total length to six miles. It crosses the Little Meander River at the McKay settlement bridge, the Meander River three-quarters of a mile above its junction with the latter branch, and the Herbert River at the Rawdon road bridge. These streams cut through deep gorges, affording good sections, but elsewhere rock-exposures are seldom met with, as the surface is covered with heavy drift. Meander River.

'The form of this upheaval is that of a flat, broad fold, the limbs of which dip north at an angle of 15° immediately north of the axis, and south at an angle increasing from 10° to 35°. It pitches to the east between the Little Meander River and its eastern extremity on the Herbert River; but, at a distance of about one mile west of the former river, the fold appears to pitch westward, thus forming a very broad dome, the centre of which is situated at a short distance to the west of that stream. Form of the anticline.

'Several veins have been prospected on the eastern dip of this dome, most of the work being done along the deep gorge of the Little Meander River, below the bridge, where many veins follow the plane of stratification of low-dipping, bluish-black, pyritous slates with occasional bands of black, hard, fine-grained quartzites; and more especially at a point some 500 feet below the bridge, where the strata curve and form an undulation dipping apparently to the north-east. These mining operations are generally called the McKay settlement gold mine.

'A few small veins running north-and-south across the stratification and dipping east at an angle of 85°, have been prospected, by John Withrow and others, on this dome, at a distance of about half a Cross veins

Nova Scotia —*Cont.*

mile west of the Little Meander River, about the same distance south of the McKay settlement road. The deepest shaft on these veins, however, does not reach over 50 feet.

Alluvial deposits.

'*Meander River Alluvial Gold Deposits.*—About 1,500 feet below the bridge on the Little Meander River, the deep and rocky gorge is succeeded by the flat intervale of Meander River, into which flows, some 1,500 feet further, the former stream. The auriferous *débris* washed down by the Little Meander River from the above-described anticlinal fold as well as from the Ardoise gold district, at the head-waters of the same stream and described in the sequel, has been deposited on this flat form in the alluvial deposits, which have lately been worked on a small scale. At the time of my visit, two men were making good wages, I was told, by washing coarse gold from the present bed of this river, some 1,500 feet below the bridge.

'The alluvial deposits of gold extend also below the forks of the two rivers, and numerous prospecting trenches were made across the intervale early last summer, for a mile and a-half down the river, through the gravel and sand to the bed-rock, to ascertain the possibility of their being worked extensively. The results of this operation have not been made public, as far as I know, but it is very probable that some parts of the old river-beds may prove sufficiently rich to be worked with profit.

Ardoise gold district.

'*Ardoise Gold District.*—This is situated on the head-waters of the Little Meander River in Hants county, directly east of Ellershouse station on the Dominion Atlantic Railway, a distance of five and a-half miles by a wagon road. Several veins have been uncovered, a few of which were worked to a limited extent, some years ago. They follow the lines of stratification of a wide band of pyritous, bluish-black, graphitic slate running N. 65° E. (mag.) and dipping south at an angle of 80°. This band forms part of the great slate belt of the Rawdon and Ardoise Hills, above described, and is situated some 2,500 feet above the base of the slate division of the gold-bearing series. The veins occurring here are not the result of an anticlinal upheaval, but have been produced on a broad curvature of the strata with the convexity facing toward the south. The zone affected by this curvature extends some distance north-and-south across the strata and much resembles in its general features the important south zone of the Mount Uniacke district just described. One particularly large belt of auriferous slate, holding veinlets of quartz, has lately been prospected here, and a series of assays conducted by Mr. F. H. Mason, Halifax, has given such satisfactory results as to warrant its being operated.

'*Dufferin Mine, Salmon River Gold District.*—I took occasion last fall, at the close of field operations, to revisit the Dufferin mine, in the gold district of Salmon River, Halifax county, being anxious to learn the result of recent extensive development there, because of its bearing on improved methods of mining in the province generally. This district was surveyed in 1897, and a plan and section on the scale of 250 feet to one inch were published the following year. As stated in the description given at page 110 of the Summary Report for 1897, the surface is so largely covered with drift that only a few outcrops could be observed; moreover, mining operations were at the time suspended, the mine was full of water, and the only other data available to make out the geological structure were those given by the company's plans and sections of the underground workings, which, while giving the general structure of the main workings, made no attempt to unravel the important structure of the measures beyond them, along the cross-cuts towards the north and south. Nova Scotia —*Cont.* Halifax county. Dufferin mine.

'Subsequently, this property was acquired by the Montreal–London Gold and Silver Development Company, re-opened and provided with a thoroughly good mining plant and a modern 60-stamp mill with 23 Frue vanners of a capacity of 240 tons per 24 hours. The important systematic developments made by this company afford an excellent opportunity for studying the structure of the anticlinal fold below the surface, and I have to thank the officers of the company for permission to make such an examination, and Mr. E. A. Daly, the manager, for providing me with every facility and assistance.

'Only a general examination was made of the extensive mining operations carried on by the first company since the discovery in 1880, but a detailed survey was made of the cross-cuts and drifts along the veins at the 134, 200 and 300 feet levels. These surveys were plotted and a transverse section through the vertical shaft has been compiled. This section shows that the form of the anticlinal fold passing through the district differs from that given in the published plan, in that, instead of a single fold, there occur two minor anticlinal flexures along the crest of the main plication. Two anticlines.

'The southern fold, the sharpest of the two, is that on which occurs the system of large superimposed saddle-veins which have been so successfully worked to a depth of over 300 feet. The northern fold, has its apex at a distance of 245 feet to the north of the first, and is much broader. Its southern limb dips south at an angle averaging 45°, and is apparently not favourable to the formation of quartz, as the 200 feet of cross-cut made at the 200-foot level, between the syncline at the vertical shaft and its apex, gave only one vein, one inch in thickness.

Nova Scotia —*Cont.*

The north limb dips to the north at an angle gradually increasing up to 78°, and does not show quartz in the forty-five feet completing the total length of the above mentioned cross-cut to the north. Quartz veins, said to be auriferous, have, however, been uncovered at the surface, at a distance of 105 feet and more to the north of its apex, and these may be worth developing. These veins form a zone extending in depth probably parallel to the axis-plane of the fold and dipping south at an angle of 78°. This inclination corresponds nearly to that of the axis-plane of the southern anticlinal fold, and as the two systems of quartz veins are 300 feet distant from one another, they could not advantageously be worked together.

'Two important and distinct water-powers are situated on the Salmon River, at a distance of three-quarters of a mile to the west and south of the vertical shaft. One of these only is utilized to a limited extent, but if the best possible advantage were taken of the united capacity of both of them, they would be a great source of economy in fuel.

Workings at the Dufferin mine.

'As already stated, all the saddle-veins worked at the Dufferin mine are situated along the apex of the southern anticlinal fold. They follow the planes of stratification and nearly always occur in bands of slate. At the surface, the fold dips south at an angle of 62°, and north at an angle of about 77°, and curves abruptly at the apex which crops out fifteen feet south of the vertical shaft. It pitches eastward and westward at very low angles, forming a long narrow elliptical dome, with its centre not far to the west of the vertical shaft. The axis-plane of the fold dips south at an angle of 77°, being 48 feet distant from the vertical shaft at the cross-cut from the 200-foot level, and 72 feet at the 300-foot level, receding 24 feet to the south of the vertical for every 100 feet of depth.

Limit of the veins

'The axis-plane of the synclinal trough dividing the two anticlinal folds runs parallel with those of the latter and lies 48 feet to the north of that of the southern one. One of the most important conclusions derived from the study of these folds is that the axis plane of the syncline forms the northern and deepest limit of the north-dipping veins along the south fold. The north lead operated by the first company was worked 120 feet in depth, to the bottom of the synclinal trough, where it naturally ended, but was thought by those operating it to be cut off by a fault. At the 200-foot level cross-cut, where the synclinal axis-plane is exactly at the south side of the vertical shaft, a north-dipping vein following a band of slate comes to an end at a point where the strata abruptly curves up under the syncline. In like manner, at the 300-foot level cross-cut, a vein, eight inches in thick-

ness, was observed to pinch out at the syncline, 24 feet south of the vertical shaft. The inclination of the northern limit of the formation of quartz will thus have to be taken into consideration in extending the mining developments to greater depths, for it will probably recede an additional 24 feet to the south of the vertical shaft for every 100 feet sunk below the 200-foot level, so that at a depth of 1,000 feet 192 feet of cross-cutting to the south will have to be done to reach it. Nova Scotia —*Cont.*

'Along the cross-cut, at the 200-foot level, the width of the quartz formation extends from the syncline, at the vertical shaft, for 177 feet towards the south, or 129 feet beyond the anticline, and no quartz was found along the remaining 194 feet of cross-cut. At the 300-feet level the cross-cut extending 254 feet to the south of the syncline, exhibited quartz veins along its whole length.

'As far as mining operations have gone, they prove that the largest and richest bodies of quartz are chiefly confined to the apex of the fold, especially for the first 200 feet in depth. At the 300-foot level the zone of larger and richer veins appears to be less confined to the crest of the fold and to extend to a greater distance to the south. This is due undoubtedly to the fact that the fold gets a little broader at this level. Should this spreading of the fold continue in depth, the zone of enlargement and special enrichment of the veins will probably gradually recede from the anticline towards the south, and will consequently be at a still greater distance from the vertical shaft. However, experience gained at Bendigo, Australia, where similar saddle-veins have been worked to depths of over 3,000 feet, proves that the form of the fold is not always constant but alternately broader and sharper, giving a succession of large saddle-reefs of variable value. In like manner, a succession of large saddle-veins and legs may be met with at the Dufferin mine to a great depth, portions of which will be sufficiently rich to be worked with profit. Richest quartz at the apex.

'All that has been said, so far, refers to the transverse section made at the vertical shaft. If we consider now the main fold on its eastern and western extension, we find that the southern plication is in the form of a long narrow elliptical dome, pitching, from a point not far west of the vertical shaft, towards the east and west at very low angles, gradually increasing to nearly 18°. The first company operated the North and South leads along the western pitch of the fold, for a length of 1,211 feet, and 577 feet towards the east, giving a total development of 1,788 feet along the first saddle-back reef, the stoped portion having an average depth of 120 feet and a maximum depth of 300 feet. At the eastern and western extremities Main fold, east and west.

Nova Scotia —*Cont.*

of these workings, the saddle-veins still kept a good average width and richness, and they may probably be found remunerative for several thousands of feet further east and west.

'Towards the west the bed-rock is heavily covered with glacial drift and no prospecting has been attempted in that direction. Towards the east a little prospecting has been done 1,200 feet east of the vertical shaft, uncovering three large promising veins on the south dip, immediately south of a prominent ridge of "whin" forming the apex of the southern fold; and, as the cover is of little thickness, more development should be done in that direction.

Fault.

'The left-hand fault shown on the published plan of the district, as running north and south at a distance of 850 feet east of the vertical shaft, could not be proved with certainty, but its horizontal displacement is probably not over 50 feet.

Lake Eagle.

'Several large veins have also been uncovered on the south dip at a distance of 3,600 feet east of the vertical shaft, on what was formerly known as the Lake Eagle property, two of which have been worked to a depth of 50 feet. The Montreal-London Company have lately acquired this ground and a vertical shaft is being sunk to develop it. The first vein cut is large and promising and there is reason to believe that the shaft as located will afford the means of working a zone of large payable veins. It must be kept in mind, however, that the zone dips south at an angle probably near 77°, and, as depth is attained, cross-cutting south will have to be made to reach it. This zone is the continuation towards the east of that of the Dufferin, and it goes to show that its whole length, 3,900 feet, from the vertical shaft to the Lake Eagle, is probably worth developing.

Large fault.

'The rock exposures north of the Lake Eagle vertical shaft, apparently indicate a double-folding—the eastern prolongation of that of the Dufferin mine. A left-hand fault passes probably through Lake Eagle in a south-eastern direction, giving a horizontal displacement of some 1,500 feet.

General conclusions.

'From the above description of the structure of the district, it will appear that the southern plication of the main anticlinal fold presents a system of large superimposed parallel saddle-veins, extending over one mile and a half in length and probably to a great depth; that large portions of these veins, already operated along a well-defined zone, have proved highly remunerative for a length of 1,788 and a depth of 300 feet, and that they may be found remunerative for a length of probably over a mile and to a great depth, if the developments are judiciously conducted. Every effort should, therefore, be

made to determine the payable portions of the veins by a careful system of testing along the development workings. In this connection I would strongly recommend mill-tests and would advise that, whenever practicable, the twelve batteries should be fed separately with ore extracted from the different veins of portions of veins. In this way, the exact values of the blocks of veins stoped will be obtained, and, if properly recorded, will show the distribution of gold throughout the veins and be of great assistance in defining the form and direction of the zone of pay-shoots and in laying out future operations. If some such system of value-plans were kept by mine managers, there is no doubt that more extensive permanent mining would be done in Nova Scotia, and many of the now abandoned mines would be found remunerative. Nova Scotia —*Cont.*

'The following are the official returns received at the Department of Mines from the Dufferin mine, from 1881 to the last year of operation of the first company in 1895 :— Yield of gold.

Year.	Tons.	Ounces.
1881	1,640	1,785
1882	3,460	4,315
1883	7,602	3,885
1884	9,799	3,397
1885	10,880	4,924
1886	11,628	6,509
1887	10,602	3,258
1888	9,925	3,354
1889	7,633	2,032
1890	6,415	2,070
1891	5,210	1,406
1892	4,220	1,042
1893	3,220	882
1894	.....	.....
1895	1,467	271
	93,701	39,130

'These figures give an average yield of 8 dwts. $8\frac{1}{5}$ grs. per ton.'

Dr. G. F. Matthew, of St. John, New Brunswick, at my suggestion, has undertaken to make an examination of the Cambrian and other old rocks of Cape Breton Island, with the special purpose of fixing their exact relations and collecting and describing the fossils contained in them. In pursuance of this object he spent about six weeks in the field last summer and is at present devoting his spare time to the study of the specimens. The following is his general account of the work done. He has already prepared and published a preliminary account Work of Dr. G. F. Matthew in Cape Breton.

Nova Scotia —*Cont.*

of some of the fossils obtained in the December number of the Bulletin of the Natural History Society of New Brunswick.

On arriving in Cape Breton, Dr. Matthew first turned his attention to the structure of the rocks that have there been referred to the Cambrian system. He writes :—

The Cambrian rocks.

'The Cambrian (proper) and the Etcheminian which underlies it, are contained in several narrow synclines between St. Andrew Channel and the East Bay of the Bras d'Or Lake and in the broad valley of the Mira River. These formations (terranes) in the narrow valleys generally present monoclinal folds, but in the Mira basin several synclines are developed. The folds usually have high dips on the east side, or are there faulted against the older rocks, felsites and syenites.

'Though both here and in the New Brunswick region the synclines in the Cambrian rocks run north-east and south-west, it will be noticed that in New Brunswick the high dips, overturns and faulted contacts are prevailingly on the north-west side of the folds, whereas in Cape Breton they are generally on the south-east side.

Upper Cambrian fossils.

'Only Upper Cambrian faunas were found in the Cambrian of this region, those of the Lower Cambrian, i.e. *Paradoxides* and *Protolenus*, present at St. John, being apparently absent here.

'The Cambrian rocks of Cape Breton show two principal divisions —a lower, consisting chiefly of flag-stones and sandy slates—and an upper in which fine dark-gray slates prevail. A pure gray colour, sometimes reaching the intensity of black, characterizes all the true Cambrian rocks of Cape Breton except the basal conglomerates, which are sometimes locally coloured by the abounding débris of the immediately underlying rocks.

Effect on topography.

'The difference in texture and cohesion of the rocks of the two divisions of the Cambrian in Cape Breton has affected the topography of the region, for the important streams of the Cambrian areas almost everywhere run over the rocks of the upper division which have been eroded to form valleys and thus give passage to these streams.

'On the contrary, the coarser and harder beds of the lower division, are usually to be found on the ridges between the streams. Such an anticlinal form is the "Big Ridge" in Mira valley. Some hematite beds occur with the Cambrian flagstones on this ridge, which have been deposited under conditions similar to those of the Cambrian hematites of Bell Island in Newfoundland. The Cape Breton beds that have been found, however, are thin. At the southern end of this ridge the surface deposits seem to be liberally charged with iron, which gives an ochreous colour to the soil and glacial *débris*.

'The underlying Etcheminian terrane is contrasted with the Cambrian by its red and greenish-gray tints. It also exhibits two sets of strata of unlike aspect—a lower mostly of red conglomerates and sandstones with effusive volcanic rocks in some districts; and an upper consisting of greenish-gray shales or slates with some usually thin conglomerate bands. These slates are the "argillites" of Mr. Fletcher's reports. The Etcheminian is generally, but not always present beneath the Cambrian, and conforms to it in structure. Nova Scotia —*Cont.* Etcheminian rocks.

'The palæontology of these two terranes is interesting. In the Etcheminian a new fauna was found, consisting so far as observed, of seven species of brachiopods and five of ostracods. The fossils of both these groups show a general resemblance to those of the *Protolenus* zone (Lower Cambrian) in New Brunswick. *All* the genera of this fauna are present in the *Protolenus* beds, but *none* of the species. Their fauna.

'In the Cambrian a fauna occurs just above the basal conglomerate, which, from the species present, would appear to be Upper Cambrian. Above this come strata which by the fossils, burrows and tracks, compare with Band *C* of Division 2 of the St. John group, which is Upper Cambrian. Passing to the upper division of the Cape Breton Cambrian, we find the *Peltura* fauna well developed at several localities, and the *Dictyonema* fauna at one. The full range of the Upper Cambrian faunas as represented in the St. John group is therefore likely to be present in Cape Breton. Fauna of the Cambrian.

'It is therefore important to have an understanding of the structure of the Cambrian system in this island and to find it conform so closely to that of the New Brunswick areas, allowing for the absence of the Lower Cambrian, (*Paradoxides* and *Protolenus* beds).'

CHEMISTRY AND MINERALOGY.

Reporting on the work done in these branches of the Survey's operations, Dr. Hoffmann says:—'The work carried out in the chemical laboratory during the past year, has been conducted upon the same lines as those heretofore followed, that is to say, it has been chiefly confined to the examination and analysis of such minerals, and ores, as were considered likely to prove of economic value and importance. Briefly stated, the ground covered, included:— Dr. Hoffmann's report. Chemistry and mineralogy.

'1. Analyses of fuels, namely of lignites, lignitic coals, and coals.

'2. Analyses of spring-, lake-, and river-waters from localities in the provinces of Nova Scotia, New Brunswick, Quebec and Ontario, the North-west Territory, and the province of British Columbia.

Chemistry and mineralogy—*Cont.*

Examinations made.

'3. Analyses of limestones and dolomites from certain parts of the provinces of Nova Scotia, New Brunswick and Ontario, and the North-west Territory. A continuation of the series of analyses of such stones already carried out in connection with an inquiry into their individual merits for structural purposes, suitability for the manufacture of lime or of hydraulical cement, or employment for metallurgical and other uses.

'4. Analyses of iron ores from various localities in the province of Nova Scotia.

'5. Analyses, partial, of nickeliferous pyrrhotites from the provinces of Quebec and British Columbia.

'6. Assays of a large number of ores for gold and silver from various localities in the provinces of Nova Scotia, New Brunswick, Quebec, Ontario and British Columbia, as likewise from certain parts of the North-east and North-west Territories.

'7. Analyses of rock specimens from the province of British Columbia.

'8. Analyses of several interesting, and, from a commercial standpoint, important minerals, some of which had not previously been recognized as occurring in Canada, as for instance:—1. Hübnerite, a tungstate of manganese, which was found, in some quantity, at Emerald, Inverness county, in the province of Nova Scotia. 2. Natron, a hydrous sodium carbonate, which has been found in a series of small shallow lakes lying not very far north of Clinton, Lillooet district, in the province of British Columbia. In one of these lakes, Lake Goodenough, that from which the material examined was taken, the deposit was found to cover the entire bottom of the lake and to be of considerable thickness, and to represent, as near as could be estimated, some twenty thousand tons of carbonate of soda. In addition to an analysis of the natron, a complete analysis has been made of the water of the lake, as likewise of the mud covering the bottom of the lake and upon which the natron rests. 3. Hydromagnesite, a basic magnesium carbonate, which has been found in considerable abundance in the vicinity of the 108-mile House on the Cariboo road, Lillooet district, and more recently by Mr. J. C. Gwillim, at the back of Atlin town-site, on the east side of Atlin Lake, in the province of British Columbia.

Natron.

Hydromagnesite.

9. 'An analysis has also been made of the celestite (strontium sulphate), from the township of Bagot, Renfrew county, province of Ontario, and an examination has likewise been entered upon of a mineral, evidently spodumene, collected by Mr. A. P. Low, from Walrus Island, east coast of James Bay, Ungava district.

Chemistry and mineralogy—*Cont.*

10. 'Miscellaneous examinations, such as the partial analysis or testing, as the case might be, of brick and pottery clays, shell-marls, graphitic shales, iron-sands, and other material not mentioned under the above headings.

'The detailed results of the foregoing work, are given in my annual report, the manuscript of which has been prepared, and is now in the hands of the printers.

Specimens identified.

'The number of mineral specimens received during the period in question, for identification, examination or analysis, amounted to one thousand and seventeen. Many of these were brought by visitors, and the information sought in regard to them was in most cases communicated to them at the time of their calling. In other instances, however, those where a partial or complete analysis was considered desirable, as also in the case of specimens which had been sent from a distance, the results were communicated by letter. The number of letters personally written, chiefly in this connection, and generally of the nature of reports, amounted to two hundred and eighty-three, and of those received, to one hundred and thirty-five.

Minerals examined

'Messrs. R. A. A. Johnston and F. G. Wait, assistants in the laboratory, have both, as a result of their unremitting assiduity accomplished a very large amount of work. The former has carried out a very large number of gold and silver assays, made many important mineral analyses, and, in addition, conducted a great variety of miscellaneous examinations, whilst the latter has made numerous water analyses, some mineral analyses, many partial analyses, and has also carried out some miscellaneous examinations.

Work of assistants.

'In the work connected with the mineralogical section of the museum I have, as heretofore, been diligently assisted by Mr. R. L. Broadbent. He has been steadily engaged in the permanent labelling and cataloguing of specimens, a work which must of necessity be of a more or less continuous character by reason of the constant additions to the collection, the re-adjustment of certain cases to allow of the introduction of additional specimens, and a variety of other work in connection with the mineralogical and lithological collections.

Contributions to museum.

'The additions to this section of the museum during the past year comprised, one hundred and eighty-one mineral specimens, one hundred and fifty rock specimens, with microscopic sections of the same from the Nipissing and Temiscaming regions, collected by Mr. A. E. Barlow, and three hundred and sixty-four rock specimens

Contributions to museum —*Cont.*

from the Ungava district, collected by Mr. A. P. Low. Of the additions to the mineralogical collection, the following were :—

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

Ami, Dr. H. M.:—

a. Copper-pyrites, iron-pyrites, and spathic iron, from Polson Lake, Antigonish county, N.S.

b. Gypsum (var. selenite), from a quarter of a mile from Grand Lake, Douglas township, Hants county, N. S.

c. Hæmatite, from Grand Pré, Kings county, N. S.

d. Native copper, from Cape d'Or, Cumberland county, N. S.

e. Barite, from six miles north of Brookfield, Colchester county, N. S.

f. Analcite, from McKay Head, above Parrsborough Harbour, Cumberland county, N. S.

g. Amygdaloidal trap, from River Avon shore, Horton Beach, Bay of Fundy, Kings county, N. S.

h. Oil shale showing effects of weathering, from the Albert mines, Albert county, N. B.

i. Honey-combed limestone, from the nine-fathom reef, seventy miles south of Burnt Island, Lake Huron, O.

Barlow, A. E.—

a. Biotite, from the township of Cardiff, Hastings county, O.

b. Magnetite (large crystals), from the township of Faraday, Hastings county, O.

c. Corundum (blue), from the township of Dungannon, Hastings county, O.

d. Pyrrhotite, from the township of Dungannon, Hastings county, O.

e. Pyroxene and orthoclase (crystals), from the township of Herschell, Hastings county, O.

Brock, R. W.—

a. Jamesonite, from D. Whitley's (Red Paddy's) claim, head of Kettle River, Yale district, B.C.

b. Gmelinite, from the War Eagle mine, Rossland, West Kootenay district, B.C.

Gwillim, J. C.—

a. Magnesite rock, from about one mile north of Pike River, Cassiar district, B.C.

b. Hydromagnesite, from Atlin, Cassiar district, B. C.

c. Volcanic ash, from Fourth of July Creek, Atlin, Cassiar district, B.C.

Contributions to museum —*Cont.*

Low, A. P.—

a. Epidote, 35 specimens, from Walrus Island, Paint Hills, east coast of James Bay, Ungava district, N.E.T.

b. Spodumene (?) 14 specimens, from Walrus Island, Paint Hills, east coast of James Bay, Ungava district, N.E.T.

c. Molybdenite, 15 specimens, from island No. 12, Paint Hills, east coast of James Bay, Ungava district, N.E.T.

d. Amazon stone, 7 specimens, from islands at Paint Hills, east coast of James Bay, Ungava district, N.E.T.

e. Garnet, from Cape Hope, east coast of James Bay, Ungava district, N.E.T.

f. Axinite, 30 specimens, from Manitounuck Sound, east coast of Hudson Bay, Ungava district, N.E.T.

g. Magnetite and hematite, 5 specimens, from Nastapoka Islands, east coast of Hudson Bay, Ungava district, N.E.T.

h. Anthraxolite, from Long Island, south of Great Whale River, east coast of Hudson Bay, Ungava district, N.E.T.

McEvoy, James :—

a. Altaite, from Pay Roll mine, Nigger Creek, twelve miles S.W. of Cranbrook, East Kootenay district, B.C.

b. Silt from near the foot of the glacier, at Glacier, C.P.R., B.C.

(*B.*) Received as presentations :—

Albert Manufacturing Company, Hillsborough, N.B. :—

Gypsum with albertite, from Hillsborough, Albert county, N.B.

Blue, John, Eustis, Q. :—

Vivianite, from lot 25, range II of Hatley, Stanstead county, Q.

Brehlich, H., Nelson, B.C. :—

Chalcocite, from the Grey Eagle claim, near Meadow Creek, Kamloops, Yale district, B.C.:—

Cameron, J. J.

Tourmaline, from the Stormont gold district, Guysborough county, N.S.

Carter, J. J., Manilla, O., per Dr. H. M. Ami, (Survey) :—

a. Calcareous tufa, from the township of Brock, Ontario county, O.

b. Shell marl, from the township of Somerville, Victoria county, O.

De Wolf, Geo., Vancouver, B.C.:—

Limonite, from the Lardeau district, B.C.

Fossil Flour Company, Bass River, N.S., D. S. Collins, Manager :—

Infusorial earth (tripolite), from Bass River, Five Islands, Colchester county, N.S.

Contributions to museum —*Cont.*

Fraser, J. D., Springville, N.S., per Dr. H. M. Ami (Survey) :—
Limestone, from Springville, Pictou county, N.S., used as a flux by the Nova Scotia Steel Company, New Glasgow, N.S.

Genest, P. M. A., Department of Crown Lands, Quebec :—
Model of a gold nugget from the Gilbert River, Beauce county, Q.

Hallwright, Dr. F. W. :—
Copper-pyrites, from Great Slave Lake and Buffalo River, N.W.T.

Hille, F., Port Arthur, O., per W. McInnes (Survey) :—
Amethystine quartz with crystals of green fluorite, from the Porcupine (Twin Cities) mine, township of Gillies, district of Thunder Bay, O.

Hunter, Mrs. H., Granite Creek, B.C. :—
Limestone concretion, from Granite Creek, Yale district, B.C.

Jones, L. G., Morden, Manitoba :—
Nodule of iron-pyrites, from Morden, Manitoba.

Klock, R. A., Klocks Mills, O.
Copper-pyrites, iron-pyrites, galena and zinc blende, from Matta wabika River, Montreal River, district of Nipissing, O.

Macfarlane, Thomas, Ottawa, O., per Dr. R. W. Ells (Survey) :—
Moss litter, from Welland county, O.:—

McAlister, John, M.P, Campbellton, N.B.:—
Native copper, from Scaumenac River, Bonaventure county, Q.

Markham, Alfred, St. John, N.B.:—
Mountain cork, from west side of harbour, near village of Lower Five Islands, Colchester county, N.S.

Obalski, J., M.E., Inspector of Mines, Quebec :—
a. Clay, from lot 45, range IV. (on Petite Paquette River), township of Macpès, Rimouski county, Q.
b. Marl, from Lac à la Peinture, township of Neigette, Rimouski county, Q.

Parsons, J. A., Halifax, N.S., per Dr. H. M. Ami (Survey) :—
Sand from Sable Island, off the east coast of Nova Scotia.

Poirier, Senator, Shediac, N.B. :—
Bog iron-ore, from Rogerville, Northumberland county, N.B.

Queen City Oil Company, per E. A. Olver, Ottawa, O.:—
Sample of Canadian coal oil (Photogene).

Ritchie, R. McG., Bryson, Q.:—
Pyrrhotite, from lot 5, range II. of Calumet Island, Pontiac county, Q.

Contributions to museum —*Cont.*

Robillard, Henry, Ottawa, O.:—
Limestone, from lot 22, con. I. (Ottawa front), township of Gloucester, Carleton county, O.

Roger, C. J., Ottawa, O., per Dr. H. M. Ami (Survey) :—
Sandstone, from South March, Carleton county, O.

Rudderham, D.:—
Infusorial earth from Cape Breton county, N.S.

Rutledge, J., Ottawa :—
Mica (phlogopite), from lot 2, range V. of Masham, Ottawa county, Q.

Ryan, A.:—
Limestone concretions, from Les Erables, Ottawa River, township of Mattawan, district of Nipissing, O.

Soues, F., Clinton, B.C.:—
Auriferous quartz, from McGillivray Creek, Anderson Creek, Lillooet district, B.C.

Sutherland, Hugh, Winnipeg, Man.:—
Silver ore, from California mine, Nelson mining district, West Kootenay, B.C.

Thompson, R. M., President Orford Copper Company, 99 John Street, New York :—

Samples of nickel refinery products :—
a. First matte.
b. Concentrated matte.
c. Copper tops.
d. Nickel bottoms.
e. Copper matte from '*c.*'
f. Blister copper from '*e.*'
g. Finished nickel oxide.
h. Finished nickel.

Thomson, H. C., 3 Park Square West, Regents Park, London, N.W., England :—
Titanic iron ore, from Rapid River, Bay of Seven Islands, Saguenay county, Q.

Wallingford, E., Templeton, Q., per C. W. Willimott (Survey) :—
Concretionary nodule, from the Blanche River, Templeton, Ottawa county, Q.

Weston, T. C., Ottawa :—
Fossiliferous limestone, from Mountain Hill Cliff, Quebec city, Q.

Contributions to museum —*Cont.*

Willimott, C. W., Ottawa

Crystals of sphene, from the township of Litchfield, Pontiac county, Q.

Yeo, C. T., Ottawa Normal School, per Dr. H. M. Ami (Survey) :—

Calcareous tufa, from the north-east corner of the township of Scarborough, York county, O.

Collections presented to educational institutions.

'Mr. C. W. Willimott was, during the first three months of the year, for the most part engaged in making up collections of minerals and rocks for various Canadian educational institutions. The following is a list of those to which such collections have been sent :—

1.	Armstrong Corners School, Gasperaux Station, N.B.....	75 Sps.
2.	No. 5 Demoiselle Creek School, Hillsborough, N.B..	75 "
3.	High School, Port Hawkesbury, C.B	100 "
4.	St. Andrews School, Annapolis Royal, N.S.....	100 "
5.	Public School, Tatamagouche, N.B	75 "
6.	High School, South Edmonton, N.W.T..... ..	100 "
7.	St. Dunstans Convent, Fredericton, N.B	75 "
8.	North Head Superior School, Grand Manan, N.B.... ...	100 "
9.	High School, Westport, Digby, N.S.....	100 "
10.	High School, Port Dover, Ont.....	100 "
11.	Public School, Pleasantvale, Albert Co., N.B.....	75 "
12.	Prince of Wales College, Charlottetown, P.E.I	100 "
13.	High School, Blackville, N.B.....	100 "
14.	Model School, Freligsburg, Que.....	75 "
15.	Shawville Academy, Shawville, Que.....	75 "
16.	Free Library, Vancouver, B.C.....	100 "
17.	St. Margaret College, Toronto, Ont.....	100 "
18.	Lennoxville Academy, Lennoxville Que.....	75 "
19.	St. Peter's Convent, St. John, North End. N.B.....	75 "
20.	No. 4 School, Meductic, York Co., N.B.....	75 "
21.	Public School, Wallace, N.S.....	75 "
22.	Trafalgar Institute, Montreal, Que.....	75 "
23.	No. 5 School, Rothesay, Nauwigewauk, N.B.....	75 "
24.	Selma School, Selma, N.B.....	75 "
25.	High School, Victoria, B.C....	25 "
26.	St. Anne's Convent, Glace Bay, C.B., N.S.....	75 "
27.	Lourdes Convent, Lourdes, Pictou, N.S.....	75 "
28.	Public School, Pisarinco, N.B..... ...	75 "
29.	Superior School, Dalhousie, N.B.....	25 "
30.	High School, Leamington, O.....	100 "
31.	Havre de Boucher School, Antigonish, N.S..... ..	75 "
32.	Aberdeen High School, Moncton, N.B....	100 "
33.	Central High School, Hamilton, Ont....	100 "
34.	Victoria Museum, Peterborough, Ont.....	100 "
35.	County Academy, Antigonish, N.S.....	100 "
36.	Notre Dame Convent, Newcastle, N.B..... ...	75 "
37.	Granby Academy, Granby, Que	100 "

'In addition to which, the following persons have been supplied :—

D. W. Macdonald, Edmonton, N.W.T., with 25 specimens, in exchange.

Collections presented to educational institutions —*Cont.*

Col. A. W. Roebling, Trenton, N.Y., U.S., with 1 specimen.

Consul General for Belgium, Ottawa, with 5 specimens.

E. H. Matthews, York Town, South Australia, with 25 specimens in exchange.

J. D. Fraser, Ferrona, Nova Scotia, with 75 specimens in exchange.

'Making a total of three thousand two hundred and six specimens thus distributed.

Work for Paris Exhibition.

'From the commencement of April to the close of the year, Mr. Willimott was principally occupied in connection with the collection, reception and despatch of the specimens from various parts of Canada intended for the forthcoming exhibition in Paris. In this work he visited Montreal, Richmond, Sherbrooke, Dudswell, Black Lake and Quebec city, all in the province of Quebec. At a later date he proceeded to Halifax, to secure uniformity in regard to the collections from Nova Scotia, brought together there by the provincial Department of Mines and Works.'

MINERAL STATISTICS AND MINES.

Statistics and Mines.

Of the work of this section, Mr. E. D. Ingall, reports as follows:—

'The section has throughout the year performed its regular function of collecting and recording information regarding the mineral resources of the country, not only for the purpose of issuing the annual report, but in order to have on record as complete information as possible relating to the various mineral deposits of commercial importance and to their development.

'Besides the information of a technical and statistical nature made public through the annual reports, much has been done, as usual, in the way of preparing numerous memoranda of information in answer to special inquirers.

'It has been attempted also, in the various annual reports, to meet the public needs along these lines by collecting from trustworthy sources all the facts available regarding one or two economic minerals or mineral industries and to present these in the form of special articles. It is hoped in this way to gradually cover the whole ground, so that inquirers may find in these reports, in epitomised form, all the available data on these matters, together with references to the literature of the subject where those so desiring may find more detailed descriptions. Wherever possible it is intended to supplement this information by studies in the field and on these lines the last annual report will be found to embody the results of a preliminary examin-

Statistics and Mines—*Cont.*

ation of the gas and oil districts of Ontario made by Mr. Theo. Denis of the section.

Issue of reports.

'The annual report for 1898 was finished toward the end of the following year, as soon as the complete information required became available. It was preceded, however, on February 21, 1899, by an advance statement of the mineral production of Canada for 1898. Besides the usual office duties connected with the above-mentioned work, the section has been engaged in the preparation of a technical descriptive catalogue to accompany the mineral exhibit of Canada at the Paris exhibition.'

Mr. Ingall spent a short time in the Buckingham phosphate and graphite mining district, Quebec, on field work with Professor Osann, of Germany.

PALÆONTOLOGY AND ZOOLOGY.

Work by Mr. J. F. Whiteaves.

Mr. Whiteaves reports that, having been elected vice-president and chairman of the Geological and Geographical Section of the American Association for the Advancement of Science for the meeting held at Columbus, Ohio, in August last, it became his duty to prepare and deliver a suitable address on that occasion. The subject chosen was the Devonian System in Canada, and it was treated from a palæontological rather than from an economic point of view. In this address an attempt was made to give a brief but reliable historical sketch of the discovery of Devonian rocks, and a summary of the latest state of our knowledge of these rocks, in every province and district of the Dominion. Its preparation necessitated much careful research and the verification of a large number of statements. It was delivered at Columbus on August 21, and advance copies, printed by the association, were distributed at the meeting and to geologists elsewhere. In this shape the address makes a pamphlet of thirty-one pages, octavo. It is printed *in extenso* in the Transactions of the Association for 1899, and had previously been published in *Science* and in the *American Geologist* for October last.

Mesozoic Fossils.

'The manuscript of the fourth part of the first volume of *Mesozoic Fossils*, referred to in the last year's Summary Report of this department, as having been written, has been revised for publication, and is now in the printer's hands. It will be illustrated by seven full page and for the most part lithographic plates. The drawings for these plates have been made by Mr. Lambe, and the plates themselves have been printed off. It is expected that the complete part will be ready for issue early in 1900.

Palæontology and Zoology —*Cont.*

Trenton fossils from Akpatok.

'A small collection of fossils from Akpatok Island, Ungava Bay, Ungava, made by Dr. R. Bell, while accompanying the Hudson Bay expedition despatched by the Canadian government in 1897, in the *Diana*, has been critically examined, and a paper upon them has been written and published in the *American Journal of Science* for June, 1899. These fossils are of special interest to the geologist, as they clearly indicate the existence of the Trenton limestone at that far distant and previously unexplored locality. Among them there were a few duplicates, which were sent to the United States National Museum, in exchange for a small series of fossils recently collected from the Trenton formation at Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

'Several other collections of fossils, and more particularly some small consignments of specimens from the Corniferous limestone near Amherstburgh, Ont., have also been examined, and the species determined as far as the state of their preservation would permit.

Report on marine invertebrata.

'In view of the fact that the federal government has recently established a marine biological station at St. Andrews, N.B., a commencement has been made of a report on the marine invertebrata of the river and gulf of St. Lawrence and Atlantic coast of Canada, with the view of placing upon record the exact state of our knowledge of the subject up to the present time. This report is intended to consist of as complete a list as possible of all the species dredged or otherwise collected, from the United States boundary to the Strait of Belle Isle, not only by Dr. W. Stimpson, Sir J. W. Dawson, Dr. R. Bell, Prof. A. E. Verrill, Dr. A. S. Packard, the writer, and others, but also of those dredged off Halifax by H.M.S. *Challenger* in 1872, and in the Bay of Fundy and Atlantic coast of Nova Scotia by the United States Fish Commission. It will be based upon notes that have been accumulated since 1873, and in it the geographical and bathymetrical range of the different species will be given as far as practicable, also notes on their synonymy and specific affinities. Considerable progress has been made with the manuscript of this report.

'Two collections of the recent land shells of New Brunswick have been examined and named for Mr. G. W. Bailey, of Fredericton.

Work by Dr. H. M. Ami.

'Dr. Ami reports that he has continued the work of determining geological horizons from collections of fossils. These comprise specimens collected from the Ottawa Palæozoic basin, also collections sent in by Prof. L. W. Bailey, of the University of New Brunswick, from the slate belt of York and other counties in New Brunswick. The last

Palæontology and Zoology —*Cont.*

named collections show that portions at least of the slate belt are Silurian rather than Ordovician. The collections recently made by himself and others from the Carboniferous rocks of Nova Scotia, have been submitted to a preliminary examination. The field-work was preceded by a study of the literature of similar geological formations in other countries.

Examination of Carboniferous limestones.

'In August, he received instructions to go to Nova Scotia and New Brunswick to examine the marine Carboniferous limestones and associated formations and obtain such palæontological evidence as might serve to fix their true position. Numerous fossils were obtained from these limestones at the following localities :—Near Queenstown, P.O.; at Gilbert Merritt's lime-kiln, in the parish of Hampstead, Queens county, N.B.; Rush Hill, parish of Wickham, Queens county, N.B., Petitcodiac, Westmoreland county, N.B.; and from Kentville Creek, Johnsons Brook and Brookfield in Cumberland and Colchester counties, Nova Scotia. Some of these limestones appear to indicate the presence of the Windsor formation.

'An extensive collection was made of the fossils from the Brookfield limestone of Colchester county, N.S., in which some thirty species were recognized. These fossils have as yet only been subjected to a preliminary examination, but provisional lists of the species have been prepared.

Fossils of the Windsor series.

'From an outcrop of limestone at the mouth of Kentville Creek, in Cumberland county, and near the head of Pugwash Basin, he obtained an interesting series of marine Carboniferous fossils belonging to the same horizon as the Brookfield and Windsor limestones of Colchester and Hants counties. The fossiliferous limestones from these three localities, may be taken as typical of the marine sediments in the counties mentioned, and are therefore classed together as representatives of the Windsor formation, a term adopted from Sir William Dawson's designation "the Windsor series" as applied to the same sediments. The Windsor formation as developed on Kentville Creek forms an interesting outcrop of highly fossiliferous limestone, the organisms being preserved for the most part in concretions or nodules of impure limestone. Bands of impure limestones and limestone-conglomerate also occur along the Joggins and Minudie shores in Cumberland county, interstratified with the sandstones and shales of the Minudie section, but no fossils were found in them. The shales, however, proved to be highly fossiliferous, at Minudie as well as along the valley of the Wallace River to the east, where the measures occur in the form of a large denuded anticline. Estherians, remains of insects, Anthrocomyæ and ferns were found in these shales. The insect wings,

are apparently referable to the *Palæodictyoptera* and the family *Gerarüdæ*, *Estheriaidæ* and *Ostracoda* were also obtained. The physical conditions under which these beds were deposited must have closely resembled those characterizing the deposit of the Coal Measures proper. Palæontology and Zoology —*Cont.*

'At Mr. Hugh Fletcher's suggestion, and while in the Cumberland coal-field, Dr. Ami examined the fossiliferous shales and sandstones of Capt. Henry Mills' Brook in the valley of the Maccan River. These he believes, represent the same geological horizon as those of the beds at Leamington and also near Springhill mines. From the marine limestones of the north-eastern flank of Claremont Hill, at Johnson's Brook, some fifteen species of fossils were obtained belonging to the horizon of the Windsor formation. Limestones referable to the same formation were subsequently examined at Summer Hill Brook on the Nerepis River, three miles west of Summer Hill settlement, in Queens county, N.B. Cumberland coal-field.

'While in Dorchester, New Brunswick, Dr. Ami, with the acting warden of the maritime penitentiary, examined the tilted and considerably disturbed and unevenly bedded sandstones and conglomerates of the Millstone Grit, which crop out immediately north of the present wooden wall of the penitentiary, with a view to ascertain their fitness for building purposes. The greater part of the rock is unfit for this purpose, but some portions of the ledges will furnish building stone of smaller sizes 5′ x 5′ x 2′ down. The rock is in part conglomerate and in part a freestone which hardens when exposed to the air. Building stone in Dorchester.

'The collections of fossils made during the past three seasons in Nova Scotia and New Brunswick* have been catalogued and placed in drawers in geographical order, for further study or reference.

'With a view of determining the relations of the Carboniferous and Devonian rocks of Nova Scotia and New Brunswick, several collections of fossil plants, crustacea and fishes from various localities in these provinces were forwarded to Mr. Robert Kidston, F.G.S., of Stirling, Scotland, and to Dr. A. Smith Woodward of the British Museum. Carboniferous and Devonian.

'The following are some of the conclusions to which Mr. Kidston has arrived from the evidence of the fossil plants. These, as well as those arrived at by Dr. White, subsequently referred to, have already been quoted by Mr. Whiteaves in his address before the American Association, for the Advancement of Science at its last meeting. Referring to the fossils of the Horton formation Mr. Kidston writes :— Report by Mr. Kidston.

'"These rocks appear to be undoubtedly Lower Carboniferous.... There is no evidence at all to support the opinion that they are of

* *Erratum.*—In Sum. Rep. for 1897, p. 135, omit *Cyclopteris (Aneimites) Acadica* and *Lepidodendron corrugatum.*

Palæontology and Zoology —*Cont.*

Devonian age.... All the evidence derived from a study of these fossils points very strongly against this view."

'Of the Riversdale plants, Mr. Kidston writes:—"The two divisions of this series, the Riversdale and Harrington River rocks, may be treated together, as they contain the same fossils and are evidently of the same age. The whole of the plants from the Riversdale series have a most pronounced Upper Carboniferous facies and markedly possess the characteristics of a Coal Measure flora. Judged from an European comparison, no other conclusion can be arrived at."

'Bearing upon the question of the identity of the flora of the Riversdale rocks of Nova Scotia with the Lancaster formation in New Brunswick, Mr. Kidston says:—"The question of the age of the Riversdale series is inseparably connected with the question of the age of the plant beds of St. John, N.B. The species contained in the Riversdale series are also met with in the St. John plant beds, where however, a greater number of species has been discovered. I do not wish to express my views as to the age of the St. John plant beds too strongly, but from what I have been able to learn from a study of the literature of the subject and an examination of specimens from these beds, it appears to me that they possess a flora of a much higher horizon than that assigned to them, and that in reality they are most probably Upper Carboniferous."

Opinion of Dr. D. White.

'Dr. David White, of the U. S. Geological Survey, who, when in Ottawa some time previously had examined many of the plant remains from the formations above referred to, has also kindly communicated his opinion in regard to the horizons represented. He states:—"(1) That the plant-bearing portion of the Horton series of Nova Scotia, as shown by Sir William Dawson in 1873, is nearly contemporaneous with the Pocono formation of the eastern United States, which has long been assigned to a basal position in the Carboniferous system. (2.) That the Riversdale series of Nova Scotia (which Sir William Dawson referred to the Millstone Grit) is of Carboniferous age and assuredly newer than the Horton series. (3.) That the plant bearing beds near St. John, N.B., are not Middle Devonian as had previously been supposed, but Carboniferous, and that they are the exact equivalent of the Riversdale series of Nova Scotia."

Statement by Dr. H. Woodward.

'In a paper by Prof. T. Rupert Jones and Dr. Henry Woodward, published in the *Geological Magazine* for September, 1899, in which two specimens of a protolimuloid crustacean from the Riversdale formation of Nova Scotia are described under the name *Belinurus grandævus*, these authors regard the Riversdale rocks as of Lower Carboniferous age. Prof. T. Rupert Jones also has come to a similar

conclusion, on the evidence of some fossil ostracoda and phyllopoda sent to him in 1898. Palæontology and Zoology —*Cont.*

'Dr. A. Smith Woodward reports upon the fish remains as follows :—

'"From the shales of the Riversdale formation near Eastville on the Stewiacke River, Colchester county, N.S.—The specimen from the Stewiacke River is determined by Dr. Traquair to be a Palæoniscid clavicle. The genus is doubtful, but is almost certainly of a Carboniferous type. Dr. A. Smith Woodward on fish remains.

'"From the shales of the Horton formation, Horton bluff and Trenholm Brook, Kings county, N.S. The Horton fossils are certainly Carboniferous, but are not enough to determine whether Upper or Lower. The pieces of bone-bed exhibit scales of *Elonichthys*, species of *Acanthodes*, and one imperfect clavicle of a Rhizodont (probably *Strepsodus*. The fine piece of jaw is a dentary of *Strepsodus Hardingi*, Dawson, sp.

'"From the shales and calcareous sandstones of McArra Brook, Antigonish county, N.S. The specimens from McArras's Brook are extremely interesting and represent the base of the Lower Old Red Sandstone of Britain. "The Pteraspidian remains are sufficient to prove that they belong to the genus *Pteraspis*. Both dorsal and ventral shields are so much like those of *P. Crouchii*, that if these Nova Scotian fossils had been found in the west of England we should have referred them to the latter species. Perhaps the rostral plate may prove to distinguish your form when it is completely known. One piece of dorsal shield, in counterpart, shows the impressions of the supposed branchial pouches on one side. The pointed fragments may be Cephalaspidean cornua, but are uncertain.

'"There is the typical *Onchus Murchisoni*, Ag.

'"Most interesting is one small fragment of *Psammosteus*, with ornament identical with that of *Psammosteus Anglicus* (see Traquair, Ann. Mag. Nat. Hist., ser. 7, Vol. II, 1898, p. 67, pl. I, figs, 1, 2.) In this fossil the chambers of the middle layer are larger than in our unique plate.

'"On the whole, I should place the McArra Brook beds on the same horizon as the Old Red cornstones of the Hereford district of England, above the passage beds."

'It will thus be seen that Mr. David White's and Mr. Kidston's views on the fossil plants of the Riversdale formation and Horton series; and those of Dr. A. Smith Woodward upon the fossil fishes of the Horton, as well as his well known views on the age of the Albert Coincidence of opinions given.

Palæontology and Zoology —*Cont.*

shales of New Brunswick; also the views of Prof. T. Rupert Jones and Dr. Henry Woodward on the evidence afforded by the Ostracoda and Crustaceans; concur in placing these formations in the Carboniferous system.

Determination of fossils.

'During the early summer months, some time was spent by Dr. Ami in determining and making lists of the species in collections made by Dr. R. W. Ells, Mr. W. J. Wilson and the late Mr. N. J. Giroux, in eastern Ontario. Some days were also spent in the field with Dr. Ells in the same region, for the purpose of defining the geological horizons by means of the fossils. The principal results are noted by Dr. Ells in his report on a previous page. Details, with lists of fossils, are reserved until the publication of the maps. Collections made by Prof. L. W. Bailey in New Brunswick, were also examined, of which the results are quoted by Prof. Bailey in his report in this summary. Several collections sent in for identification were likewise dealt with.

'In the early part of the summer, Dr. Ami completed a report on some Cambro-Silurian and Silurian fossils from Lake Temiscaming, Lake Nipissing and Mattawa outliers. This has since appeared as an Appendix to Mr. Barlow's report on the Nipissing and Temiscaming region.

Borings in Ontario.

'A number of drillings from Montreal and from the counties of York and Lambton, Ontario, were examined with interesting results in some cases. The existence of several hundred feet of bituminous shales and limestones in the south-eastern corner of Lake Huron was ascertained, which indicate a possible modification of the limits of the Portage and Genesee, the Chemung and Hamilton formations of that region.

Museum work.

'Time was also found by Dr. Ami to prepare several small collections of fossils for educational institutions from duplicate material on hand.

'The various additions to the Ethnological collection of the Museum made during the year have been duly entered and recorded, and some of them placed in the Museum.

'During the year Dr. Ami has also prepared papers on the following topics with special reference to Canadian geology. On the Subdivisions of the Carboniferous System in Eastern Canada, read before the Nova Scotia Institute of Science, Halifax. On a Collection of Fossils from the Trenton formation of Cumberland, Ontario, made by Prof. T. Slater Jackson, in 1890. On the occurrence of *Belinurus grandævus*, a New Species of Palæozoic Crustacean recently described by Prof. T. Rupert Jones and Dr. Henry Woodward from the Eo-Carboniferous

of Riversdale, Nova Scotia. On a New or hitherto Unrecognized Geological Horizon in the gas and oil region of Western Ontario, Canada.' Palæontology and Zoology —*Cont.*

Mr. L. M. Lambe reports as follows :— Work by Mr. L. M. Lambe.

'The greater part of my time during the past year has been occupied in completing a revision of the genera and species of Canadian Palæozoic Corals. The manuscript of this report, to form the second part of the fourth volume of *Contributions to Canadian Palæontology*, is now finished, and gives the results of a study of the Aporosa and the Rugosa, two groups of madreporarian corals. Descriptions are given of ninety-four species, included in twenty-four genera. Drawings, composing thirteen plates, for the illustration of this report, have also been prepared.

'The first part of the fourth volume of *Contributions to Canadian Palæontology*, consisting of a revision of the Madreporaria Perforata and the Alcyonaria, has been printed. It contains descriptions of seventy-four species, with some varieties, belonging to twenty-two genera, making nearly one hundred pages of text, illustrated by five plates of figures.

'These two reports, together, will form a monograph on Canadian Palæozoic Corals that, it is hoped, will prove of use in leading to a better understanding of the numerous species of fossil forms of the Zoantharia and the Alcyonaria, as regards their structure, their specific and generic relations to each other and their range in geological time. Determination of sponges.

'Two years ago the examination of a collection of calcareous, monaxonid and tetractinellid recent sponges from the Gulf of St. Lawrance, Labrador, Greenland and the Arctic Ocean, belonging to Professor D'Arcy Thompson, of University College, Dundee, Scotland, was undertaken, with a view to publishing any results arising therefrom that might prove of interest from a zoological standpoint. Considerable headway has been made with this collection, the preliminary work, principally the preparation of microscopic slides, being done as time permitted, for the most part out of office hours. Since the middle of November my time has been almost entirely devoted to the determination of the Calcarea, which, from their generally small size and complex structure, offer somewhat increased difficulties to a satisfactory elucidation of their specific characters. Some of the forms in the collection are apparently undescribed, and it is hoped that a paper with explanatory figures will shortly be ready that is intended to supplement the one already published on the sponges from the Atlantic Coast of Canada.

Palæontology and Zoology —*Cont.*

'Drawings were prepared, in the early part of the year, for six plates, viz., XXXIV. to XXXIX. inclusive, illustrating Part IV., Volume I. of *Mesozoic Fossils*.

Contributions to museum.

'The following is a list of specimens collected by, or received from, officers of the staff, during the year 1899 :—

Professor Macoun :—

Pair of the Ipswich Sparrow, and of the Common, Arctic and Roseate Terns ; four sets of eggs of the Arctic Tern ; and a collection of marine invertebrata ; all from Sable Island, Nova Scotia.

Dr. R. W. Ells :—

Black River fossils from Point Seche and other places along the north side of Lake Coulonge, Ottawa River ; also from a quarry on the line of the Cornwall and Ottawa Railway, about half a mile south of Embrun station.

Drs. R. W. Ells and H. M. Ami :—

Black River limestone fossils from the quarries at Glen Robertson, on the Canada Atlantic Railway, and from a quarry on the River à la Graisse, in East Hawksbury.

Dr. R. W. Ells (per Howells Fréchette) :—

Set of thirty-three eggs of the Snapping Turtle (*Chelydra serpentina*), and one, containing the very unusual number of ten eggs of the Bronzed Grackle (*Quiscalus quiscalus æneus*), from Manotick, Ont.

A. P. Low :—

Skeletons of Cross Fox, and Marten.

Skin of Bearded Seal.

Skins of male and female Goshawk, Rough-legged Buzzard, Pigeon Hawk and Kittiwake.

Set of eggs of the Goshawk, Redpoll, White-crowned Sparrow and Black Guillemot.

Collection of eggs from Nachvak and Fort Chimo, Ungava.

Specimens of carved walrus ivory from Hudson Bay.

Two Eskimo bows and arrows and a fish spear.

Skeleton of Polar Bear, presented by Rev. W. G. Walton, of Fort George.

Fifteen skins of hawks, ducks, &c., presented by Miles Spencer, of Fort George, Hudson Bay.

W. McInnes :—

One skull of black bear ; two skulls of fisher (male,) and one of fisher, (female) ; also a collection of beaver gnawed wood, beaver teeth, &c., from the Rainy River district.

Contributions to museum —*Cont.*

Dr. H. M. Ami :—

Large collections of fossils from the Devonian and Carboniferous rocks of southern New Brunswick and northern Nova Scotia, from the Cambro-Silurian (Ordovician) rocks of the eastern part of the Ottawa basin, and from the Pleistocene deposits of the Ottawa valley.

A. E. Barlow :—

Set of eggs of the Spotted Sandpiper, of the Night Hawk and Brown Thrasher ; from Peterborough county, Ont.

R. W. Brock :—

Indian stone pestle, from Burton City, B.C.; and pair of West Kootenay ' bear-paw ' snowshoes.

D. B. Dowling :—

Twenty fossils from the Niagara formation of Moose Lake, Saskatchewan.

J. C. Gwillim :—

One fossil from Willow Creek, Atlin, B.C. ; and an obsidian arrow-head from Atlin Lake.

The additions to the palæontological, zoological and ethnological collections from other sources during 1899, are as follows :—

By presentation :—

(A.—*Palæontology.*)

U. S. National Museum, Washington, D.C. :—

Twenty specimens of eleven species of fossils from the Trenton limestone at Silliman's Fossil Mount ; and two ventral valves of *Obolella crassa*, Hall, from the Lower Cambrian rocks at Troy, N.Y.

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

180 fossils from the Cambro-Silurian drift at Winona, Ont., and from the Clinton and Niagara formations near Hamilton.

T. C. Weston, Ottawa :—

Fine specimens of *Cheirurus Apollo*, *Bathyurus Saffordi*, and four other rare fossils from the Lévis rocks at Point Lévis, P.Q. ; and fifty fossils from the Mountain Hill rocks at Quebec City.

T. J. Pollock, B.A., Aylmer :—

Two specimens of *Coscinium proavium* (Eichwald ?) Billings, from the Black River formation at Aylmer.

Contributions to museum —*Cont.*

J. J. Carter, Manilla, Ont. :—

Fine specimen of *Calymene senaria*, Conrad, from a loose piece of limestone on lot 6, township of Brock, Ontario county, Ont.

Joseph Boyle, Dawson, Yukon District :—

Portion of tusk of Mammoth, from Quartz Creek, Klondike district.

(B.—*Zoology.*)

S. Short, Rockliffe, Ottawa :—

Specimen of Saw-whet Owl (*Nyctala Acadica*) from Rockliffe.

Captain W. Thorburn, Pine Lake, Alberta :—

Full set of eight eggs of the American Magpie (*Pica pica Hudsonica*) from Three Hills Creek, Alberta.

Dr. A. Horsey, Ottawa :—

Male Horned Lark (*Otocoris alpestris*), in the flesh, from the vicinity of Ottawa.

G. F. Dippie, Toronto :—

Set of eggs, consisting of six eggs of the American Coot (*Fulica Americana*), and two of the Lesser Scaup Duck (*Aythya affinis*) taken June 14th, 1896, at Burnt Lake, Alberta.

Aubrey Rowan-Legge, Ottawa :—

Set of four eggs of the Purple Finch (*Carpodacus purpureus*) with one Cowbird's egg, from Hull, P.Q.

W. H. Harrington, Ottawa :—

Fine specimen of the Glass-rope Sponge (*Hyalonema Sieboldii*, Gray), from Vries Island, Bay of Tokio, Japan.

A. McL. Hanks, Tacoma, State of Washington :—

One specimen each of *Panopœa generosa*, Gould, and *Zirphœa crispata*, L., from Tacoma.

J. Schupe, Mahone Bay, N.S.:—

"Sword" of Swordfish (*Ziphias gladius*), from the Grand Bank, Newfoundland.

J. C. Lantz, Mahone Bay, N.S. :—

Another "sword" of Swordfish, from the Grand Bank.

Edwin Beaupré, Kingston, Ont. :—

Adult male of the Arctic Three-toed Woodpecker (*Picoides arcticus*) from Kingston. In the flesh.

— Courbeaux, Prince Albert, Sask.:—

Skin of Cowbird, of Lapland Longspur, Western Vesper Sparrow, Western Savanna Sparrow and Fox Sparrow.

Contributions to museum —*Cont.*

W. Spreadborough, Bracebridge, Ont. :—

Twelve specimens of five species of fishes, seventeen specimens of seven species of snakes, and twenty-four specimens of nine species of batrachia, from Ontario.

(C.—*Ethnology.*)

J. J. Carter :—

One stone adze, a stone sinker, four stone disks, eleven pieces of pottery, an ancient iron axe head, and four copper implements, from North Orillia, Simcoe Co., Ont.

A. P. Low, Ottawa :—

Fine model of Kyak, from Ungava Bay ; and lower lip of bear, used by Indians as a charm, from Fort George, Hudson Bay.

By exchange :—

One egg of Puffin, and set of three eggs of Cormorant, from Labrador ; egg of Whistling Swan, from Mackenzie Bay ; two eggs of the Great Horned Owl, from Scarborough, Ont. ; and set of five eggs of the Great Crested Flycatcher, from near Toronto.

By purchase :—

Set of seven eggs of Holbœll's Grebe, from Alberta ; set of five eggs of the Downy Woodpecker, one of two eggs of the Whip-poor-Will, from Port Hope ; set of four eggs of the Scarlet Tanager, and one of six eggs of the White-breasted Nuthatch, from Ontario ; and set of four eggs of the Red-breasted Nuthatch, from Alberta.

From C. Hill-Tout, Vancouver, B.C.—

Collection of about 250 Indian implements, &c., and two remarkably deformed Indian skulls, from British Columbia.

From A. Aaronson, Victoria, B.C.:—

Ethnological collection of over 500 objects from the coast region of British Columbia.

NATURAL HISTORY.

Work by Prof. J. Macoun.

Professor Macoun reports as follows on the work done by himself and by his assistant, Mr. James M. Macoun :—

'During the winter months, after the date of my last report, I was engaged principally in the routine work of my office, which included the determination of a great many specimens from collections in all parts of the Canada. My own collections on Cape Breton Island

Natural history-*Cont.*

and Mr. Spreadborough's in the neighbourhood of the Yellow Head Pass in the Rocky Mountains, were arranged and named. Some time was also devoted to the revision and completion of the manuscript for Part VII. of my catalogue of Canadian Plants which will include the Lichens and a revision of what has already been published on the Mosses and Liverworts.

'Early in June, my assistant Mr. J. M. Macoun, was placed in charge of the Canadian forestry exhibit at the Paris Exhibition, and much of his time since that date has been devoted to the collection of specimens and other work in connection with that exhibit.

'My assistant being otherwise engaged, no plants have been got out for mounting since last spring, nor have any duplicates been distributed from the herbarium. Between January and May, 826 sheets of plants were distributed, and 1,487 sheets were mounted and placed in the herbarium.

Catalogue of Canadian birds.

'Immediately upon my return from the field, in September, the manuscript for Part I. of a catalogue of Canadian Birds was sent to the printer. This catalogue will include all our Canadian species between the Pygopodes or Diving Birds and the Columbæ or Pigeons, about 300 species. The distribution and breeding habits of each species is given, my sources of information being all available publications dealing with Canadian ornithology and a great mass of unpublished material, the result of my own observations and those of other members of the Geological Survey staff, as well as of many other naturalists throughout Canada.

Plant collections from Yukon and Atlin.

'During the past season, besides my own collections in New Brunswick and on Sable Island, the more valuable received have been from Mr. J. B. Tyrrell, who collected at Dawson and vicinity, and Mr. J. C. Gwillim, who collected in the Atlin district of British Columbia.

'The material received from Mr. Tyrrell shows that the summer climate of Dawson is little inferior to that of the Ottawa valley 200 miles north of Ottawa. That the climate would change for the better as soon as the coating of moss and the dense forest is removed is shown by the early flowering of the Anemone (*Anemone Nuttalliana*) which occurred on the first of May, and other species coming in quick succession thereafter. These flowers grew along the dry slopes of the Yukon where the snow melted early.

'Mr. Gwillim's collections are interesting in showing that the general flora of the lower altitudes of northern British Columbia is much alike. An increase in the altitude brought in species that are limited in range and in some instances new to the flora. Four interesting species were gathered on July 22 on a mountain above Atlin Lake at

an altitude of 5,700 feet above the sea. These were *Geranium erianthum*, *Aconitum delphinifolium*, *Pedicularis capitata*, and an Astragalus, which I believe is new to science. Natural history–*Cont.*

'Large collections, including many hundred specimens, have been determined from Prince Edward Island, Quebec, Ontario, Rocky Mountains and British Columbia. The chief of these were received from the Rev. Mr. Ducharme, Rigaud, Que., from William Scott, B.A., Head Master of Toronto Normal School, from Mr. William McCalla of St. Catharines, Ont., from Mr. Sanson, Banff, Rocky Mountains, and from the Department of Agriculture, British Columbia. Other collections determined.

'Under your instructions I made, during the past summer, a careful investigation of the fauna and flora of Sable Island, and a part of New Brunswick. In making an examination into the climatic conditions prevailing in the St. John valley, as affecting the vegetation of that region, I thought it advisable to see that part of Maine bordering on New Brunswick. At Fort Fairfield, near the International boundary, I met some members of the Maine Botanical Society, and with them travelled through that part of Aroostook county, known as the "Garden of Maine." I next went to Woodstock on the St. John River where I remained for over a week. While there, I made a thorough examination of the flora of that region, listing 627 species of plants. These, without exception, indicated a climate suitable to all kinds of farming. This statement applies to the whole valley of the St. John River, from ten miles below Woodstock to Edmundston, one hundred miles above it. Field work.

'Later in the season I spent two weeks in the St. John valley and examined the country in the vicinity of Aroostook Junction, Grand Falls and numerous other points, and everywhere found rich soil, luxuriant vegetation and bad farming. It is quite true that the hills in many places are steep and therefore difficult to cultivate, but even in the best districts the methods followed by most of the farmers are not such as to give the best results. St. John valley, N.B.

'Much of the valley is especially adapted to fruit-growing, and I saw several large orchards, but these like the agricultural lands, showed great neglect and ignorance of scientific methods of caring for fruit-trees. In one very large orchard, the trees were planted so close together that their tops formed a complete cover for the whole surface of ground below them. Many trees in this orchard, and others I visited, had been killed by mice, hundreds having been girdled in this one orchard in the winter of 1898–99. This was not to be wondered at, as the heavy growth of grass of the preceding season had Fruit growing.

Natural history—*Cont.*

been left standing in the orchard and fence-corners, thus forming excellent breeding-places for the mice. This great destruction of fruit-trees could be prevented there, as it is elsewhere, by careful culture. Most of the fruit grown is either fall or summer apples. Growing on trees which stood so close together that their branches interlocked none but the fruit on the upper branches had sufficient light and air to attain a merchantable size. Early in September I saw heaps of the smaller apples under the trees; these were being barrelled and sold at prices that would hardly repay the labour expended. The fact that the sides of the trees next roads or cultivated fields bore good fruit, was conclusive proof that the poor fruit which grew in these orchards was due neither to bad soil nor to unsuitable climatic conditions but to the wrong methods of cultivation which are followed.

Indifferent farming.

'In many respects the farms in the region visited are like those in Cape Breton Island. There is little system and hence little success. Much of the country is well adapted to dairying and sheep-raising, but as yet few attempts have been made to take advantage of natural conditions which will ensure success, if to them is added the practical knowledge which is necessary. Though some progress has been made in dairying, much remains to be done. As to fruit-growing, I have no hesitation in saying that just as good results could be obtained in the St. John valley as in the Annapolis valley if the same knowledge existed among the farmers and the same care was taken of the trees.

Sable Island.

'Through the courtesy of Major F. Gourdeau, Deputy Minister of Marine and Fisheries, I was conveyed to and from Sable Island on a government ship, and I have to thank Mr. Jonathan Parsons, the marine agent at Halifax, Capt. Campbell, of the *Newfield*, and Supt. Boutellier and his family on the island, for many kindnesses and such assistance as they were able to render me in the prosecution of my work.

Its appearance.

'In the forenoon of July 20, I reached Sable Island and landed near the main station. I was agreeably surprised later to find that practically the whole island was covered with verdure, though the whole extent of the subsoil and most of the surface was pure sand and without any admixture of humus. Sand-hills as I have seen them along Lake Ontario and in the North-west, consisted of raw sand without vegetation, and this was what I expected to see on Sable Island; but this idea was dissipated at once, on landing.

'During the five weeks I remained on the island, I endeavoured to investigate everything connected with its natural history. In the

following short report, I will give the general results of my observations :— Natural history–*Cont.*

'The island itself is a mass of pure sand and at one time occupied a very much larger space than it does at present. One fact stands out prominently that the island is constantly decreasing in size, and can never increase except by an elevation of the land. The popular opinion that as it wastes in one part it makes in another is fallacious. Another erroneous idea is that the wind wastes the hills and levels the land and causes destruction. The wind is a builder and the sea is the leveller. The wind certainly shifts the sand but it cuts out in one place only to build up in another. By it the sand is blown inward, but none to sea, except perhaps to a small extent during a very heavy gale. On the other hand, the currents that are set in motion by the winds, and others of a permanent character, are constantly cutting away the sand and carrying it out to sea, and if a high tide should throw some of this back, which it often does, the wind, by blowing this inward, at once begins to build up new hills. Whenever there is the slightest obstruction a mound is formed, sand-wort (*Arenari pepoides*) immediately takes possession, and so year by year the mound grows higher and soon sand-grass (*Ammophila arenaria*) gets a foot-hold and the building grows apace, till a hill may be found where a few years before the surface was on a level with the water. In some parts of the island, notably the north side, the wasting action of the sea is not very great. The chief waste is now taking place between a point about nine miles east of the West End Light and the extreme western point on the south side. Wind and sea action.

'Opinions have been expressed that the sand is stratified, but these opinions are founded on imperfect observation. From one end of the island to the other the sand is the same, being chiefly quartz mixed with a little black sand containing garnets. The apparent stratification is merely the yearly layers laid on by the wind in winter. It has also been stated that there are considerable deposits of black or magnetic-iron sand in various parts of the island, but this is not the case. The black sand, in small quantity, is disseminated throughout the whole mass ; but it is only under exceptional conditions that it becomes large enough in quantity to be noticed. Sand deposits.

'The physical features of the island are peculiar, and if thoroughly studied would add many interesting facts to those already known. All old accounts make the island very much larger than it is now and give much greater heights for its hills, of which the highest are now but little over 100 feet. When the Admiralty survey of the island was Island decreasing in size.

Natural history-*Cont.*

made in 1799 it was found to be thirty-one miles long and two broad, though according to the older French charts it had been forty miles in length and two and one quarter in breadth. Lieut. Burton, who surveyed the island in 1808, found it to be thirty miles long and two wide.

Lagoon.

'In the earliest accounts of the island, we read of a lagoon that extended at least twenty miles from east to west. The sea has so encroached upon the land as to cover part of this lagoon, the sand-bar which separates the present lagoon from the sea covers another part of it, and the part that remains is only eleven miles long, and is so filled with sand that last summer it was in places only six inches deep.

'Until 1836, there was a wide opening from the sea on the south side near where the West End Light now stands. In that year it closed, and two vessels were caught in the lagoon, which then became a lake. Prior to this we have accounts of the dangers of Sable Island, but nothing to indicate that it had no harbour. From a careful examination of all the surroundings, I am of the opinion that when Sable Island rose out of the sea after the Glacial submergence it was of great extent in an easterly and westerly direction. That it was either two high banks of sand with an opening at each end and deep water between, or had the form of an atoll with an opening to the south and deep water within, so that, up to 1836 there was a harbour for small vessels in the lagoon. This opinion is borne out by the lagoon itself, as it is deeper at present in some places than the sea around the island for nearly a mile out. The fresh-water ponds are in hollows and were parts of the old lagoon which were not filled up completely by the advancing sand. In a few years the lagoon will be entirely filled with sand and a few of the deeper spots will become fresh-water ponds.

Sand-hills along the coast.

'In the earliest times the outer line of the island was the highest part just as it is now, and there is no doubt that 200 years ago the hills forming the outer fringe were as high as the old navigators stated, but the action of the wind cutting in the hill on the sea-face and forcing the sand over the crest of the hill or up the gullies which are being constantly cut in the sea face. The new hills never attain the height of the old ones as part of the sand is taken away by the sea and finally lost. This movement is unceasing, and by its action the island is constantly getting narrower and the hills lower. Less than ten years ago sand-hills extended all along the south side, and large quantities of hay were cut on them. Five miles of these hills have been destroyed and the sand blown into the lagoon; but already, as mentioned above, new mounds are being formed and will grow until the sea reaches their seaward face and then they also will disappear.

'All the sand-hills are covered with sand-grass (*Ammophila*) and the wonderful vigour of this grass is well shown everywhere, but more particularly where the sand has just been deposited, or is in a raw state. I found one underground stem or stolon over twelve feet long which had sixty-four series of roots and no less than forty-seven tufts of leaves. The growing point was so hard and sharp that it might almost penetrate wood. This one species of grass with the wild pea (*Lathyrus maritimus*) constitutes the bulk of the wild hay cut for winter fodder and the winter pasturage of the wild horses. As the sand encroaches on the old land, this grass grows with it and covers it, except near the stations where the grass is worn off, and then the wind soon shows its power by making gullies of great depth.

Natural history-*Cont.*

Sand-grass and wild pea.

'What I term the old land is that part of the island not yet encroached upon by the sand from either side. In this old land are to be found the fresh-water ponds and old ridges and flats covered by *Empetrum nigrum* (crowberry), and the few low-growing shrubs that constitute the woody plants of the island. Every part of this old land is cut up by paths made by the wild horses and cattle. Year by year these areas are getting less, and many plants formerly growing on the island have no doubt become extinct on account of the sand movement. When cutting commences, it continues until the level is reached where moisture is permanent, and invariably this level is found filled with roots of shrubs that once grew there, but which at present, a few yards away, has from forty to eighty feet of sand over it. The west winds seem to be the most powerful, and they are the ones that cut up the hills at a distance from the beach. These winds force the sands eastward, then follows the Cranberry (*Vaccinium macrocarpon*) which appears immediately and flourishes in the damp sand mixed with a little humus.

Old level of the island.

'The fresh-water ponds are a curious feature of the island east of the lagoon, which is cut off from them by a wide barrier of sand. Near No. 3 station, at the foot of the lagoon, there is a series of ponds with boggy margins which have all the appearance of "quaking bogs." The slight connection between them, with their depth, shows that they were at one time connected with the lagoon. All these ponds and slight hollows have more or less humus around them and in them, mixed with sand. Their margins and all shallow pools with hard bottoms are much frequented by cattle and horses at present and have been in the past as the following observation will show.

Fresh-water ponds.

'As the sea wears away the sand the bottoms of these ponds are exposed, and this bottom material when thrown up on the beach is called peat. It is not peat, but humus mixed with sand as above-mentioned.

Natural history–*Cont.*

Less than two years ago quite a wide bed, having a thickness of a few inches, was exposed on the north-west side where no ponds now exist, and sand-hills fifty feet high occur. This was seen at low-tide. It was noted at the time that it was marked with tracks of cattle and calves which had pastured on it before it was covered by the sand of the advancing hills. Now the hills themselves had been forced further inward, and the hollow where the cattle pastured before the introduction of horses on the island was covered by the sea.

Widest part of island.

'The island is at its widest between Stations Nos. 3 and 4, or from eleven to fifteen miles east of the main station, which is three miles east of West End Light. This is real "old land,' and is also the region of "barrens," (covered with *Empetrum nigrum*) and cranberry beds, not bogs; for there are no bogs on the island. Along both the northern and southern beaches there stretches a line of sand-hills, running from 60 to 80 feet high, here and there broken into by the sand being cut out by the wind and sent inwards. Stretching from either side towards the interior is a series of low mounds covered very closely with *Empetrum nigrum* and *Juniperus communis* mixed more or less with other shrubby or herbaceous plants. Ninety per cent, however, of the vegetation is crowberry and juniper, both heavily covered with fruit.

Origin of cranberry beds.

'I made a careful examination of the whole interior, and found that about every half mile or more it was crossed by a crescent-shaped ridge of sand, "raw" on the western face, but covered on the eastern slope with the usual sand grass. The winter storms blow out the sand down to where dampness is permanent and there cease to affect the wet sand. This is the cause of the flat beach by the lagoon and the cranberry beds. Always to the west of the base there was a space without any vegetation, and next cranberry vines extending over this in thin beds. In this manner all the cranberry beds originate. They are all on the damp sand, occupying or bordering such places.

Climate.

'The climate of the island is very equable. During the five weeks I remained there the range of the thermometer was only twenty degrees, the lowest reading being fifty-six degrees and the highest seventy-five degrees Fahrenheit. The day temperature is moderated by the sea breeze, while that of the night is moderated by the same means. In ten years the lowest winter reading has been six above zero. The winter storms are always accompanied with the severest cold and this factor causes the winter months to be most disastrous. Taken as a whole, the climate is very pleasant.

'I am inclined to believe that trees have never grown upon the island. On one occasion I saw roots protruding from under a sand-hill over thirty feet high, and on digging them out found that they represented part of the remains of a specimen of *Juniperus Sabina procumbens* (creeping juniper). It was rooted in a layer of black soil and when taken out showed that it had lain flat on the ground. Two of the roots, including the bark, measured $3\frac{5}{8}$ and $3\frac{3}{8}$ inches in diameter respectively, while the crown, where the branches began to spread was over seventeen inches in circumference or nearly six inches in diameter. This growth and others observed under sand-hills indicate long periods of vegetation without encroachment of sand, so that when these shrubs lived, the lagoon was a quiet lake and the north side of the island was miles removed, as no sand reached these localities for many years. Natural history–*Cont.* Probably no trees.

'Though there are no trees on the island and shrubs never attain more than a foot in height, these, if sheltered from the sea air and winter gales attain a considerable size. About fourteen years ago, Mr. Boutellier planted a willow and an elm, both of which are now about five feet high. Every summer they make a fine growth, but during the winter are killed back to the point at which they are protected by an adjoining fence. Even in summer, as I learned from my own observations, the leaves above the shelter of the fence are small and badly formed, and after a strong gale or heavy fog the tender ones become blackened or shrivelled at the edges, while those that were protected were very large and well formed.

'Fuschias and geraniums grown in the open air changed their habit, spreading out instead of growing erect, while their flowers were produced below instead of above the leaves. From these facts I concluded that no deciduous-leaved tree would succeed on the island. Spruce or other conifers would perhaps do better and the experiment is worth trying.

'Mr. Boutellier, who is a good farmer, and a very intelligent man, has succeeded in growing crops and keeping the sand from being blown away. He has learned that the purest sand, with a coat of manure, will grow all kinds of vegetables and the best of hay. When he wants to add a little more to his cultivated ground, he levels the sand, gives it a coat of manure and plants or sows his seeds. If for hay, the question of the retention of the sands is settled at once, as it cannot blow away unless the sod is broken up, and a few inches of sand blown on it only makes it the more secure. Crops grown

'Attempts have been made to farm in some places, but these always resulted in failure, and always will, as the sand is incapable in itself of supplying all that is wanted to mature the plant, and there is not

Natural history–*Cont.*

enough manure made at the stations to do more than fertilize the gardens and some small fields where hay is grown. I saw oats in July with leaves well on to an inch wide, but the oats and brome grass were struck with rust owing to the warm fogs that occurred at that time, and so had to be cut at once.

Plants collected.

'Of flowering plants, 191 species were obtained on Sable Island, and nearly one hundred species of cryptogams. Up to the present I have not had time to determine all the species, but enough is known to show the origin of the flora. All the shrubs are natives of Newfoundland and Nova Scotia. *Empetrum nigrum*, which may be said to be the characteristic plant of the old land of the island, seems to have come when the cold was much greater than at the present time. The herbaceous perennials, except the few introduced, are also of northern origin, but the chief annual, *Sabbatia chloroides*, is of southern extraction. One grass, the sweet vernal grass (*Anthoxanthum odoratum*) of England, is quite common on the old land, and has no appearance of being introduced, yet it has never been recognized as indigenous in America. It is certainly indigenous on the island or a resident of such long standing that it has made itself at home in all suitable places. With the exception of this grass all other introductions are of such recent occurrence that they cannot be mistaken.

Few introduced plants.

'I expected to find many introduced plants on the island, but was surprised to find only thirty all told, and only three of these widely spread. These were white clover, fall dandelion and the sweet vernal grass, which latter may be an introduction. Small patches of clover, timothy, butter-cups, red top, and wild barley, with a few other species, all introduced with other seeds, were seen in meadows. About the buildings were shepherd's purse, lamb's quarter, chick-weed, door-weed, wild buckwheat and a few other species, but none of these could be called plentiful.

Flora of sand-hills.

'The outer sand-hills are altogether covered with *Ammophilla aranaria*, which binds the sands together, and as the whole island is sand, this species is found mixed with other things on the interior mounds and minor elevations. A species of rush (*Juncus Baltic*) is also a permanent species and on the older ridges *Vaccinium Pennsylvanicum*, *Myrica cerifera*, *Empetrum nigrum*, juniper (*Juniperus communis*), ground hemlock (*Juniperus procumbens*) and a few grasses make up the bulk of the flora. Dwarf roses are abundant, but like all the other shrubs, die almost to the ground every winter.

Birds.

'Only about a dozen species of birds breed on Sable Island, and only one of these is a land bird, and this seems peculiar to the island. I refer to the Ipswich sparrow, which, although taken on Cape Cod is

not known to breed anywhere else than on Sable Island. Another land bird—the Canada Nuthatch—possibly bred on the island this year. They were seen in pairs at all the stations, but neither young nor eggs were found. Natural history-*Cont.*

'There are no native mammals on the island, but there are a few foxes which were introduced some years ago for the sake of their fur, but which should be extirpated at once, as they have already stopped the ducks from breeding, lessened the number of terns, and have almost prevented the raising of poultry by the residents at the eastern stations. No native mammals.

'The fresh-water ponds contain a few small fishes, but there are no snakes, frogs or toads. Fishes, &c.

'Both around the shores and in the lagoon where they are not likely to be disturbed, thousands of seals can at any time be seen basking in the sun.

'A few insects were collected, including beetles, butterflies, moths and dragon-flies. As soon as time will permit, all the collections will be worked up.'

MAPS.

Mr. C. O. Senécal, who, on July 1, succeeded Mr. James White as geographer and chief draughtsman, reports as follows on the mapping work :— Maps.

'During the past year, Mr. L. N. Richard has completed the compilation of the Nottaway River map; he also compiled the map of Ottawa City and vicinity, made corrections on the Dominion map and Manitoulin Island sheet from recent surveys, reduced a series of astronomical observations for the map of Hudson Strait, and attended to other work passing through the office.

'From January to August 6, Mr. W. J. Wilson has been employed on the map of the Dominion, and has traced a number of railway plans and profiles at the Department of Railways and Canals, and generally assisted Mr. J. White in the compilation of the altitudes of the country. He afterwards continued the compilation of Manitou sheet (sheet No. 4, Western Ontario), which is at present well advanced towards completion. On September 5, Mr. Wilson left for the field to assist Mr. R. Chalmers in the area covered by Andover sheet (sheet No. 2 S. W. New Brunswick) and returned to the office on November 10.

'Mr. J. F. E. Johnston has been engaged in the compilation of Grenville sheet (sheet No. 121, Ont. & Que.) which he almost completed before leaving on May 19, to assist Mr. R. G. McConnell in the

Maps—*Cont.* Klondike gold-field. Since his return, October 16, he has been engaged in plotting his field-work.

'Mr. O. E. Prud'homme has had, as in former years, charge of the stock of maps held for sale and distribution; he was employed on the compilation of the eastern sheet of the map of the Dominion, and in tracing various maps for the engraver. He has also made the pantograph reductions for the compilation of map of Hudson Strait, and a number of tracings and reductions for sheets Nos. 119, 120 and 122, Ont. and Que.

'Mr. A. Michaud was employed on the compilation of map-sheets of Nova Scotia and on general draughting work from June 14 to September 1. Mr. H. Taché has been employed since September 15. He has made several pantograph reductions for various maps in course of preparation, besides tracing a large number of township and other plans for office use. He also catalogued plans and maps from time to time. Mr. H. Lefebvre has been employed since December 18, and has drawn for zinc-etching reproduction, seven diagrams and three small maps of gas and oil areas in the counties of Essex, Lambton and Welland, Ontario.

'From January to July, my own time was spent in the compilation of the Mineral map of New Brunswick, drawing same for photolithography, in the compilation of part of map of the Rocky Mountains and in various compilations for the map of the Dominion. A tracing from photographic reduction of map of Basin of Nottaway River, was also made for the engraver.

'On July 1, I was appointed Geographer and Chief Draughtsman, and my time has since been spent in supervising the work generally, laying down projections for new maps, correcting and revising engraver's proofs of maps, preparing memoranda for the director, supplying information to the librarian and others, &c.

'What has been said by my predecessor, last year, with regard to the delay in the preparation of maps, may be repeated and emphasized here: "There is a congestion of mapping work in the office and one or two additional map-compilers are required to catch up with the work." New editions, revised to date, of several maps will probably soon be required, and considering the quantity of work already accumulated, slow progress will be unavoidable unless the staff of draughtsmen is increased.

'The western sheet of the Dominion map is almost completely engraved, a proof of the black having been received and corrected. Alterations from new surveys of Atlin Lake, Stikine River, Klondike

gold-field, &c., have been compiled and reduced and are nearly ready for the engraver. Maps—*Cont.*

'During the year, fourteen new maps, including the revised edition of the Sydney coal-field sheets have been published; twenty other maps and plans are in the engraver's hands. Of this number are sheets Nos. 42 to 48, 56 to 58, Nova Scotia, the publication of which is still deferred pending the determination of certain questions relating to geological classification. Forty-five other maps are completed or in various stages of compilation.

'An enumeration of the maps published during the year or in course of preparation is appended herewith:—

	Maps published.	Area in square miles.
604	British Columbia—Shuswap Sheet—Geology—Scale 4 miles to 1 inch.	6,400
669	" — " —Economic Minerals and Glacial Striæ—Scale 4 miles to 1 inch	6,400
664	Manitoba, Saskatchewan and Keewatin—Lake Winnipeg Sheet—Scale 8 miles to 1 inch	45,680
665	Quebec—North-west Sheet "Eastern Townships map"—Three Rivers Sheet—Scale 4 miles to 1 inch	7,200
667	Quebec—Gold Areas and Glacial Striæ of South-east Quebec—Scale 8 miles to 1 inch	12,160
668	Quebec—Map showing Graphite area near Buckingham—Scale 40 chains to 1 inch.	
634	Noova Scotia—Sheet No. 49—Musquodoboit Sheet—Scale 1 mile to 1 inch	216
652	Nova Scotia—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.	
650	" —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.	
675	New Brunswick—Map of Principal Mineral Occurrences—Scale 10 miles to 1 inch	38,000
	Dominion of Canada—Scale 250 miles to 1 inch. (Index map for Paris Exhibition, 1900).	

Maps, engraving or in press.

	Dominion of Canada, 2 sheets, each 28″ x 34″, including the Dominion from the Atlantic to the Pacific Oceans and from International Boundary to Hudson Strait and Great Bear Lake—Scale 50 miles to 1 inch	3,500,000
677	Relief Map of Canada and the United States—Scale 250 miles to 1 inch.	
663	British Columbia—West Kootenay Sheet—Scale 4 miles to 1 inch	6,400
676	British Columbia and Alberta—Yellowhead Pass Route from Edmonton to Tête-Jaune Cache—Scale 8 miles to 1 inch.	
605	Ontario—Sheet No. 126—Manitoulin Island Sheet—Scale 4 miles to 1 inch	3,456
630	Ontario—Sheet No. 129—Mississagi Sheet—Scale 4 miles to 1 inch	3,456
626	" —Map showing the occurrences of iron ore, and other minerals in portions of the Counties of Frontenac, Lanark, Leeds and Renfrew—Scale 2 miles to 1 inch	1,700
681	Ontario—Sketch Map of Oil areas in Lambton County—Scale 4 miles to 1 inch.	
682	Ontario—Sketch Map of gas-field in Essex County—Scale 4 miles to 1 inch.	

Maps—*Cont.*

		Area in square miles.
683	Ontario—Sketch Map of gas-field in Welland County—Scale 4 miles to 1 inch.	
593	Nova Scotia—Sheet No. 42—Trafalgar Sheet—Scale 1 mile to 1 inch.	216
598	" — " 43—Stellarton " — " " .	216
600	" — " 44—New Glasgow Sheet—Scale 1 mile to 1 in.	216
608	" — " 45—Tony River " " " .	216
609	" — " 46—Pictou " " " .	216
610	" — " 47—Westville " " " .	216
633	" — " 48—Eastville " " " .	216
635	" — " 56—Shubenacadie " " " .	216
636	" — " 57—Truro " " " .	216
637	" — " 58—Earltown " " " .	216

Maps, compilation complete.

	Ontario and Quebec—Sheet No. 121—Grenville Sheet—Scale 4 miles to 1 inch	4,051
	Quebec—Basin of Nottaway River—Scale 10 miles to 1 inch	56,800
	Nova Scotia—Sheet No. 53—Lawrencetown Sheet—Scale 1 mile to 1 inch	216
666	Nova Scotia—Laurencetown Gold District—Scale 500 feet to 1 inch.	
	" " —Mount Uniacke Gold District—Scale 250 feet to 1 inch.	
	" " —Renfrew Gold District—Scale 500 feet to 1 inch.	
	" " —Waverly Gold District—Scale 250 feet to 1 inch.	

Maps in progress.

663	British Columbia—West Kootenay Sheet (partly engraved)—Scale 4 miles to 1 inch	6,400
	British Columbia—Map of Rocky Mountains—Scale 4 miles to 1 inch	
	Keewatin and Saskatchewan—Grass River Sheet—Scale 8 miles to 1 inch	
	Western Ontario—Sheet No. 4—Manitou Sheet—Scale 4 miles to 1 inch	3,456
	Ontario—Ottawa City and vicinity—Scale 1 mile to 1 inch.	
	" —Lake Nipigon map—Scale 4 miles to 1 inch.	
	" —Nipigon River map—Scale 1 mile to 1 inch.	
	" —Sheet No. 111—Brockville Sheet—Scale 4 miles to 1 inch...	3,456
	" —Sheet No. 118—Haliburton Sheet—Scale 4 miles to 1 inch..	3,456
	" —Sheet No. 119—Perth Sheet—Scale 4 miles to 1 inch.....	3,456
	" —Sheet No. 120—Ottawa Sheet—Scale 4 miles to 1 inch	4,224
	" —Sheet No. 122—Pembroke Sheet—Scale 4 miles to 1 inch...	3,456
	Ungava and Franklin—Map of Hudson Strait—Scale 25 miles to 1 inch	16,800
	Ungava—Map of East Coast of Hudson Bay—Scale 25 miles to 1 inch.	16,800
	New Brunswick—Sheet No. 1 N.W.—Surface Geology—Scale 4 miles to 1 inch	3,456
	New Brunswick—Sheet, No. 2 S.W.—Surface Geology—Scale 4 miles to 1 inch	3,456
	Nova Scotia—Sheets Nos. 59 to 65, 76, 82, 100 and 101—Scale 1 mile to 1 inch	2,376
	" " —Sheets Nos. 54, 55, 66 to 69, 73—Scale 1 mile to 1 inch.	1,512
	" " —Catcha Gold District—Scale 250 feet to 1 inch.	
	" " —Montague " —Scale 250 feet to 1 inch.	
	" " —South Uniacke Gold District—Scale 250 feet to 1 inch.	
	" " —Tangier " —Scale 250 feet to 1 inch.	

Library.

Library and publications.

The librarian, Dr. Thorburn, reports that during the year ended December 31, 1899, 8,137 copies of the Geological Survey publications were distributed, consisting of Annual Reports, special reports and maps; of these 6,735 were distributed in Canada, the remainder, 1,402 were sent to scientific, educational and literary institutions elsewhere.

There were received as exchanges 2,774 publications. These consist of reports, transactions, periodicals, pamphlets and maps.

The number of publications purchased during the year was 109. Periodicals subscribed for, 34.

The number of volumes bound has been 29.

The number of letters relating to library matters sent out was 1,012, besides acknowledgments for publications distributed, 678.

The number of letters relating to the library received was 1,466, and of acknowledgments, 767.

The number of publications sold during the year was 3,915, for which $559.06 was received.

There are now in the library about 13,000 volumes, in addition to a large number of pamphlets.

NOTE.—The books in the library can be consulted during office hours by any one wishing to obtain information on scientific subjects.

Visitors to Museum.

Visitors to museum.

The number of visitors to the museum continues to show an annual increase, having been during the year 1899, 35,895.

Staff, Appropriations, Expenditure and Correspondence.

Changes in staff.

The strength of the staff at present employed is forty-eight.

During the year the following changes have taken place:—

Mr. J. B. Tyrrell, resigned.

Mr. J. C. Gwillim, appointed assistant geologist.

Mr. James White, transferred to the Department of the Interior.

Mr. C. O. Senécal, appointed geographer *vice* Mr. J. White.

Appropriation and expenditure.

The funds available for the work and the expenditure of the department during the fiscal year ending June 30, 1899, were :—

——	Grant.	Expenditure.
	$ cts.	$ cts.
Civil list appropriation	52,650 00	
Geological Survey appropriation	55,429 39	
Boring appropriation	10,000 00	
Civil list salaries		50,564 60
Exploration and survey		24,277 14
Wages of temporary employees		12,830 65
Boring operations		7,516 02
Printing and lithography		13,695 24
Purchase of books and instruments		1,885 95
" chemical apparatus		213 34
" specimens		526 17
Stationery, mapping materials and Queen's Printer		1,354 23
Incidental and other expenses		1,495 31
Advances to explorers on account of 1899-1900		16,067 79
		130,426 44
Deduct—Paid in 1897-98 on account of 1898-99 $17,288.15		
Less—Transferred to casual revenue 371.72		
		16,916 43
		113,510 01
Unexpended balance civil list appropriation		2,085 40
boring "		2,483 98
	118,079 39	118,079 39

The correspondence of the department shows a total of 9,625 letters sent, and 9,483 received.

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

GEORGE M. DAWSON,
Deputy Head and Director.

Atlin Gold Field

PINE CREEK.

Methods of working on the larger streams.