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

SUMMARY REPORT

ON THE

OPERATIONS OF THE GEOLOGICAL SURVEY

FOR THE YEAR 1894

BY

THE DIRECTOR

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OTTAWA, 10th January, 1895.

The Hon. T. MAYNE DALY, M.P.,
Minister of the Interior.

SIR,—I have the honour to submit herewith the Annual Summary Report of the Geological Survey Department for the calendar year 1894. The work of the department has been successfully continued during the past year and some substantial progress has been made, although, in consequence of the reduced amount of money actually available for general purposes, the extent of the operations has had to be curtailed.

Contents of this report.

In this Summary Report it is intended to give, in accordance with the usual custom, a brief statement of the executive and office work of the department, together with somewhat more extended notices of the preliminary results of the various scientific investigations and explorations in the field. Such notices include the more notable points ascertained during the progress of the field work and especially those which appear to be of immediate economic importance. The systematic and detailed reports and maps of the several districts examined, which often take several years for their satisfactory completion, are published from time to time throughout the year, and in their collected form appear in a series of numbered volumes which constitute the principal and more permanent record of the work accomplished.

Work of the Geological Survey.

The operations of the Geological Survey in the field, constitute the basis of the entire work of the department. These naturally divide themselves under two principal heads: (1) Reconnaissance surveys and

Work of the Geological Survey.

explorations, covering in a general way large tracts of country, and (2) the systematic mapping and description in detail of less extensive areas. The first inevitably precedes the second class of work, and for many years it must, in the nature of things, remain the only method possible of dealing with the vast regions of Canada which lie beyond the boundaries of connected settlement. While the exploration of new districts, in which geographical information is obtained concurrently with data on the general geology and mineral resources, may attract popular attention to a greater degree, the methodical delineation of the geological features of the older parts of Canada must be regarded as at least equally important and as requiring no inferior ability or diligence on the part of those engaged in it.

Parties in the field.

During the year, Mr. A. P. Low's exploratory expedition in the Labrador Peninsula has been successfully completed, while Mr. J. B. Tyrrell has been engaged in a second expedition in the hitherto unknown country to the west of Hudson Bay and north of the Churchill River. In British Columbia, Ontario, Quebec, New Brunswick and Nova Scotia, the field work has been chiefly devoted to a continuation and extension of the investigations necessary for the regular series of map-sheets into which these provinces have been divided.

In consequence of the lack of money already alluded to, it was absolutely necessary to reduce the number of parties working in the field during the past season, as well as to diminish the amount accorded to the work in each district, thus decreasing the length of the field work. The total number of parties employed was twelve, as compared with sixteen during the previous season. It was not possible to invite the co-operation in the prosecution of the work of Abbé J. C. K. Laflamme of Quebec, Dr. F. D. Adams of Montreal, or Prof. L. W. Bailey, of Fredericton, a circumstance much to be regretted, as these gentlemen have in previous years contributed largely to the progress of the Survey.

The actual distribution of the field parties was as follows:—

British Columbia	2
North-west Territories (boring operations)	1
Keewatin District	1
Ontario	3
Quebec	1
Labrador Peninsula	1
New Brunswick	1
Nova Scotia	2
	12

Publications.

During the year the sixth volume of the new series of detailed reports of the Geological Survey has been printed, and it will shortly

be completed for issue. In selecting material for this volume, preference has been given to the statistical and other reports of which the value must depend largely upon prompt publication, while it has been found necessary to hold over a number of manuscript reports and maps, till a further appropriation for printing becomes available. The geological maps actually printed during the year, include eight sheets of the Nova Scotian series, on the scale of one mile to the inch, and one sketch-map of south-western Nova Scotia. Six additional sheets of the series first referred to, and the south-western sheet of the Eastern Townships series (Quebec) are well advanced and will shortly be printed. Publications.

The accumulation of material awaiting publication promises to constitute a source of embarrassment to the work of the Survey as a whole, and it is earnestly to be hoped that the means will soon be afforded to render it possible to give to the public these results of surveys and investigations already completed. Exclusive of the reports comprised in the sixth volume, above mentioned, and besides those now in course of completion by members of the staff, the manuscripts in hand will make, when printed, more than 700 pages; while about thirty-two separate maps are now ready to go to the engraver.

I may also again venture to direct your attention to the wholly inadequate accommodation afforded to the museum and offices by the present building on Sussex Street. The collections now contained in this building, including the departments of mineralogy, lithology, palæontology, botany, zoology and ethnology, either on exhibition or classified and readily accessible, aggregate more than 120,000 specimens. The greater part of the space available is devoted to the illustration of the minerals and general geology of Canada, but it is impossible to display the specimens to advantage, or in such a manner as to attract the public notice which they deserve. The position of the building and its construction, further render it liable to the constant danger of destruction by fire, and when it is remembered that the collections include the typical specimens which have been described in the publications of the Survey since its initiation, besides many others of a character which it would now be impossible to duplicate, the very serious nature of this risk will be understood. The building also contains much accumulated material in maps, plans, notes and records, together with the entire reserve stock of the printed reports of the Survey and a library comprising a large number of scarce and valuable scientific works. Museum.

Early in October, Dr. A. R. C. Selwyn, C.M.G., F.R.S., under whose direction so great an amount of important work has been car- Changes in staff.

Changes in staff.

ried on by the Geological Survey since the retirement of Sir W. E. Logan in 1869, obtained leave of absence, and on the 7th of January was granted his superannuation. Mr. T. C. Weston, whose connection with the Survey dates from 1857, was superannuated on August 1st. To Mr. Weston's assiduity and skill, the museum owes much, both in the matter of collections and arrangement.

The department has also suffered the loss of two members of the staff by death. Mr. Scott Barlow, geographer and chief draughtsman, died on March 29th, after nearly thirty-eight years of continuous and valuable work in the department. Mr. A. S. Cochrane, assistant topographer, died on December 2nd, after seventeen years of service. Some of the more important surveys made by Mr. Cochrane are described in the report for 1879-80 (p. 7 C.) Mr. Amos Bowman, who although but for a short time on the permanent staff, had been engaged for some years in the work of the Survey in British Columbia, particularly in the Cariboo mining district, died on June 18th. He was not at the time of his death in the employment of the department.

Boring at Athabasca Landing.

Experimental boring at Athabasca Landing.

The occurrence of great quantities of bitumen or maltha along a portion of the Athabasca River has long been known, having been noticed and commented upon by the very earliest travellers in the region. Beds of sand or very soft sandstone of Cretaceous age, varying from 140 to 225 feet in thickness, are there found to be more or less completely saturated with bitumen, for a distance of some ninety miles along the river. These beds are known as "tar sands." More recently a number of smaller occurrences of bitumen in the form of "tar springs," as well as sources of combustible gas, have been found at different places over a very extensive district. All these circumstances point to the probable existence of a great petroleum field, of which possibly some parts have already exhausted themselves in saturating the lowest Cretaceous sands, but of which probably the greater portion is still effectually sealed by the thick covering of overlying rocks. It is believed that the source of the petroleum which has given rise to the deposits of bitumen is in the Devonian strata, which here immediately underlie those of Cretaceous age.

In the search for petroleum of commercial value, in which the more volatile constituents may still be retained, two principal modes of its probable occurrence in quantity, present themselves:—(1) The "tar sands," at a distance from their outcrop and where sufficiently covered,

may contain reservoirs of such petroleum, secondarily derived; (2) the original sources of the petroleum, probably existing in porous beds of the Devonian, may themselves be reached, after passing through the "tar sands" or their equivalents. Athabasca boring—*Cont.*

In 1890, Mr. R. G. McConnell, of this Survey, made a careful examination of the geological conditions along the Athabasca and Peace Rivers and in the intervening country, with special reference to the presumed existence of an oil field.* He ascertained, with as much accuracy as possible from the natural outcrops, the thickness and lie of the shales and sandstones of the Cretaceous system by which the greater part of the region is covered. In his report he writes:— Geological features.

"The tar sands evidence an upwelling of petroleum to the surface unequalled elsewhere in the world, but the more volatile and valuable constituents of the oil have long since disappeared, and the rocks from which it issued are probably exhausted, as the flow has ceased. In the extension of the tar sands under cover the conditions are different, and it is here that oils of economic value should be sought. In ascending the Athabasca, the tar sands are overlaid at Boiler Rapid by a cover of shales sufficient to prevent the oil from rising to the surface, and in ascending the river, this cover gradually thickens. * *

* * The question of the continuity of the tar sands and their petroliferous character under cover, can, however, only be settled in a decided manner by boring, and it is highly desirable that drilling operations should be undertaken for this purpose. At the mouth of Pelican River, the tar sands are probably covered by about 700 feet of strata, and this amount increases as the river is ascended. At the Athabasca Landing, if the formation extends to that point, it probably lies at a depth of from 1,200 to 1,500 feet below the surface, but the distance of the Landing from the outcrop of the tar sands, and the variability in the thickness of the Cretaceous formations make it impossible to give more than a rough estimate."†

The importance of actually ascertaining by means of boring operations the existence or otherwise of economically valuable bodies of petroleum in the Athabasca region has been recognized for many years, but the remoteness of the region and the apparent impossibility of immediately utilizing any discoveries which might be made, have hitherto prevented the necessary experiments. The recent completion of a line of railway to Edmonton has, however, considerably changed the conditions in these respects. It was thus decided by you that the Arrangement for boring operations.

*An earlier notice of the tar sand deposits by Prof. Macoun, and a preliminary geological description of the Athabasca by Dr. R. Bell will be found in Reports of Progress of the Geological Survey, 1875-76, p. 169, 1882-84, part CC.

†Annual Report Geological Survey of Canada, vol. V., (N.S.), p. 66 D.

Athabasca boring—*Cont.*

time had arrived when some experimental boring might with advantage be undertaken by the Government, and a vote of $7,000 was obtained from Parliament during the past session for the purpose of initiating this work, the arrangements for which were entrusted to the Geological Survey. After careful consideration, it was determined that a bore-hole should in the first instance be sunk at Athabsca Landing, at which place the depth of strata to be passed through in order to reach the horizon of the "tar sands" had, as above stated, been estimated by Mr. McConnell at approximately from 1,200 to 1,500 feet. On some grounds it might have been more advantageous to begin boring at a locality further to the north and east, where the depth of cover would be smaller and the actual known outcrop of the "tar sands" less distant, but the difficulties of transport for machinery and casing beyond the Landing militated against this. In another respect also Athabasca Landing appeared to be a suitable spot for a first test:—A wide low anticlinal by which the Cretaceous rocks of the plains are affected over a great area, tends towards the Saskatchewan near Egg Lake and if continued should reach the Athabasca near the Landing. The arch formed by these rocks is so low and diffuse that in consequence of the scarcity of natural sections it is difficult to trace it, but if continued to the Landing, experience elsewhere gained shows that the structure should be a favourable one for the concentration of any supplies of petroleum contained in the strata.

Selection of site.

Contract for boring.

After some inquiry and the receipt of tenders from thoroughly competent drillers, the lowest and most favourable of these was accepted and a contract for the work of boring was entered into with Mr. A. W. Fraser. Mr. Fraser has had much previous experience in boring for petroleum, both in Ontario and for the Indian Government in Burma and Baluchistan. So far as they have yet gone, the operations have been conducted rapidly and successfully by Mr. Fraser.

Total depth reached.

On October 24th, the bore-hole had reached a depth of 1,011 feet, when it was found necessary, owing to the incoherent character of the rocks, to stop work pending the arrival of more casing. This it is proposed to place in the hole during the winter, but the drilling itself can scarcely be resumed till the spring, as the great quantity of gas met with, renders it dangerous to keep a fire in the derrick-shed or anywhere in the vicinity of the well.

The following account of the work is summarized or extracted from Mr. Fraser's report, received on December 19th.

Mr. Fraser reports that the plant for the boring was shipped from Toronto on 14th July, 1894, by the Canadian Pacific Railway. It

arrived at Edmonton on the 26th of the month, when teams were at once procured and the machinery and tools were sent on to Athabasca Landing. Athabasca boring—*Cont.*

The Landing is one of the principal forwarding points of the Hudson's Bay Company, and the company has in consequence acquired there, a grant of a section of land. As this covers most of the flat near the river, Mr. Fraser found some difficulty in selecting a suitable spot for the boring operations, which he had been instructed should be upon government land. A good site was, however, finally chosen 550 feet west of the company's west line, 10 feet above low-water level in the river and some 250 to 300 feet lower than the surrounding country. This site was inspected and approved early in August by Dr. A. R. C. Selwyn. Details of the work.

Ground was broken on the 1st August, and on the 15th of the month, when all the machinery had arrived, the drilling was begun. An excavation was first made by hand to a depth of 14 feet, in which a strong wooden pipe, made of $1\frac{1}{4}$ inch plank and 10 inches in inside diameter, was inserted. To the depth of 14 feet, the material passed through was chiefly clay, but at 6 feet from the surface a seam of coarse gravel was met with. The wooden pipe was fixed in a very hard boulder-clay.

The further continuation of the boring is reported on in detail by Mr. Fraser, as follows :—

"The drilling proper was then begun through a gray shale. At 23 feet, a stratum of hard rock was encountered about 6 inches thick.

"At 37 feet, iron casing was put in, of a diameter of 7 inches, inside measurement.

"From this depth to 136 feet a gray shale continued. At 136 feet we encountered a hard stratum about one foot thick. The shale was falling so badly that it was impossible to obtain a sample of these cuttings.

"From 136 feet to 182 feet the shale was the same, very soft and caving in very badly. At the latter depth, another hard stratum, 1 foot thick, was met with.

"From 182 to 230 feet the same sort of shale continued, no hard streaks being encountered.

"At this depth (230 feet) the $5\frac{5}{8}$ (inside diameter) casing was put in, as the shale was falling in so quickly that no progress could be made without the casing.

"At 245 feet a hard streak, similar to the preceding ones, was struck, and on drilling into it a strong flow of gas was met with. This flow threw the water that was in the bore-hole over the top of the der- Gas met with

Athabasca boring—*Cont.*

rick. There was no oil with this flow of gas, but it made the drilling more difficult, as it cut down the shale and caused it to cave in badly. We therefore drilled another 15 feet and put the casing down at 260 feet.

"At 267 feet more gas was struck.

Large flow of gas.

"From this depth to 334 feet the drilling was through shale and it caved very badly. At 334 feet another large flow of gas was struck. The roaring of the gas could be heard half a mile away from the works, and it was considered unsafe to work with the boiler in its former position, so it was removed 55 feet. My foreman, who had seen the big gas well at Kingsville, Ont., assured me that the flow of gas was as strong as in that well.

"After striking this flow of gas, it was impossible to make any progress. We worked for days and could not get to the bottom of the bore-hole. Finally, by adopting the plan of letting the water for drilling down the hole in the sand pump, we managed to get the drilling started again.

"At 338 feet a hard streak was met with about one foot thick.

"From 388 feet to 400 feet the drilling was through very soft shale.

"From 400 feet the shale was slightly harder, and at 425 feet a hard stratum about one foot thick occurred. From 425 feet to 450 feet the formation was gray shale, with several streaks of hard rock from 6 inches to 2 feet thick.

"From 450 feet to 500 feet, the drilling was through the usual gray shale.

"From 500 feet to 550 feet, the shale was darker and very soft and caved badly.

"From 550 feet to 580 feet, streaks of sand rock varying from 1 to 2 feet thick were met with.

"From 580 feet to 600 feet, the formation was dark shale and very soft.

"At 625 feet, the 5⅝ inch casing was put in. The formation was soft shale and not hard enough to support the casing which was hung on the clamps at the top.

"From 625 to 780 feet, no change was met with. It was soft black shale between these depths.

Flow of salt water.

"At 780 feet salt water was struck. The water was not in very great volume. A fragment of rock obtained from this depth, showed crystals of salt, but this specimen has been lost. A strong flow of gas was also obtained at this depth. After passing this water vein, the shale caved in so badly that it was deemed advisable to put in the 4⅝

casing. This conclusion was come to after much time had been spent in pumping the mud. The casing was put in to a depth of 825 feet. Athabasca boring—*Cont.*

"From 825 feet to 900 feet the shale was much harder and bluer in colour, but after passing 900 feet it again became soft and dark in colour. It continued so to 1,011 feet, the present depth of the well.

"At that depth further progress was found to be impossible without putting down the casing. This could only be done by getting an under-reamer, to work a shoulder off the bore-hole ahead of the casing, and without pulling the latter. Suspension of work for the winter.

"It was thought advisable to obtain about 300 feet of the $5\frac{5}{8}$ inch casing in addition to the 625 feet already in the hole, and drive it down past the salt water vein at 780 feet. This would take so much pressure off the $4\frac{5}{8}$ inch casing.

"The $5\frac{5}{8}$ inch casing was then driven a few inches to ascertain whether it would be possible to drive it or not. As the season was so far advanced that the necessary tools for under-reaming and the 300 feet of $5\frac{5}{8}$ inch casing could not be gotten on the ground before the extreme cold weather set in, it was determined to close down operations for the season, with the exception of driving the $5\frac{5}{8}$ inch casing as far as it would go on its arrival on the ground.

"To prevent the $4\frac{5}{8}$ inch casing from becoming fixed in the bore-hole during the winter months, the 825 feet was drawn up and placed to one side for spring operations. The 625 feet of $5\frac{5}{8}$ inch casing remaining in the bore-hole amply protected it.

"Since that time, the sanction for the purchase of the 300 feet of $5\frac{5}{8}$ inch casing having been obtained, it was purchased and sent to Athabasca Landing, together with the necessary tools for carrying on the under-reaming ahead of the casing.

"After the inner casing had been pulled out, and there remained in the 625 feet of $5\frac{5}{8}$ inch, an iron cap was screwed into the latter, and from the evidence of the pressure of gas, it was estimated that there was at least 50 pounds pressure to the square inch.

Summarizing the above, Mr. Fraser gives the present state of the boring as follows:— Summary of bore-hole.

Depth of bore	1,011 feet.
Cased with $7\frac{1}{2}$ inch casing	37 feet.
Cased with $5\frac{5}{8}$ inch casing	625 feet.

On the ground for use in the spring,

$4\frac{5}{8}$ inch casing	1,200 feet.
En route $5\frac{5}{8}$ inch casing	300 feet.
En route $4\frac{5}{8}$ inch casing	100 feet.

Athabasca boring—*Cont.*

Judging from the rocks so far passed through, as compared with Mr. McConnell's published section, obtained from natural exposures further down the Athabasca River, Mr. Fraser expresses his doubt as to whether the La Biche shales are unusually thick at the Landing or whether the Pelican sandstones may here be wanting and the La Biche and Pelican shales combined in a single series. Mr. Fraser inclines to the first mentioned theory and on this supposition adds,—

Remarks by Mr. Fraser.

"Owing to the greater thickness of the La Biche shales, the oil sands will probably not be met with at a less depth than 1,500 feet.

"With a view to the economic value of the discovery of petroleum in the far North-west, the present site must be regarded as a wise selection. Had the test been made lower down the river, and nearer to the outcrop of the "tar sands," the finding of petroleum might have been more certain, but if found, nothing could be done about it until tests were made at the Landing or elsewhere to discover whether it was not to be had nearer to the railway.

"Much interest has been taken in the development of this oil field by the residents of Edmonton and the surrounding country and they expect a material increase of prosperity should oil be found in quantities sufficient to make it a profitable enterprise. Already a few have profited by the money spent in prospecting and have earned small sums of money which have materially helped them in paying for lands.

"The Hudson's Bay Company has evinced great interest and its agents at Edmonton and Athabasca Landing, Mr. Livock and Mr. Wood, have used every endeavour to help on the work, and I am greatly indebted to them for their ever willing help."

Examination of drillings.

Specimens of the drillings obtained from different depths in the bore-hole have been subjected to a preliminary examination by Mr. McConnell, with the object of instituting a comparison between the beds passed through, and those described by him in the natural outcrops further down the river. In consequence, however, of the uniformity of the material met with in the boring, no results of a positive character were obtained, and at the present stage of the work it is not possible to decide the stratigraphical question above referred to by Mr. Fraser, nor to make any closer estimate of the probable depth to be penetrated than that already quoted from Mr. McConnell's report.

Expenditure.

The total expenditure on this boring to date has been $4,203.37, but the full amount due to the contractor for the depth now reached is not payable, according to contract, till the completion of the boring to the contract depth of 1,200 feet. Over $1,000 of the above expenditure has been incurred in the purchase of casing and its transport to Edmonton. If it is deemed advisable ultimately to withdraw this

casing from the present hole, most of it will probably be servicable for a second boring. This, and the fact that the boring plant is now all in the district, should render the cost of further experiments relatively much less than that of the first. Athabasca boring—*Cont.*

It appears to be most important that the investigation of the petroleum fields of Athabasca and Northern Alberta, thus begun during the past summer, should be continued until the main features at least of the character and value of these fields shall have been determined. The boring at Athabasca Landing has not yet attained the minimum depth at which the occurrence of petroleum at that place is considered probable; but should petroleum not be encountered in considerable quantity at a less depth, and should no unforeseen accident occur in connection with the work, I would advise that this boring be carried down to a depth of at least 1,500 feet. In any case the information obtained thus will be of great value in determining the position and useful depth for further sinkings. In the event of the discovery of petroleum at Athabasca Landing, the machinery should be moved to another carefully selected locality further to the south and nearer to railway communication. In the opposite event, the continuation of the investigation is no less necessary, for its abandonment at that stage would tend only to discourage further enterprise, while the probability of an ultimate success would in reality be not materially lessened. It would then, however, be advisable to select a place for a second boring further down the Athabasca River, nearer to the actual outcrop of the bitumen-bearing sands and where the depth of the overlying rocks is less, although the distance from existing means of communication is greater. Plan of further operations.

All indications favour a belief in the existence of a great petroleum bearing region in the North-west, and the results which would flow directly from the definition of such a region, are so important, as to warrant any expenditure which may be necessary in that direction. It is not probable that petroleum, if found in Northern Alberta or in Athabasca, would seriously compete in the east with the already established petroleum industry of Ontario; but the considerable and yearly increasing demands of British Columbia and the North-west Territories would afford a local market which might be large, as, if the oil could be furnished at a low price, it would undoubtedly be employed as a liquid fuel for railways in many parts of the country. The comparative proximity of the Athabasca region to the Pacific, further indicates that an enormous foreign demand, coextensive with the shores of that ocean, might be most profitably supplied from this region. The extent of this market may be in part realized when it is stated that Importance of the experiment.

Athabasca boring—*Cont.*

the export of illuminating and paraffine oils from the United States to Japan, China and Hong Kong alone, amounted in 1893 to 67,572,136 gallons.

British Columbia.

British Columbia.

The principal part of the time spent by me in the field during the past summer was devoted to the completion and extension of geological work previously undertaken in British Columbia. It was, however, arranged that I should in the first place occupy a few days in the foothills of western Alberta, in examining some of the more recently discovered outcrops of coal and in further investigating the superficial deposits of that region; also that I should, if possible, pay a short visit to that part of the Cariboo district of British Columbia in which extensive hydraulic mining operations have lately been initiated.

On the 23rd of June I left Ottawa, accompanied by Mr. R. G. McConnell, and on arriving at Lethbridge, engaged a light wagon, three horses and a driver, with which equipment we spent about sixteen days in various parts of the foot-hill region between Macleod and Calgary, arriving at the last-named place on July 9th. From Calgary, Mr. McConnell went to the scene of his further operations in the West Kootanie district, while I proceeded to Kamloops, meeting my assistant, Mr. J. McEvoy, there.

General nature of work done.

Attention was then directed to the revision and further investigation of a number of localities comprised within the area of the Kamloops map-sheet, situated for the most part in the vicinity of Kamloops Lake and along the Thompson valley below the lake. The matters upon which further information was desired, were those which had occurred in connection with the compilation of the geological map and report last winter. As this map and the report are now ready for publication, it will be unnecessary to allude further in this summary to the results obtained, except in the case of certain localities visited where minerals of economic value have lately been found or worked, some notes on which may be of immediate interest. This part of the work was completed on August 4th, when, leaving Mr. McEvoy with two men and the horses, to continue the examination of the region east of Kamloops, I set out for the Cariboo district.

From the time of leaving Ashcroft station, on the railway, to the date of my return to that place on August 18th, thirteen days were occupied in the journey to and from the South Fork of Quesnel River and Horsefly River, including the time spent at these localities. Although but a few days were thus actually available for the investig-

ation of the hydraulic mines near these places, the observations made are of much interest. Some details respecting them are given below. British Columbia—*Cont.*

After rejoining Mr. McEvoy, the remainder of the season was spent in continuing the exploration of the area of the Shuswap sheet, including a critical re-examination of some parts of the sections of the older rocks afforded by the Shuswap Lakes. During the time in which I was engaged in this work, Mr. McEvoy made an independent exploration on foot, across the mountains between the heads of Adams and Shuswap Lakes. As the Shuswap sheet is not yet ready for publication, a few of the more important points noticed will be mentioned here.

On October 2nd I left Kamloops for Ottawa, having been recalled there in consequence of Dr. Selwyn's departure for England on leave of absence.

Mr. McEvoy remained in the field till November 5th, when the broken character of the weather rendered it advisable to suspend operations. He reached Ottawa on November 14th.

Recent developments of economic minerals in the area of the Kamloops sheet.—What may prove to be an important deposit of cinnabar has lately been found in the vicinity of Copper Creek, Kamloops Lake, and several contiguous claims have been taken up on this, on the west side of the valley of the creek, near its mouth. The claims have, I believe, been combined in a single property, but the best looking deposit of ore occurs on the "Rosebush claim," where a shaft about fifty feet deep, connecting below with a drift more than fifty feet long, has been opened. The height of this place is about 450 feet above the lake. Other small openings have been made in the same vicinity, as well as a second shaft, thirty-five feet deep, on the "Yellow Jacket claim," about a quarter of a mile northward of the Rosebush. Deposit of cinnabar.

The cinnabar occurs in irregular sparry veins, consisting chiefly of calcite and quartz, with some dolomite, traversing zones of a gray felspathic and dolomitic rock which readily weathers to a yellowish colour. Both these zones and the contained veins, as a rule, run nearly magnetic north-and-south through the main rock of the hills, which is a dark greenish-black, Tertiary eruptive, containing pyroxene and olivine, possibly a melaphyre, but much decomposed. A considerable quantity of rich ore has been taken from the wider portions of the main vein opened on the Rosebush. Although the slopes of the hills are abrupt, they are almost everywhere covered with drift deposits, and much more work is necessary in order that the true value of the deposit may be ascertained. Exploratory trenching in an east-and-west direction

British Columbia—*Cont.*

would be the most economical method in the first instance. A little antimony sulphide (stibnite) is observable in some parts of the ore.

Another claim, upon which very little work has been done, is the "Last Chance, No. 2," situated on the east side of Copper Creek, near the junction of the Tertiary volcanic rocks with a small area of decomposed granite. Small quantities of cinnabar are found here, and some narrow seams of molybdenite also occur. In the adjacent granitic mass, minute bright red specks of cinnabar may also be detected, and it would appear that the extensive decomposition of the basic volcanic rocks of this region, by heated waters or steam, has led to the diffusion of a certain quantity of cinnabar, through some parts of both classes of rocks, and to its concentration in some of the veins.

Decomposition of a similar character, has affected the rocks seen on the opposite side of Kamloops Lake, along the railway, to the east of the mouth of Cherry Bluff Creek. No cinnabar has been observed here, but distinct traces of cinnabar are found in seams cutting some of the rocks at Six-mile Point, also on the south shore, but further to the west.

These occurrences indicate that search may be made for cinnabar over a considerable area, with some prospect of success.

Copper ore.

Also on the east side of Copper Creek, but about half a mile back from the lake, a claim named "The Tenderfoot" has been taken up on an irregular deposit of copper ore (bornite). But little work has been done here, and there appears to be little reason to hope that the deposit will prove to be a really valuable one.

Native copper.

Copper Creek derives its name from the fact that the Indians have from time immemorial known it as a locality of native copper. Specimens were obtained last season from the serpentinous decomposed rocks to the east of the stream, which show some of this native copper, but the quantity is probably inconsiderable from an economic point of view.

China-stone.

Specimens having been received from Mr. G. De Wolf and others, of kaolin and china-stone from a locality on the west side of the Thompson opposite Spatsum station, this locality was visited during the summer. It was found to lie in the remarkably shattered decomposed zone of rocks which runs along this part of the Thompson River for many miles; but in this place, the rocks instead of being merely silicified and reddened, have suffered a more complete change.

They appear to have been in the first instance thoroughly decomposed and pyritized, and subsequently more or less completely leached by acid waters resulting from the decomposition of the pyrites. The materials so produced, when cut into by lateral ravines, form bare

crumbling banks of red, yellow and white colours, upon which scarcely any vegetation grows. Some parts of these are almost purely siliceous, while others consist of mixtures of quartz and kaolinite in varying proportions, with often a perceptible efflorescense of soluble salts with a styptic taste. The white and thoroughly leached rocks are those which have attracted attention as china-stone, and in them, kernels and veins of pure white gypsum occasionally occur. It is doubtful, however, whether any great quantity of china-stone could be easily quarried, free from iron stains, while the kaolinite could only be obtained pure and in quantity by crushing and washing the lighter coloured parts of the deposit. British Columbia—*Cont.*

It is difficult now to say, what the original composition of the rocks here was. Their alteration is evidently in connection with the edge of the granitic mass to the eastward. The area occupied by these peculiarly altered rocks is probably about half a mile long by quarter of a mile wide.

The Glen Iron Mine, situated on the western part of Cherry Bluff, Kamloops Lake, was re-visited during the past summer. This deposit was noted in my report for 1877 (p. 118 B) and is also farther described by Mr. J. McEvoy in his summary report for 1893. No work was in progress at the time of my visit in 1894, but operations have been since resumed. There is evidently a large quantity of excellent magnetic ore at this place. Glen Iron Mine.

An inspection was also made of the property of the Van Winkle Hydraulic Mining Company, on the west bank of the Fraser about two miles above Lytton, where a good hydraulic plant has been established and is being operated. I was so fortunate as to meet here Messrs. J. M. Buxton and H. E. Newton, both interested in this enterprise. The original Van Winkle Flat, well known in former years as rich placer ground, consisted of the lower river-terraces, from a height of about one hundred feet above the river, down nearly to the river level; while river-bars, bare only at low water, were also worked with profit. The work was confined to the upper layers of these terraces and flats, and is reported to have averaged at the rate of about $6 per day to the hand. Van Winkle Hydraulic Co.

The object of the present owners is to work by the hydraulic method, the whole mass of the higher terraces or "benches" which rise from the river in successive steps toward the base of the mountains on the west. The first principal bench has a height of about 100 feet above the mean high-water of the Fraser, the next is about sixty feet higher, and there are others at still greater heights.

British Columbia—*Cont.*

The water employed is obtained from the south branch of Stein Creek, and being chiefly derived from the melting snow of the higher mountains, it cannot be depended upon after the weather becomes cold in the autumn. An ample and constant supply might, however, be obtained by extending the ditch to the main stream of Stein Creek. The water is delivered at the sand-box at a height of 377 feet above mean high-water of the Fraser, giving a head of more than 300 feet at the work. The pipe-line from the sand-box is about 1,500 feet long, with a diameter of eighteen inches, and about 1,600 miner's inches of water is employed. A large amount of gravel has already been excavated, the pit taking the form of an isosceles triangle, of which the apex touches the river, the base being at a distance of about 1,200 feet. The ground has not proved so rich as was anticipated, but the working face is now being carried back into the second bench, in which the gravels, wherever prospected, appear to be more highly auriferous.

Age of the auriferous drifts.

It is difficult to explain the geological relations of the gravels exposed in this work, without entering into the general question of the deposits of the Fraser valley in greater detail than is here possible. The history of these deposits is traced in the report on the Kamloops sheet, now ready for publication; but as this is the first attempt on a large scale to work the higher benches of the Fraser valley, the main facts may be alluded to.

All the gravels here exposed are believed to be later glacial or post-glacial in age. No boulder-clay is seen, nor is any true bed-rock reached. The lowest deposit cut through, consists of well rolled gravels, sometimes bouldery, with a sandy matrix, which pass largely, at a distance from the river-bank, into coarse irregularly stratified sand and fine gravels, occasionally lightly cemented. This deposit appears to represent what now remains of that filling of the valley due to a period subsequent to that of the removal of the boulder-clay by river erosion. It is comparatively poor in gold.

When the conditions permitting such accumulation changed, and the river again began to cut down through the deposits above mentioned, it flowed from time to time over different parts of the whole width of the valley, producing the existing series of terraces and benches in the course of its irregular excavation, and leaving portions of its bed at different heights, filled with more recent river gravels. These consist in part of the rearranged material of the lower deposit, in part of materials brought by the river from places up stream. In these old river gravels the greater part of the gold, found at this place, occurs. It is to be noted, that wherever the lateral streams in the immediate vicinity cut through gold-bearing rocks, the lower deposit

first described, may be expected to contain a considerable proportion of gold. This should be the case for instance in the vicinity of Lillooet. Of the old river-channels themselves, the higher must in all cases be the older, the lowest and latest being represented by the gravel deposits of the flats nearest to the present stream. British Columbia—*Cont.*

In the Van Winkle pit, the stratified auriferous gravels forming the upper part of the lower, or 100-foot bench, are probably newer than those of the next bench above, which is now being worked into; but this cannot be actually determined till the lowest part of the channel filled by the last-named gravel is exposed, and its height compared with that of the 100-foot bench. The older auriferous gravels due to a still earlier period of river erosion, which may be assumed to exist on the bed-rock proper, or upon whatever may remain of the boulder-clay, must now be altogether beneath the level of the present river.

In the vicinity of Lytton, two companies are also at work experimenting with barges and sand pumps or equivalent apparatus, with the object of working the auriferous gravels of the present river-bed, but no details are available in respect to the result of these operations. Renewed interest is also being taken in the gravel deposits near Lillooet and elsewhere, and there is now every prospect that all such deposits along the Fraser River will be thoroughly examined and, where found satisfactory, worked. River dredging.

Notes on the Area of the Shuswap Sheet.—The work done on this area consisted chiefly in the tracing out of some of the geological boundary lines and in the re-examination of parts of the shores of the Shuswap Lakes, for the purpose of ascertaining the interrelation and limits of the older formations there, in the light of later investigations on Adams Lake and in the Selkirk Range. The excellent sections found along Adams Lake in 1890, showed, that overlying the Shuswap series (referred to the Archæan) there is a great thickness of rocks which have been provisionally classed as Cambrian, consisting below of black argillites and limestones, named the Nisconlith series, and above of green and gray schists named the Adams Lake series. The same rocks appear on the Shuswap Lakes, but their arrangement and the conditions of metamorphism in which they are found, render the problem there more intricate. The results obtained during the past season on the Shuswap Lakes, have not yet been laid down on the map, but in the main, it may be stated, that there is now no great difficulty in separating the several rock-series in accordance with the key furnished by Adams Lake. In a few places, however, the extreme degree of metamorphism which the rocks have suffered makes such separation Work done on Shuswap Sheet. Old rocks Shuswap Lakes.

British Columbia—*Cont.*

more troublesome and less satisfactory. The rocks representing the Adams Lake series, under certain conditions assume an almost gneissic character, and whatever angular unconformity may have existed between the Cambrian and the Archæan has generally been obscured by the close flexure and compression to which both together have since been subjected.

The economic importance of the separation referred to is, however, not inconsiderable, because of the differences in character which may be traced in the ores met with in the two formations respectively, those of the Cambrian areas having, particularly in the Kootanie region, so far proved to contain most of the more valuable ores.

There is every reason to believe that the lowest Cambrian or Nisconlith series is really unconformable to the Shuswap series, and it is very probable that it has been originally deposited irregularly upon an already denuded surface of these older rocks. While the Nisconlith rocks are often chiefly composed of argillites, they appear in most places on the Shuswap Lakes to be represented by argillaceous limestones of dark colours and in flaggy layers, generally more or less micaceous.

Exploration, Adams Lake to Shuswap Lake.

The Shuswap Lakes appear to have been excavated in an area of the older rocks characterized by large and irregular infolds of the Cambrian strata, and one of the most notable features met with, is the great abundance of quartz veins in the vicinity of these lakes. This whole region is therefore one, inviting examination by the prospector, and likely, in some places at least, to repeat the conditions already found under similar circumstances in the West Kotanie district.

On the country traversed by him between Adams and Shuswap Lakes, Mr. McEvoy gives the following note :—

"Leaving Adams Lake on the 18th September, from the mouth of Mo-mich' River, which flows in on the east, side five miles from the head of the lake, we followed the north side of the river on foot. Two miles up, a small lake, a mile long, was reached. This lake is connected by a few rods of rapid water with another lake, two miles and a quarter in length. The valley of the river and the country about the lake is covered by timber of fair growth, Douglas fir, cedar and white pine.

"Salmon run up to this lake plentifully at this season, and ascend the stream at its head for some distance further. From the head of the lake, the Indian route followed lay in a north-east direction for a distance of three miles and a half, when we came to a river which is the main water supply of Mo-mich' River. The altitude of this point is practically that of the summit of the pass to Shuswap Lake, and is between 1,600 and 1,700 feet, only, above sea-level.

"From this place there was no track whatever, but after following up the north-west side of the river for some distance we crossed it and turned due east. The route was through a dense forest of fine timber consisting of white pine and cedar. At a distance of four miles, Tuk-em-ap-ten, a lake three miles long, is situated. There, some open and flat land was found, with very good soil, a considerable tract being a natural meadow. Leaving the head of Tuk-em-ap'-ten Lake, the summit of the pass was crossed and the head of Hum-am-ilt reached at a distance of three miles. White silts were noted on crossing this summit, and as viewed from either side, the summit presented a terrace-like aspect. Here we were delayed two days by wet, cloudy weather, during which it was impossible to get the necessary sketches from the adjacent hills, and during our wait we made a "dug-out" canoe with which to traverse the lake. Hum-am-ilt Lake proved to be seven miles and a half long, with four narrows, across one of which the beavers had made a dam during the summer. The stream flowing out of this lake falls into Shuswap Lake, three miles and a half below Seymour River, at the head of Seymour Arm.

"The country between Hum-am-ilt Lake and Shuswap Lake supports a heavy growth of very fine timber, which will before long be of great value, if it can be preserved from destruction by fire.

"The rocks throughout the whole route are gray gneisses of the Shuswap series, with areas of granite in several places. The latter, owing to the scarcity of exposures, will be difficult to define.

Silver ores, Adams Lake.

At a later date, Mr. McEvoy visited a recent discovery o silver ore near Adams Lake, which he thus describes :—

"The 'Homestake' mine is situated on Pass or Squa-am Creek about two miles and a half in a straight line from the end of Squa-am Bay, Adams Lake. The location is on a small stream flowing into Pass Creek on the north side, at a height of 750 to 800 feet above the bottom of the valley. A good deal of ore has been taken out and shipped, from the first opening, which is on a somewhat irregular vein dipping in general N < 70°, and branching to the west. The country-rock having since caved in, little could be seen of this vein at the time of my visit.

"About ten feet above the last, is a band of bedded rock highly impregnated with barite and galena carrying silver. Specimens of this ore can be distinguished from vein matter by its banded appearance. The mass varies in thickness from about ten feet at the stream, to twenty-five feet and more at a point about 200 feet to the west. The dip of the whole mass is N. < 25°. A drift, now one hundred and twenty feet long, is being run in below to intersect this deposit. The country

British Columbia—*Cont.*

rock is a talcose schist, light gray in colour, and in the vicinity of the first-mentioned locality is an almost pure talc-schist, dipping to the north at an angle of 25 degrees."

Depth of lakes.

During the time spent on the Shuswap Lakes, and while Mr. McEvoy was travelling northward to the head of Adams Lake, the opportunity was taken to ascertain the depth of these lakes. This was found to be extremely uniform over considerable parts of their area, but with unexpected and as yet unexplained exceptions. Little Shuswap Lake has a nearly flat bottom, with a depth varying from about 58 feet to 74 feet measured in this as in other cases, from the mean high-water mark. The deepest water found in Great Shuswap Lake was 555 feet, about six miles northward from Cinnemousun Narrows, in the Seymour arm, but nearly the whole lake is notably deep. Adams Lake however, much exceeds either of the Shuswap Lakes, as it is for a length of some twenty miles, about 1,150 feet, the greatest depth being 1,190 feet. As the height of the surface of this lake is 1,380 feet above the sea-level, its present bed is therefore 190 feet only above the sea, although distant nearly 200 miles from the nearest part of the ocean.

Hydraulic mining in Cariboo.

Observations on Hydraulic Mining in the Cariboo District.—Although hydraulic mining has long been practised in the Cariboo region, it has hitherto been on a comparatively small scale and confined to the immediate vicinity of the older mining camps. The isolation of the district from main lines of communication has limited enterprise in this direction almost entirely to what could be done with local resources. During the past summer, however, work on a much larger scale has been actually begun in several places, with results, so far as it has gone, of a very gratifying character. Capital has been interested in this expansion of hydraulic mining sufficient to meet the heavy initial expenses of long ditches and pipe-lines with the most approved modern appliances. These operations have already drawn general attention to the extensive gravel deposits of the Cariboo region, which, although less rich than the old channels originally worked by drifting, are enormously greater in area. The country as a whole is one well supplied with lakes and streams at every different level, and thus well suited for the hydraulic working of any of the gravels which may prove to be of a payable character.

It is but just to add, that the present renewed interest in the Cariboo district is very largely due to the practical knowledge and advice of Mr. J. B. Hobson, who is in charge of the works of the Cariboo Hydraulic Mining Company and of those of the Horsefly Hydraulic Mining Company, both of which it is anticipated will be in full opera-

tion early next spring. It is certain that extensive prospecting work will be carried on next summer in various parts of the district, and it is therefore advisable to give here, some of the more important facts already determined which may be of service to the prospector. During my short visit to the district, attention was chiefly given to the developments made by the two companies above named, and some notes on these will first be given. The places referred to will be found laid down on Mr. Bowman's map of the Cariboo mining region, published with the Annual Report of the Geological Survey (new series) vol. III. British Columbia—*Cont.*

The property of the Cariboo Hydraulic Mining Company, is situated on the south side of the South Fork of Quesnel River, about three miles above the village of Quesnel Forks. It comprises several claims and is believed to cover about 8,500 feet of an old high channel of the river, separated from the modern deep and cañon-like river gorge, for a considerable part of its length, by an exposed rocky ridge known as French Bar Bluff. Near the lower end of the property, on Dancing Bill Gulch, successful hydraulic mining, on a small scale and with imperfect appliances, has been carried on for a number of years by a Chinese Company. At a distance of about 3,000 feet further east, on Black Jack Gulch, a good deal of work had been done by the South Fork Company, but without effectively reaching the richer gravels, which are below the level of the rim-rock where this has been cut through. Short ditches had been made by both these earlier companies, and the exposures in their hydraulic pits afford most of the information obtainable as to the character of the deposits. A ditch with a total length of seventeen miles, and a capacity of 3,000 miner's inches, has now been laid out by the present company and will be completed in the spring. This is to derive most of its water from Polley's Lakes, situated in the hills to the south-eastward. It is also, I believe, ultimately proposed to bring an equal volume of water from Moorhead Lake, by means of a second ditch which will be thirteen miles in length. Cariboo Hydraulic Mining Co.

At the lower or "China pit" the bed-rock of the old channel where cut by the present river-bank is believed to be approximately 134 feet above the river. The head of the train of sluices near the working face is 200 feet above the same datum, while the sand-box at the top of the bank is at a height of 489 feet; giving a head of water equal to about 289 feet, with ample fall for the dump, which is made direct into the river. Two monitors of five and five and a half inches diameter of nozzle respectively, are established in this pit. Mr. Hobson estimates that the old Chinese company removed in all, about 150,000 cubic yards of the bank, from which, it has been ascertained, $135,000 Lower pit.

British Columbia—*Cont.*

of gold was obtained, without the employment of mercury, being at the rate of about 90 cents per cubic yard. The scanty water supply available in advance of the completion of the main ditch, enabled a run of only forty-seven hours to be made in the early summer. The mean volume of water employed was 2,000 inches and the yield was 302 ounces.

Upper pit.

The floor of the pit of the old South Fork Company is about 200 feet above the present river, and bed-rock has been found in test pits at a depth of about 30 feet below this floor, while above it, on one side of the gully, is a nearly vertical face of clay and gravels about 200 feet in height. The head of water from the sand-box to the present bottom of the pit is about 246 feet; but as already stated the rim-rock has not yet been cut through to the full depth of the old channel. It is proposed to begin active work here in the spring.

Geological conditions.

The geological conditions as displayed in the two pits above described are of great interest, but in the present summary it is possible only to allude briefly to the main facts.—In the old South Fork pit, the section, in descending order, shows—(1) Ordinary boulder-clay with many glacially striated stones, 60 feet; containing little or no gold. (2) Stratified sands and gravels 120 to 130 feet; yielding gold to the amount of about five cents to the cubic yard. (3) Hard "lower boulder-clay" with very few glacially striated stones, 30 feet; not known to certain any gold. (4) Well rounded gravels, to bed-rock, 30 feet; rich in gold, some prospects obtained from trial pits being as high as $20 to the cubic yard.

In the "China pit" the section exposed is as follows: (1) Stratified gravels, seen along a portion of the top of the face only, greatest thickness about 30 feet. These contain gold to the amount of about five cents to the cubic yard. (2) Boulder-clay about 100 feet thick, in what appears to represent the axis of the old channel, but running out to nothing on each side; not known to hold any gold. (3) Rather hard roughly stratified gravels and sands, with clayey mater; the stones well rounded and often large. Maximum thickness about 310 feet to bed-rock, minimum thickness (where the overlying boulder-clay is deepest) about 200 feet; rich in gold.

The gold content of the several deposits, as above stated, results from tests made by Mr. Hobson and communicated by him to me. The equivalency of the strata in the two pits is not quite certainly determined, but No. 1 in the "China pit" is believed to represent No. 2 in the "South Fork pit," No. 2 to represent No. 3, and No. 3 to represent No. 4 respectively. The bed-rock appears to be generally a much altered and shattered greenstone (diabase?) penetrated by syenitic dykes and including a considerable body of syenite near the "China pit." In

regard to age, it would appear that the lower and richer deposit in each pit is pre-glacial, while the upper gravels in the "South Fork pit" (No. 2) are, certainly, and those in the "China pit" (No. 1) probably, of inter-glacial origin.

Horsefly Hydraulic Mining Co.

The Horsefly River, empties into Quesnel Lake at a distance of twelve miles from the outlet of the lake. Its sources are in a mountainous country to the eastward, but its lower part, here particularly referred to, flows northward. A good deal of prospecting and some remunerative mining has been done at different times along this river and its tributaries, and the Harper claims have for many years attracted more or less attention as extremely promising, but owing to various difficulties have not been extensively worked. The Horsefly Hydraulic Company's claims, are situated on the river at a distance of about six miles south of Quesnel Lake, and here very important operations have now been initiated. The river was notably rich in this particular part of its length and the bars had all been worked over by Chinamen some years ago. Mr. McCallum, the discoverer of these claims, rightly believed that the modern placers must have some local source of the nature of an old channel. In search of this he endeavoured, by ground-sluicing, to work back in the bank of the river, but finding the ground too heavy for his water supply, eventually drifted into the bank and succeeded in striking the old auriferous gravels. These were at first worked by drifting and afterwards with a small hydraulic plant, supplied from Rat Lake, which is now used as a reservoir by the new company. The mining rights of the discoverer were secured by purchase by the Horsefly Hydraulic Company, and in the course of the prospecting carried out for this company by Mr. Hobson, much has since been learnt in regard to the character and extent of the deposit.

Working plant.

By the system now successfully completed, water is brought from Mussel Creek, a southern feeder of the Horsefly, by a ditch and pipe-line aggregating over eleven miles and a half in length. The ditch is about ten miles long, with a capacity of 20,000 miners' inches. The pipe-line is steel, 30 inches in diameter, in two lengths aggregating 8,300 feet. There is also about 600 feet of flume. From the sand-box the water is led to the pit by two lines of 22-inch pipe, each of which is intended eventually to supply two monitors. Water is delivered from the main ditch with a head of 168 feet, and from the pooling reservoir with a head of 106 feet. The bed-rock constituting the floor of the pit is about 90 feet above the level of the river, and the working face (60 feet in height at its highest part) at the time of my visit was about 560 feet back from the river-bank. The dump is formed in the river itself, which is a moderately rapid stream, capable (particularly in high water) of removing a larger quantity of debris.

British Columbia—*Cont.*

Respecting the actual average gold content of the gravels, much has doubtless been ascertained since my visit, some $13,000 being reported as the result of the last "clean-up". The preliminary run made by the company, was estimated to have dealt with 21,333 cubic yards of gravel. It produced gold to the value of $5,000, or at the rate of about 25 cents per cubic yard, but about a third of the area then worked had already been drifted on bed-rock by Mr. McCallum, rendering it probable, in Mr. Hobson's opinion, that the unworked ground would average about 40 cents. A small quantity of platinum occurs with the gold at this place.

Yield of gold.

Geological conditions.

The bed-rock in the hydraulic pit consists of pale, Tertiary (Miocene or Oligocene) shales, clays, sandstones and conglomerates, only moderately indurated and, in general, easily removed by the jet whenever this is required. These rocks contain a few fossil plants and insects, and are inclined in various directions, but their upper surface is a nearly horizontal denudation plane. The working face shows, resting upon them, a thickness of from 30 to 50 feet of gravels, roughly stratified, and varying in character in different layers from almost bouldery material to sand. A few feet near the bottom is irregularly cemented, and some parts of this "cement" is so hard that it cannot be disintegrated by the water. The cementing material is chiefly calcite, but strontianite is found in crusts of half an inch or more in some of the interstices. Stems and fragments of wood are occasionally seen in the lower layers, in a condition approaching that of lignite. The general colour of the auriferous gravels is yellowish, but becomes bluish toward the base. They are directly overlain by a regular layer, of from ten to fifteen feet in thickness, of ordinary boulder-clay, which, except where covered by later gravels, forms the general surface of the country in the vicinity. In another part of the pit, a local deposit of rather fine, gray gravel is found between the boulder-clay and the auriferous gravel, but unconformable to both. This yields a small prospect of fine gold, but the boulder-clay itself is not yet known to hold any gold.

Pliocene gravels.

The auriferous gravels at this place are therefore distinctly preglacial in age, and may, with little doubt, be assigned to the Pliocene period of the Tertiary. While it is probable that they represent an old river-channel, this has not yet been clearly demonstrated, nor is it at all certain that they have any intimate connection with the present course of the Horsefly. The problem is one not only of great interest, but also of great importance in connection with the future developement of the field.

The upper end of the Harper claims, where some work has been done, is situated about four miles further up the river than the last. Small sections, made in the course of work near the river bank, here show yellowish auriferous gravels, precisely like those of the Horsefly claims and capped in the same way by boulder-clay. Several small shafts have been sunk in this vicinity and part of the river bank and bed has been worked by drifting and wing-damming. The Miocene bed-rock is found nearest the surface at six feet below the river-level. Though not thick, the auriferous gravels in this neighbourhood have proved to be exceptionally rich, and they appear to be somewhat widespread. Some miners were engaged at the time of my visit, in putting in water-wheels to drain small open-cast workings on the east side of the river; but for the working of the deposit here on a large scale, the hydraulic elevator would probably be the most appropriate appliance.

Harper claims.

Adjoining the Horsefly claims on the north, is the Thompson claim, where the owner has been engaged for some years in drifting into the bank, with the purpose of reaching the supposed continuation of the depression or old channel in which the auriferous gravels of the Horsefly claims occur. The drift is now about 1,200 feet long. It cuts through Miocene rocks like those already described, somewhat flexed, and including a considerable bed of conglomerate, which I was informed, contains a little fine gold. There is no surface indication to show where an old channel may be expected to pass, and it would appear to be advisable here, to test the ground by boring in advance of the drift, before this is pushed further in the present direction.

Thompson claim.

The notes above given refer only to localities actually visited by me last summer. I hope to give, at a later date, a fuller account of the various deposits seen, which it is impossible to explain in detail without diagrams and sections. Exploratory work is being conducted at present in a considerable number of places throughout the Cariboo district thought to be suitable for hydraulic mining. Further attempts, with better appliances than before, are also being made to "bottom" some parts of the continuation of the well known auriferous channels of the central and mountainous portion of the district.

Mr. C. F. Law has kindly supplied some details of the work being done on the deep ground in the Willow River valley, in which he is interested. This is the main continuation of the valley of the famous Williams Creek. Near the mouths of Mosquito Creek and Red Gulch, four prospect holes have been bored to bed-rock through the alluvial materials filling the Willow River valley. The bed-rock was reached at a depth of from 67 to 109 feet. The old channel was discovered at the depth last mentioned, at a distance of about 500 feet to the south-

Willow River valley.

British Columbia—*Cont.*

ward of the present river, and was found to be capped by a hard ferruginous cement, beneath which is four feet of pay gravel, which from the samples brought to the surface appears to be very rich. Some good payable gravels were also encountered in the side ground, and a shaft, with adequate pumping and other machinery, is now being sunk on the deposit.

Work of a similar character to the above is also I understand being carried on by the Slough Creek Mining Company, in the valley so named, in which the old channel upon bed-rock is reported to have been reached by boring at a depth of 245 feet.

Gravel deposits at Quesnel.

In an article in *The Province* (Victoria, B.C., Nov. 10, 1894) Mr. Law directs special attention to a gravel deposit on the west side of the Fraser, opposite the mouth of the Quesnel River, which he proposes further to investigate. The deposit is capped by basalt, and Mr. Law very properly draws attention to the probability of its extension, and the existence of others like it in the great basaltic area to the west of the Fraser, * quoting Mr. Hobson's opinion to the effect that the Quesnel River system at a former period (before the excavation of the Fraser Valley) flowed westward to the coast. The gravel deposit here particularly referred to, was first noted by Dr. Selwyn in 1875, and a section showing its relations, based on measurements by Mr. Webster, is given in my report for 1875-76, (pp. 257, 263) according to which the base of the basalt capping is about 700 feet above the Fraser or approximately 2,380 feet above sea-level. Mr. Law has already ascertained that these gravels contain at least some gold, and from the appearance of the exposures he believes them to represent an old river-channel. Should this prove to be the case, it does not, however, follow that the old river flowed westward, it is perhaps even more probable that the general direction of the drainage in this region, was northward, during a considerable portion of the Tertiary period, as I have elsewhere suggested. Attention may further be directed, in this connection, to the notes given in my report already referred to (pp. 263-264) on very similar gravels met with on the lower part of the Blackwater River and elsewhere along the Fraser Valley. Some of these closely resemble the more lately discovered auriferous gravels of the Horsefly, and may be of the same age, although it would not necessarily follow from this, that all are equally auriferous, this being likely to depend on the local source of the gravels in each case.

General conditions of gold occurrence.

Many of the general questions relating to the conditions governing the occurrence of auriferous placer deposits in the Cariboo district as

* See Geological Map of a portion of British Columbia between the Fraser River and the Coast Range. Report of Progress, Geological Survey, 1875-76.

a whole, so far as these are already known, require treatment in greater detail than can here be accorded. It must suffice at the moment, to point out that the late developments have already resulted in greatly extending the area of prospecting and prospective mining, in the manner previously suggested by me on more than one occasion.* The central portion of the Cariboo district,—that in which the highly concentrated auriferous deposits of Williams, Lightning and other well known creeks have been worked—may be described as a mountainous region, surrounded by lower hills and lowlands to the south, west and north. In this mountainous tract, the valleys of streams are deeply cut, and the modern streams still occupy the lines of a very ancient erosion. In surrounding regions, the lower portions of the same streams have evidently, at different periods, flowed in many different courses, both before and after the date of the great basalt eruptions ; being there subject to changes induced by comparatively slight alterations in relative level of different parts of the country, as well as to many other causes. Where the older channels thus formed, or the gravelly deposits discharged by them on wider areas, antedate the basalt flows, it is now as a rule difficult to find any superficial indications of their existence; but in the case of later streams, and in places to which the basalts have not extended, many of the old valleys may still be found and followed without difficulty. The superficial filling of such valleys, together with the latest changes in the courses of streams, have resulted chiefly from the deposits and effects of the ice of the glacial period, and the study of all the conditions and events of that period has, in British Columbia, a most direct connection and importance in relation to the questions of mining. Allusion has been made to some of these effects in previous reports, but much yet remains to be ascertained and applied, for the problem is essentially a new one in regard to placer mining, no such conditions of a general kind being met with in California, Australia or any other country in which alluvial gold mining has been extensively prosecuted.

British Columbia—*Cont.*

Importance of glacial phenomena.

In the pages which follow, some account is given by Mr. McConnell of recent discoveries and work in the West Kootanie district. A much more general interest is being awakened in mining throughout the province, and it may safely be affirmed that British Columbia has now fairly entered on a period of rapid and thorough development of its mineral resources.

Cost of field work $1,833.93.

* Mineral Wealth of British Columbia. Annual Report of the Geological Survey. Vol. III., (N.S.) p. 45R *et seq.*

British Columbia—*Cont.*

Mr. R. G. McConnell was engaged during the earlier months of the year, in working up the results of his exploration of the previous summer in the Finlay River and Omenica country, of northern British Columbia. Many of the specimens brought back were carefully examined, a report on the expedition was in part written and a map prepared, the last-named branch of the work being conducted by Mr. H. Y. Russell. Mr. McConnell left Ottawa for the field on June 19th, and after a couple of weeks occupied in the foot-hills of western Alberta, as noted on a previous page, spent the remainder of the summer in the southern part of the West Kootanie district. The work thus begun here, it is intended eventually to publish as one of the regular sheets of the geological map of British Columbia; the map-sheet as laid out, including Kootanie, Lower Arrow and Slocan Lakes, with the country in their vicinity.

On his field work, Mr. McConnell makes the following report :—

West Kootanie, work by Mr. McConnell.

"Nelson, which was selected for headquarters, was reached on July 26th, and on the 28th work was commenced at Ainsworth and carried on in different parts of the district until Oct. 15th. The principal regions examined were Ainsworth, Toad Mountain, Ymir Mountain and vicinity, the mountains south of Balfour, part of the Slocan region, Crawford Bay and Trail Creek. During the season I was zealously assisted by Mr. H. Y. Russell, who took charge of the topographical work.

"An endeavour was made to obtain a general knowledge of the geology of the different portions of the district, and to make as complete a collection as possible of the representative rocks and minerals for purpose of study during the winter, rather than to attempt at once to work out any part of the field in detail.

The rock series.

"The stratified rocks of the district may be roughly divided into three main groups. The oldest of these, the Shuswap series of Dr. Dawson, is probably of Archæan age, and consists of gneisses, mica-schists, bedded diorites and crystalline limestones. Resting on it is a great series of alternating bands of green schists and dark argillites, several thousands of feet in thickness, the age of which has not been determined. The latter is overlaid, apparently conformably, by a great volume of dark slates which are often calcareous and occasionally pass into impure limestones.

"The Shuswap series occupies the basin of the Kootanie Lake, from Kaslo south, for at least forty miles. It borders both shores of the lake, in bands varying in width from one to two miles or more. The strike, north of Balfour, is nearly north-and-south, but south of the

West Arm of Kootanie Lake it trends more to the west. The dip is almost invariably to the west, except where overturns have taken place. British Columbia—*Cont.*

"The series of green schists, dark argillites and limestones which overlies the Shuswap rocks, are well exposed along the wagon road from Kaslo to Three Forks. A section was measured at this point, but has not yet been worked up. The green schists and associated rocks extend southward with a gradually diminishing width to a point on the West Arm of Kootanie Lake, two miles west of Balfour, where they are nearly, or altogether cut off by the granites. Southward from this point, about four miles east of the Ymir Mountains, two bands of argillites interbedded with crystalline limestones occur, which probably belong to the same formation. The band of green schists which begins near Ward's Ferry, on the Kootanie, and strikes eastward across Toad Mountain to the head of the Salmon, then down the valley of this stream, are probably of the same age. The distribution of the latter band assumes the form of a bay of stratified rocks opening to the south, and penetrating towards the north the central granitic area of the district. The Toad Mountain schists are underlain on the east by the gneiss of the Shuswap series, and overlain on the west near Red Mountain by reddish-weathering slates. Green schists.

"The upper series of stratified rocks, consisting mostly of dark evenly bedded slates with some limestones, is largely developed in the Slocan country, and is well shown along the Kaslo wagon road from Fifteen-mile house westward to a point a couple of miles west of Three Forks, where this series is cut off by an area of eruptive rocks. Southward, the slates of this series strike into the great granitic mass which occupies the central part of the district, and are all cut off, with the exception of a narrow strip which skirts the granite on the west as far south as the West Arm of Kootanie Lake. Dark slates and limestones.

"Dark slates, somewhat similar in general appearance to those in the Slocan country, were observed on the Pend-d'Oreille River near the International Boundary and also on Sheep Creek, but it is impossible to say as yet if they belong to the same period.

"East of Kootanie Lake, the stratified rocks are subject to a different arrangement. At Gray Creek, the only place where they were examined in detail, the Shuswap series of schists and limestones are succeeded by several thousands of feet of quartzites and conglomerates, a group, so far as I know, entirely unrepresented west of the lake. Above the quartzites, light and dark green schists, interbedded with quartzites and conglomerates, occur, and are exposed along the valley for four miles, when they are succeeded by a band of quartzites about 2,000 feet thick, above which is a series of green schists.

British Columbia—*Cont.*

The latter is overlain by a band of coarse dolomitic conglomerate passing upwards into a dolomite. The dolomites occur near the summit of the pass, and are followed by green schists similar to those lower down in the series. It is probable that the latter are repeated by faulting, but owing to the summit being covered with snow at the time of my visit, I was unable to prove this.

Eruptive rocks.

"The eruptive rocks of the district occupy wide areas and belong to several periods. The oldest, as far as ascertained, consist of a series of basic dykes cutting the Shuswap group, but now in many instances so altered and foliated by pressure and other causes that they have the appearance of constituent beds. They occupy in some localities a considerable proportion of the area assigned to the Shuswap series. They are older than the overlying formations.

"Eruptive granitic rocks, much younger than those referred to above, occupy the western part of the region, from about the north end of Lower Arrow Lake south to Trail Creek and east to within a few miles of Kootanie Lake. They cover a continuous area of fully 2,000 square miles. Numerous bosses and dykes of granite and pegmatite also occur further to the east, along the borders of Kootanie Lake. The granites, where examined, are usually grayish in colour, are coarse grained, as a rule, and are often porphyritic. The principal constituents are feldspar, quartz, biotite and hornblende. The granites cut all the formations from the Shuswap series up to the Slocan slates, and are consequently younger than any of the stratified rocks of the district. A series of eruptive rocks still younger than the granites, is represented by diorites, and diabase and uralite porphyrites. These rocks occupy a considerable area in the Trail Creek country, and are important, as they hold the principal lodes of the district. It is possible that some of the porphyritic rocks, so abundant in the Toad Mountain region, may belong to the same group.

"In addition to the main areas of eruptive rocks, numerous dykes, some of them connected with the main areas, others much younger, as they cut through everything, are met with in every part of the district.

Visits to mines.

"A hurried visit was paid during the summer to the most important mining camps of the West Kootanie district, but as these must all be examined in detail in the future, it will only be necessary here to give a brief statement of the principal characteristics of some of the most important mines visited.

"In the Slocan country, my examination was limited to a few of the mines in the vicinity of the South Fork of Carpenter Creek.

Slocan.

"The 'Slocan Star' one of the principal mines examined, is situated on Sandon Creek, about a mile above its mouth. It was discovered

in August, 1891, by John Sandon and Bruce White, and has been worked continuously for the last eighteen months. Nine hundred tons of ore, principally galena had been taken out, and awaited shipment. This ore it was expected would average 100 ounces in silver and $2 to $3, in gold per ton, besides the lead, which was estimated at 76 per cent. British Columbia—*Cont.*

"The great fissure on which the 'Slocan Star' is situated, runs in a nearly east-and-west direction, almost at right angles to the strike of the country-rocks, and can be traced through several claims. It dips to the north at an angle of from 45° to 60°. It is irregular in character, widening out to sixty feet or more in places and in others dwindling down to less than six. Numerous short tributary cracks penetrate the country-rocks on both sides, and fragments of the latter have fallen into the rift in great numbers. The gangue is principally quartz and spathic iron. The country-rocks consist of hard, evenly bedded, dark slates, often calcareous and occasionally passing into quartzites. They are considerably disturbed for some distance on both sides of the fissure. "Slocan Star."

"The workings on the 'Slocan Star' consist of four tunnels. The upper two are short, but the third or main tunnel has been driven in as a cross-cut for 140 feet, and then follows the vein for over 500 feet. Ore occurs all along, but the main ore-body was struck at a distance of 130 feet from the end of the cross-cut and is of extraordinary proportions for such high-grade ore. It has a length of 150 feet and a width ranging from a few inches up to six feet or more, of ore entirely pure, with the exception of occasional thin partings of quartz and siderite. The solid galena is besides bordered on both sides by a considerable thickness of concentrating ore. Beyond the main ore-body, smaller ones were met with, and at the present end of the tunnel, the vein is four feet wide. The galena occurs both in a fine grained and a coarse cubical condition and in places has a foliated appearance probably due to pressure.

"A fourth tunnel 300 feet below No. 3, had been driven in 300 feet, but at the time of my visit had not reached the ledge.

"For many of the above particulars in regard to the 'Slocan Star' am indebted to Mr. Bruce White.

"East of the South Fork of Carpenter Creek, the high ridge separating the latter from Kaslo Creek is literally ribbed with valuable lodes. Along the southern slope of the ridge, seven nearly parallel leads, some of them traceable through several claims, occur within a distance of less than a mile. Of this group only the 'Ruecau' and 'Bluebird' were examined in any detail.

British Columbia—*Cont.*

"Ruecau."

"The 'Ruecau' runs in a direction N. 29° E. and dips to the east at an angle of 70°. The lead on which this mine is situated can be traced, for a distance of 4,500 feet, according to Mr. Harris, the manager, whom I have to thank for much information. The fissure varies in width from four to twenty feet, and is broken through hard, dark slates, which it cuts almost at right angles. The slates are traversed by numerous porphyritic dykes, all of which are older than the fissure, as they are cut by it.

"A tunnel following the lode has been driven in at the 'Ruecau' for a distance of 355 feet. The first sixty feet proved to be nearly barren, then ore was struck, and has since been followed pretty constantly for a distance of over 250 feet. The ore occurs on the hanging wall, and varies in thickness from a few inches up to several feet. Small disconnected ore-bodies are also met with on the foot wall. The ore is principally galena, largely altered into oxides and carbonates, the proportion being about one of the former to three of the latter.

"Eighty tons of galena, which it is stated yielded 176 oz. of silver to the ton and 76 per cent lead, were shipped from this mine during the winter 1893-94, and 500 tons of oxides and carbonates await shipment.

"The 'Bluebird' (Mr. Taylor manager) is situated about half a mile east of the 'Ruecau.' The lead has a width of from one to five feet and extends in a direction N. 70° E., with a series of little northerly jogs. The vein-filling consists of quartz, calc-spar and masses of the shaly country rocks.

"Bluebird."

"The 'Bluebird' has been worked in an intermittent manner for the past three years, and 340 tons of ore, stated to average 132 oz. silver and 72 per cent lead, have been taken out. The ore is galena, partially altered by atmospheric agencies into oxides and carbonates. It occurs in a series of disconnected and often overlapping ore-bodies, ranging from a few inches up to a foot or more in thickness. Ore-bodies of considerable size also occur interbedded with the slates adjoining the fissure. The 'horses' and country-rock of this mine, in common with that of most of the mines in the district, are impregnated to some extent with mineral, assays showing 5 oz. silver per ton and 6 per cent lead.

Other mines.

"Besides the two mines referred to above, work was being actively prosecuted at the time of my visit at the 'Deadman,' from which some very rich ore has been taken, and also at the important 'Noble Five' group; while on the northern slope of the ridge the 'Dardanelles' and 'Antelope' were in active operation.

"Some of the best mines in the Slocan district are situated on the long ridge separating the South Fork of Carpenter Creek from Slocan

Lake, but I was obliged, owing to lack of time to defer the examination of these to another season. British Columbia—*Cont.*

"Most of the claims in the Ainsworth district were examined and reported on by Dr. Dawson in 1889, and with the exception of a short visit to the 'Highland' mine, my time, while in this camp, was occupied in geological work. Ainsworth.

"The 'Highland' mine is situated north of Cedar Creek, about half a mile west of, and 1,100 feet above Kootanie Lake. The country rock here is a well foliated mica-gneiss, striking nearly north-and-south. The fissure on which the mine is situated has a width of from 10 to 20 feet, and cuts the gneisses in a north-easterly direction. The vein-filling consists of layers of soft whitish clay (probably kaolin), and quartz, together with masses of the country rock. The vein has been uncovered for a couple of hundred feet and several ore-bodies, principally galena, exposed, the largest of which has a thickness of from 6 to 7 feet. The workings include one open-cut and two tunnels, the lower of which has been driven in about 200 feet. The ore is stated to average 55 oz. of silver per ton and from 60 to 80 per cent lead.

"In the Toad Mountain country, work is being prosecuted at the 'Silver King' and 'Poorman' mines, both of which have been described by Dr. Dawson in the report previously referred to; but with these exceptions few of the mines in this locality are being worked extensively. Considerable prospecting has, however, been done during the past season and several promising gold and silver properties have been reported. Toad Mountain country.

"A short visit was made to the 'Fern' mine, situated south of Hall Creek. This property consists of a quartz lead, traversing the green schists of the region. The lead has been opened up at several places and is fairly regular, with a width of from 5 to 6 feet. The quartz holds auriferous iron- and copper-pyrites besides some free gold, and is reported to assay, from traces, up to $70 per ton in gold.

"The Trail Creek mining camp is situated about seven miles west of the Columbia River, and six miles north of the International Boundary. The principal ore here is an intimate mixture of pyrrhotite and chalcopyrite, very similar to the Sudbury ore. It occurs in an area of eruptive rocks, consisting mostly of diorite and uralite porphyrite. The ore is mined chiefly for gold. The eruptive area is traversed by four or five main leads, each of which can be traced through several 1,500-foot claims, and on one, ten claims are stated to be located. The leads are nearly parallel, have an approximately east-and-west direction, and dip to the north at angles of from 60° to 70°. The Trail Creek.

British Columbia—*Cont.*

main productive belt has a width of less than a mile, but some good claims occur beyond this limit.

"The ore occurs along the leads in ore-bodies ranging in size from small stringers a few inches wide, up to great lodes 10 to 15 feet in thickness and from 100 to 150 feet or more in length. The richness of the ore is also very variable, assays showing it to run from traces up to several ounces of gold to the ton.

"Leroy."

"One of the most important mines in the district, and that in which the most work has been done, is the 'Leroy.' This mine was located in 1890 by E. F. Topping, but is now being worked by a stock company with Colonel Peyton as managing director and E. W. Liljegram as local manager. It is situated on a spur of Red Mountain, about half a mile west of, and 350 feet above the town of Rossland. The mine is worked by means of a shaft following the ore-body. At the time of my visit, the shaft was down 300 feet and ore ranging in thickness from 1 to 10 feet had been followed all the way. At the bottom of the shaft the ore is 4 feet thick. A surface opening 40 feet west of the shaft, shows 6 to 7 feet of clean ore and the ore-body can be traced 100 feet or more east of the shaft. A second ore-body, several feet in width, occurs south of the shaft, and a third, stated to be 12 feet in width, but which was covered up at the time of my visit, lies to the north. The ore is a nearly pure mixture of pyrrhotite and copper-pyrites, flecked occasionally with small quartz blebs. The foot wall is well defined in places and is separated from the ore by a thin calcite layer. No distinct hanging wall was observed. 2,000 tons of ore, stated to average nearly $40 in gold per ton and from 3 to 5 ounces in silver, have been shipped from the 'Leroy.'

"The rocks in the vicinity of the 'Leroy' are fissured for a width of from 60 to 70 feet, but it is possible that these may be shrinkage cracks and that the ore here, like similar occurrences in Sudbury and other places, may simply represent the first basic segregations from a solidifying magma. More detailed investigations will however be necessary before this can be proved.

"War Eagle."

"A couple of hundred yards north of the 'Leroy,' is situated the important 'War Eagle' claim. This claim was located in 1890 by J. Bourgeois and J. Moriss and is now bonded to Clark, Finch & Campbell. Development work has not proceeded so far on the 'War Eagle' as on the 'Leroy,' but the surface has been well explored and several ore-bodies exposed. There are two nearly parallel leads on this claim, separated at the eastern end by about 100 feet and at the western end by about 40 feet. The leads run nearly south-east at the centre of

the claim, but turn round toward the ends into a nearly east-and-west direction. They have the usual northerly dips. British Columbia—*Cont.*

"The principal ore-body on the southern or main lead, occurs 500 feet east of the western end of the claim, and has a maximum width of from 8 to 9 feet and a length of from 100 to 150 feet. A shaft has been sunk to a depth of 50 feet, passing through solid ore all the way. At 250 feet west of the shaft, a second ore-body, 5 to 6 feet in width, has been uncovered, while near the eastern end of the claim a third occurrence of ore, 4 feet wide in places, has been traced for 100 feet.

"The 'War Eagle' ore is similar in character to that of the 'Leroy,' and is stated to average $36 in gold to the ton.

"Considerable work has also been done on the 'Centre Star,' supposed to be a continuation of the 'Leroy,' on the 'Nickle Plate' and on the 'Josie,' the former lying to the south and the latter to the north of the 'Leroy,' but at the time of my visit all three were idle from various causes. At the 'Josie,' besides the ordinary iron and copper sulphurets, mispickel also occurs. A large quantity of ore has been shipped from this mine. Other mines.

"Half a mile north of the 'Leroy,' is the 'Cliff' mine, one of ten claims, all supposed to be situated on the same lead. This mine is owned by Wharton, Bros. & Cook, and was located in 1890 by Gay Reeder. The principal openings consist of a tunnel 45 feet long and a shaft 20 feet deep, situated 150 feet west from the mouth of the tunnel. The tunnel follows ore all the way, the ore-body being narrow at the entrance, but gradually widening, until at the end, the tunnel is entirely in solid ore. At the surface, above the end of the tunnel, 12 feet of ore is exposed. The ore in the tunnel is mostly pyrrhotite with some copper-pyrites and is reported to carry gold to the value of $8 to $9 to the ton. At the shaft the ore-body is smaller, varying from 4 feet at the surface to 2 feet at the bottom, but the ore is stated to be much richer, running from $25 to $27 to the ton.

"A large number of other claims, some of which show considerable bodies of ore, have been staked out in this neighbourhood, but it is impossible to give an account of these in this short summary.

"West of the main Trail Creek camp, on the west bank of Goat Creek are the 'O. K.' and 'Gold Hill' claims, two mines, of an entirely different character from those just described. The 'O. K.' was discovered in 1892 by John Y. Cole, one of the present proprietors. It consists of a gold-bearing quartz vein, running in a direction a little south of east through a compact, greenish, partly serpentinized rock, probably an altered eruptive. A tunnel following the lead has been driven in Goat Creek.

British Columbia—*Cont.*

for 300 feet. The quartz varies in thickness from a few inches up to 2 or 3 feet, and is remarkably rich in places, picked specimens often showing numerous flecks of free gold. Besides the free gold, considerable quantities of iron, copper and lead sulphurets all carrying gold are also present. A car load of assorted ore from this mine, ran $178 per ton, and the average yield is stated to be about $38 per ton. A five-stamp mill is in operation here.

"The 'Gold Hill' mine, owned by Welsh & Morris, is situated a couple of miles north of the last. The opening made on this, is a shaft 30 feet deep, sunk in a nearly vertical porphyry dyke which cuts black slates. The dyke is traversed by irregular quartz veins carrying gold, which do not appear to enter the slates. Ten tons of ore have been shipped from this property and about as much more awaits shipment. The ore was expected to average $120 to the ton.

"In the preparation of this summary of the season's work, I have been obliged to depend entirely on my field notes, as none of the numerous mineral and rock specimens collected have yet been assayed or examined in the office."

The cost of the season's exploration by Mr. McConnell was $1,400.

North-west Territories and Keewatin.

North-west Territories and Keewatin.

In the last Summary Report, mention is made of the exploration conducted by Mr. J. B. Tyrrell in the tract of country lying between Athabasca Lake and Hudson Bay, including the hitherto almost unknown "Barren Grounds" of the north. Mr. Tyrrell did not return to Ottawa in time to furnish a report on his work for publication with others of the same year, and it is therefore considered advisable to introduce his preliminary report here, although it relates to the year 1893.

Mr. Tyrrell's expedition of 1893.

Mr. Tyrrell was accompanied by his brother, Mr. J. W. Tyrrell, as assistant, topographer and Eskimo interpreter. He engaged three Iroquois Indians of Caughnawaga, Q., and a fourth man from Prince Albert, as canoemen. The party thus constituted, and provided with two Peterborough canoes, proceeded to Edmonton, Alberta, by rail. From this point Mr. Tyrrell gives the following account of the expedition :—

"At Edmonton we obtained our supplies for the whole season, and had them, with our canoes and party, transported in wagons to Athabasca Landing, where our journey by water was to commence. The bulk of our supplies were there put in the Hudson's Bay Company's steamer 'Athabasca' to be freighted down to Fort Chippewayan,

while we proceeded down the river in the two canoes. At Fort McMurray we were met by two men with a canoe, from Fort à la Crosse, and our party now consisted of eight men, all told, in three canoes. North-west Territories.

"At Fort Chippewayan we were obliged to wait several days for the steamer to arrive with our provisions, but it pulled in to the wharf on the evening of the 20th of June. The following day was spent packing everything in waterproof bags ready for a final start. My chronometer had been rated at the observatory in Toronto, but I took advantage of the delay to rate it again here.

"On the morning of the 22nd of June we loaded our canoes with provisions almost down to the gunwales, and started the survey of the north shore of Lake Athabasca with solar compass and boat-log, checking our distances by observations for latitude and longitude. Huronian rocks were found in several places, and associated with one of these occurrences is an extensive deposit of iron ore, consisting of hæmatite and limonite. Athabasca Lake.

"At Fort Chippewayan, Dr. McKay, of the Hudson's Bay Company, had induced an Indian named Moberly to accompany us and show us the way as far as the height of land north of Black Lake, but after trailing along behind us with his family to a winter house of his own at the east end of Lake Athabasca, he refused to go further, and we were obliged to proceed without guides or local assistance of any kind. Moberly had been a considerable drain on our stock of provisions, and had spent the evenings telling the other men of insurmountable natural dangers which they would encounter, and of the fierceness of the Eskimo who swarmed through all that northern country, until he had them about ready to refuse to accompany us any further. His desertion was therefore an advantage to us rather than a hindrance. Four days and a half were spent crossing the two long portages west of Black Lake, and on the evening of the seventh of July we paddled to a point on the north side of this lake, where a portage, on an Indian hunting route, leads off to the north. This route had been discovered in 1892, when I was making a survey of Black Lake, and an Indian who accompanied me in that year, said that it led northward to the height of land, beyond which was a large lake that emptied northward, and that the river which flowed from it ran to 'Tobon' Lake, near the country of the Eskimos, where the Indians used to go in pursuit of caribou many years ago. He also drew a sketch of the route up to Daly Lake, north of the height of land, beyond which he did not know. Black Lake.

North-west Territories—*Cont.*

"We carried our canoes and goods across this portage, which proved to be two miles and a quarter in length, and then crossed six small lakes, and an equal number of portages to Chipman or Wolverine Lake, through which the Chipman River flows on its way to Black Lake. More than a day was spent in this lake looking for the way, after which we ascended Chipman River through Birch Lake to Selwyn Lake, a long but very irregular body of clear water.

Height-of-land.

"On July 18th we reached the height of land, where a portage, a mile and a quarter in length, forms the Indian highway from Selwyn to Daly Lake and the northern edge of their present hunting grounds. On the shores of Daly Lake, the forest became thin and intermittent, poplar being here seen for the last time on our journey northward. After considerable search and some loss of time, we found the outlet of the lake, where a stream, called by the Chippewayan, the Telzon, or 'wide shallow river,' flows from it towards the north. On July 22nd, we began the descent of the stream, which either rushed down heavy rapids or widened into lakes thickly studded with islands. In these lakes it was necessary to follow the crooked winding shore in order to find the outlet, while it was always essential to land at the head of a rapid in order to decide on the proper channel down which to run the canoes, or to determine where to make the portage.

Telzon River.

"Five weeks had now passed since we left Fort Chippewayan, and our provisions were disappearing rapidly, for we had seen no game that we might add to our stock from time to time. On the morning of the 29th, while paddling through a small lake, we saw an immense herd of caribou on its eastern shore, standing in a low, wet, grassy bog near the water, at the foot of a long, stony slope. We went ashore and shot a number of bucks, and as there was here a small scattered grove of stunted black spruce and tamarack, the next three days were occupied in cutting up and drying meat for the rest of our trip. While the men were thus busy, I secured a number of photographs of the herds of caribou, and afterwards built a cairn on the summit of a conspicuous hill, and deposited under it a brief record of the trip up to that time.

"On August 2nd, we continued down the river, over heavy rapids, and across small lakes, until on the evening of the 5th, just as a dense fog settled over us, we came to, and camped in, a small grove of stunted black spruce bushes, which proved to be the last wood on the river. The next morning, as I looked from the top of a hill behind our camp, I saw a great lake lying before us of which the surface appeared to be almost covered with a solid sheet of ice.

"Our journey by water seemed to be at an end, but on descending to the mouth of the river, a narrow lane of open water was found between the land and the thick ice, and on this water we travelled in the lake for 117 miles, being in one place obliged to portage across a a point against which the heavy ice was jammed. North-west Territories—*Cont.*

"The weather had now become very cold, wet and stormy, so that we were two weeks in travelling the above 117 miles, for six days of which time, however, we were prevented by snow, rain and wind from putting our canoes into the water.

"All the way from Black to Doobaunt Lake, a distance of 404 miles by our line of travel, the country was almost entirely underlain by red and gray gneisses of Laurentian age, although at one place, on a small island in a lake not far from Doobaunt Lake, an outlier of unaltered fossiliferous Cambro-Silurian limestone was discovered. But in Doobaunt Lake the character of the rock suddenly changed. We here found red and gray sandstones and coarse conglomerates, cut and altered by dykes and masses of dark green trap and bright red quartz-porphyry, forming an aggregation of rocks very similar to those of the Keweenawan or upper copper-bearing series, of Lake Superior, and probably of the same age. The red quartz-porphyry is a highly characteristic rock of the Lake Superior beds. These beds are also undoubtedly similar to, and are probably a continuation of the sandstones and traps on the Coppermine River, which have long been known to contain native copper. On the north shore of the lake there is also an outcrop of white Huronian quartzite. Geological formations.

"Below the lake, the river flows through a deep narrow gorge, the walls of which are composed of hard conglomerate or dark-green trap, holding crystals of amethyst. Past this rapid, we were obliged to carry our canoes over a portage two miles and a half in length, to a small lake on which there was a good deal of ice. From the foot of this portage, the country becomes much more sandy, the hills being generally long sandy ridges, while sandy terraces, possibly marine, extend up their sides to a height of one hundred and twenty feet. River below Doobaunt Lake.

"On the evening of August 19th, the same day on which we left the portage, we saw a solitary Eskimo deer-skin tent on the top of the right bank, ten feet above the river. Soon we saw the people running about, and it became evident that the camp was in consternation, for we were coming from the land of the Chippewayans, the hereditary enemies of the Eskimos. But the call *Chimo, Chimo,* brought an answer from the tent, and a tall fine looking man, still shaking with nervousness, came out to meet us. A present of a plug of tobacco set Eskimos.

Keewatin.

him a little more at his ease, and sent his two wives and six children into the tent looking for a pipe. When the pipe had gone round, and some trifling presents had been given to all the members of this dual family, we obtained a rude sketch of the river to its mouth in Hudson Bay, but where it opened into the Bay he could not tell us. He said, however, that we would meet plenty of Eskimos on the river below. The next day we came to a lake lying among hills of boulders, with a very few exposures of the underlying red quartz-porphyry on its shores. We paddled hard against head winds along its shore for two days, and at length came to the river, at the foot of a beautifully terraced hill of white Huronian quartzite. The weather was constantly rough and cold, with heavy north winds, and occasional showers of drizzling rain. The next day we passed to the west of the terraced ridge of hills, 300 feet high, and paddled against head wind down the swift river between little ridges of boulders. Once we were obliged to make a portage a quarter of a mile in length. Small willows were now very scarce, and when the reindeer-moss was wet, as it often was, we were unable to make a fire without the assistance of a little alcohol.

"Groping our way through another lake, we found the river flowing off toward the north-west, between sandy banks, with a current of three miles an hour. To the right, high bare hills of reddish-green, fine-grained trap rose from 300 to 400 feet above us, while to the left extended an undulating grassy plain. Portages had to be made, here and there, past heavy rapids. After widening for a short distance, the stream suddenly narrowed to a swift rapid between walls of bright red quartz-porphyry, and then entered a gradually deepening channel of red bouldery till, which extends to another rapid, where a portage was made over a hill of the bright red porphyry. This rock is quite massive, but is much jointed, and decomposition has run along the jointage planes, with the development of a green crust.

Branch from the west.

"On the evening of August 25th, the river broke up among sandy hills and islands, and a large branch appeared to flow in from the west. On the banks clumps of willows were growing, and a great quantity of drift-wood was scattered about, among which were trunks of white spruce a foot in diameter, limbs of black poplars, &c. These had doubtless been brought down the west branch, which must be fairly well wooded and at the same time have few lakes on its course to arrest the driftwood.

"The river now turns sharply eastward, and flows through a country underlain by red sandstone and hard conglomerate, to approximately longitude 98° 30′, where hills of Laurentian gneiss again appear to the north. The stream then continues to flow along the contact of the

sandstone and the gneiss for forty miles, where it turns abruptly northward, and flows over a ridge of gray gneiss, forming a heavy rapid, down which we were obliged to run the canoes one at a time. The river here swings round to the south-east, and with a swift current of six or seven miles an hour enters a gradually deepening valley, the sides of which are composed of light green Huronian schists, cut by dykes of dark green diabase, and veins of quartz, calcite and fluorspar, associated with masses of pyrite. Descending this river for thirty-five miles, we passed two small camps of Eskimo and reached the west end of Baker Lake on the second of September. Keewatin—*Cont.*

"Our journey through the unknown interior country was now accomplished, for we had reached a point which had been visited by two old sea-captains in the eighteenth century, although it had not been by any means accurately located by them. We had surveyed a line of 810 miles in length through the very middle of the area which we had been sent to explore. Of this distance 538 miles was through lakes, where the distances were measured with a boat-log, and the bearings taken with a solar or prismatic compass; 272 miles was on rivers where the distances were estimated and the bearings taken with a prismatic compass. These distances thus obtained were constantly checked by observation for latitude and longitude. The lengths of the portages were obtained by pacing.

"The stormy weather of autumn had now set in, and often prevented us from launching our canoes for several days at a time. For the past month caribou had been plentiful in the country through which we were travelling, so that we had no difficulty in obtaining an abundant supply of fresh meat, but they now became very scarce, and on September 3rd we shot the last deer of the season.

"The survey with solar compass and boat-log was continued along the north shore of Baker Lake, which was found to lie on the line of contact of the gneisses to the north, and the red conglomerates to the south. Both rocks were cut by many dykes of red and green trap, while in the gneiss was found a band of red crystalline limestone. The Keweenawan sandstones and traps, similar to those which are so rich in native copper on Lake Superior, had now been traced for 225 miles across country as the crow flies, but the necessitie of rapid travel prevented us from giving them more than a very hasty examination. Baker Lake

"At the head of the river flowing from Baker Lake, we met the incoming tide, and as the currents in Chesterfield Inlet were thereafter very irregular, we were unable to use the boat-log with any degree of

Keewatin—*Cont.*

accuracy, so that the remaining distances were estimated, checked by observations for latitude and longitude.

Chesterfield Inlet.

"Chesterfield Inlet was found to be a fiord-like body of water, with banks of red and gray granite and gneiss. The mouth of the inlet was reached on the 12th of September, two months and twenty-two days after leaving Fort Chippewayan.

"We now began the heavy task of travelling down the tidal shore of Hudson Bay in our little open canoes For the first three days the weather was beautifully fine, and we covered more than a hundred miles of the distance, but then storm after storm broke over us, and in the next twenty days we made only 120 miles, an average of six miles a day. The survey had been kept up to this point and the shore had been found to be composed very largely of dark green Huronian schists and quartzites, almost everywhere studded with minute grains of copper-pyrites and cut by quartz veins.

West coast of Hudson Bay.

"On the 22nd of September the ground was covered with a heavy fall of snow, and on the 25th we walked twenty miles, often on the crusted snow, to the mouth of a river in search of caribou, but we were only able to shoot one ptarmigan, which we divided for dinner. Our provisions were now entirely exhausted, and had not one of the men had the good fortune to shoot a polar bear we should certainly have starved to death. On the 6th of October the winter had settled down on us, and even in the sun at midday the thermometer seldom rose above freezing point. We were without food or fuel, and many of our clothes were worn to rags. Two hundred and fifty miles of shore still lay between us and Fort Churchill, the nearest point where we could obtain supplies. Our canoes were loaded with specimens of rocks and minerals which we had collected both in the interior and on the coast.

"It was clearly impossible to reach Churchill travelling as we had been, and I therefore decided to leave everything behind which was not absolutely necessary for the safety of the party. The shore was a vast snow-covered plain, but a slightly gravelly eminence was chosen, half a mile from high-tide mark, and on it, one canoe, all our rock specimens, instruments and whatever else was not necessary for our existence, were carefully piled in a heap and covered with tarpaulins. Our note-books, photographs and collection of plants, with guns, ammunition, blankets, and two tents, were put in the remaining two canoes, and thus lightened, and with four men with paddles in each canoe, we started southward again, determined to reach Churchill by water if possible.

"The shore was very low and flat, and at low tide the water was generally several miles from the line reached by it at high-tide, so

that we were able to land or launch our canoes but once in each twelve hours, at the time of high tide. Any rocks seen on the shore were Laurentian granites and gneisses. Keewatin—*Cont.*

" We struggled onward for ten days, living on what few ducks we could shoot in the open water. The weather was very cold and the water that was splashed over us by the wind constantly froze on our clothes and hands. When night came on, on the 14th of October, it was ebb-tide and we were out among ice and boulders almost out of sight of land. That night we spent in our canoes, one of the men having both his feet badly frozen, while another was very ill with dysentery. On the afternoon of the 15th we gained the edge of the solid ice, and hauled the canoes over it to the shore, where we pitched a tent just as a heavy storm of wind and snow broke over us. There was now driftwood on the shore, and with it we made a fire and cooked some ducks that we had shot, getting the first food that we had tasted for thirty-six hours.

" Assured that we were now not very far from Churchill, I sent two men on foot through the snow to the fort for assistance. On the afternoon of the third day they returned with dog-teams, bringing us pork and flour, and on the 19th of October we were carried to Churchill. Here we obtained shelter with the clerk in charge for the Hudson's Bay Company, and we received every kindness from Rev. J. Lofthouse, the missionary to the Eskimo for the Church Missionary Society, but fresh meat was not to be had, and the men gained strength very slowly on the limited diet of salt pork, flour and oatmeal. Fort Churchill.

" We remained here until the 6th of November, when we crossed the Churchill River on the new ice and started on snow-shoes for York Factory. We had secured one dog-team from the Hudson's Bay Company, to carry our provisions and the man whose feet has been so badly frozen, while the other men were obliged to haul their bedding on small toboggans. Other dog-teams belonging to the Hudson's Bay Company assisted us for part of the way, as they were going to recover some stuff that had been left on the shore between York and Churchill by one of their officers in the latter part of September. Fort Churchill to York.

" When we arrived at Nelson River, the scanty supply of provisions which we had been able to obtain at Churchill was exhausted. The river was found to be full of running ice, so that we were unable to cross it either in the boat, which we found there, or on the ice, and our party, now augmented by three local Indians, was obliged to remain on its bank for ten days, subsisting on the few rabbits, foxes, etc., that we were able to catch. The weather had been very cold, the thermo-

Keewatin—*Cont.*

meter often falling at night to 20° F. On the 24th of November we arrived at York Factory, where we were able to procure a plentiful supply of provisions. Dr. A. Milne is the officer in charge here for the Hudson's Bay Company, and as Michael, the man with frozen feet, was unable to walk, and we were unable to obtain transport for him, we left him under the doctor's care, to be sent out with the winter packet.

Fort York to Winnipeg.

"Here we obtained another dog-team, and provisions for twelve days, and on the 28th of November started through the deep unbroken snow for Oxford House, 250 miles distant. The country passed through was generally flat and swampy, thinly wooded with small black spruce. Late on the evening of December 7th, we arrived at Oxford House, rather tired and footsore after our ten days' walk. After a delay of six days, waiting for a relay of dogs, we again started, and arrived at Norway House on the 20th of December. Here the men from Isle à la Crosse and Prince Albert were paid off, and sent home by way of Cumberland, while I obtained fresh dog-teams and drove southward across Lake Winnipeg to Lower Fort Garry, where we arrived on the evening of the first of January. After remaining in Winnipeg a few days to settle with the Hudson's Bay Company, I proceeded to Ottawa, where I arrived on the morning of January 11th, having been absent eight months and five days.

Distance travelled and surveyed.

"During this time we travelled, beyond our railway journey, 6,200 miles. In this distance the following surveys were made:—770 miles over lakes, where the distance was measured with a boat-log, and in order to avoid local attraction, or the weakness of the magnetic needle, the bearings were taken as much as possible with a solar compass; 272 miles of rivers and 360 miles of the coast of Chesterfield Inlet and Hudson Bay, where the distances were estimated and the bearings taken with a prismatic compass, the variations being constantly determined with the solar compass. Throughout all the above distance, observations were taken with the sextant and artificial horizon as often as possible, both for latitude and longitude. 250 miles more of the shore of Hudson's Bay was geologically examined. Of 200 miles travelled on foot from Churchill to York, a careful track-survey was kept, the bearings being taken with a prismatic compass. For 400 miles travelled on foot from York to Norway House, a record was kept of the geology, forests, &c., of the country passed through. For 948 miles the country had previously been travelled over and reported on by officers of this Survey or others.

"A collection of 230 species of plants was made, and 256 photographs were taken during the expedition."

In the spring of 1894, Mr. Tyrrell was authorized to undertake a second expedition through the "Barren Grounds" by another route, starting from the north end of Reindeer Lake, and proceeding thence, by whatever way might prove to be practicable, to the west coast of Hudson Bay. He was accompanied by Mr. R. Munroe Ferguson, who bore his own share of the expense of the journey. The party did not return to Winnipeg till January 7th, and it is thus possible to include only the following brief outline of the work done. Mr. Tyrrell writes as follows :— North-west Territories and Keewatin.

"On June 9th we started for Winnipeg, where arrangements were made with the Hudson's Bay Company for obtaining supplies from any of their trading posts at a certain fixed rate. His Honour Lieut.-Governor Schultz, also gave us a large birch-bark canoe to accompany us through part of the distance. With the assistance of Mr. William Clarke, four men were engaged, and on June 16th we left Selkirk and crossed Lake Winnipeg, arriving at Grand Rapids on the 22nd, and Cumberland House on the 2nd of July. On July 4th we left Cumberland, and on July 18th reached Du Brochet trading post of the Hudson's Bay Company, at the north end of Reindeer Lake, having travelled 600 miles in our canoes since leaving Grand Rapids, making such geological investigations as the time at our disposal would permit. Here we secured two Chippewayan Indians as guides, and began our regular survey with compass and boat-log. We ascended Ice River for seven days, and then left it and travelled through Thanout and Theitaga Lakes, which discharge their waters by Thlewiaza River into Hudson Bay, passing through Nooeltin or Island Lake. Winnipeg to Reindeer Lake.

"On August 5th we reached Kasba Lake, at the head of Kazan or White Partridge River in north latitude 60° 10′, having travelled 221 miles from Reindeer Lake, in which distance there were fifty-three portages, with a total length of 15·75 miles, across which our canoes and provisions had to be carried, usually necessitating four trips on each portage. The east shore of Kasba Lake was surveyed, and the river for a short distance down to Ennaida Lake, which lies on the edge of the Barren Lands. Here our Indian guides turned back, and we proceeded northward, until on August 17th we reached a camp of Eskimos. The next day we hired two Eskimos to accompany us down to the shore of Hudson Bay, thus relieving us of any uncertainty as to our route. We followed the river for two weeks, passing a large number of Eskimo camps, exploring the west shore of Yath-kyed Lake on our way. When in north latitude 63° 7′ we learned definitely that the river flows into Baker Lake, at the head of Chesterfield Inlet, Kazan River.

North-west Territories and Keewatin—*Cont.*

but by a series of long portages we should be able to reach a river flowing into Hudson Bay much further south. We crossed the portage with the help of seven Eskimos, and in spite of continuous storms of rain, snow, and wind, descended the river, reaching Hudson Bay about north latitude 62° on September 18th, just three days earlier than we had reached the same point last year. Fine weather now set in, and continuing our journey down the shore in our two canoes, we reached Fort Churchill on October 1st. The winter had now begun, and further travel in canoes was impossible. We were therefore obliged to remain here until the ice had set fast on the rivers and lakes. During our detention, the surveys up to that date were plotted, ready for reducing on a map, the quartzite rocks of the vicinity were carefully examined, and a collection of fossils was made from the Cambro-Silurian limestones.

Churchill to Winnipeg.

"At Churchill, we purchased from Indians one team of five dogs, hired two Indians with a team of four dogs, and a team of dogs from the Hudson's Bay Company to accompany us for six days. Thus equipped we started on November 28th in a south-westerly direction for Split Lake, provisioned for fourteen days, taking the route that may hereafter be followed by the Hudson Bay Railway. We reached Split Lake in eighteen days, having made a track-survey throughout the distance from Churchill, and on December 23rd we reached Norway House. Thence we continued our tramp to Dog's Head, Lake Winnipeg, at which place we took conveyances and drove to Selkirk, where we arrived on the evening of January 7th.

"The route followed from Reindeer Lake to Hudson Bay was 815 miles in length, of which 303·5 miles was measured with boat-log, 480 miles estimated, and 31·5 miles, over 81 portages, paced. 1,700 miles in all were travelled in canoes. A track survey was made on snow-shoes for 275 miles from Churchill to Split Lake, the total distance travelled between Churchill and Winnipeg being 725 miles."

Ontario.

Nipigon Lake. Messrs. McInnes and Dowling.

Mr. W. McInnes spent the earlier part of the year 1894 in compilation work in the office, in connection with sheet No. 9 of the series of Rainy River and Thunder Bay district maps, and in working up the geological notes of the past and previous seasons. The notes of the late Mr. W. H. Smith, on sheet No. 6 of the same series, were gone over, and from them the geological boundaries were laid down on that sheet. It seemed advisable that the report on the geology of the district covered by sheet No. 6 should be included in that on sheet No. 9, and work on the combined reports occupied the remaining office time.

Ontario.

During the past summer Mr. McInnes and Mr. D. B. Dowling were engaged in making a survey and geological examination of Lake Nipigon in Western Algoma. No work had been done in this region since the exploration of Dr. Bell in 1869, the results of which appear in the Report of the Geological Survey for 1866-69 with supplementary notes published in the report for 1871-72. The design of the present exploration was that it should serve as a basis for a more detailed geological and topographical map of the region.

Mr. McInnes reports as follows on the work of the summer :—

"Leaving Ottawa on the 12th of July, my time was employed, until the arrival of Mr. Dowling on the 30th of July, in examining the various sections exposed along the line of the Canadian Pacific Railway and about Nipigon Harbour. Near Loon Lake, the basal beds of the Nipigon (Keewanawan) series were found to lie in a horizontal position on the upturned edges of the Archæan gneisses. The lowest bed is here a conglomerate with paste of quartz and felspar and pebbles of gneiss and of various schists and diorites of the Huronian (Keewatin). The valleys between the rounded hills of Archæan are filled with drift material showing, however, the horizontal beds of the Nipigon series protruding in many places. The actual contact of the two sets of rocks was seen in only a few places, where patches of the conglomerate were left clinging to the sides of the rounded hills of gneiss. The relationship of the two, clearly indicates, not only an unconformable overlap of the conglomerate, but also that the rounding of the Archæan in its broad aspects was finished before the Nipigon rocks were laid down.

Surveys carried out.

"On the arrival of Mr. Dowling, a party was made up for the purpose of carrying on the regular work of the summer. A survey with transit and Rochon micrometer telescope was made of the shores of the lake, and this was connected with the line of the Canadian Pacific Railway and Lake Superior by a line carried along the river between these points. Mr. Dowling, assisted by Mr. W. Lawson, did the instrumental work and took general charge of the surveying. Smoke from forest fires in the country south of Lake Superior hampered the work very much, coming up with the prevailing southerly winds in such density as to make work with the instruments difficult and the fixing of many of the islands in the lake impossible. The work of the season was necessarily carried over much of the ground already reported on by Dr. Bell in 1869, and little has been added to his work except in matters of detail. It may be interesting, however, particularly as the report referred to is out of print, to make some general remarks about the lake.

Ontario—*Cont.* Nipigon Lake.

"The lake has a very irregular shore-line with deeply indented bays and irregularly jutting points. Its greatest length from north to south is about sixty-five miles and greatest width forty-five miles. The lake lies in a trough, excavated in rocks of the Nipigon (Keewanawan) series and in the traps which cut and overflow these sediments, the Nipigon rocks having themselves been laid down in an older basin in the Archæan gneisses and schists.

"Its depth is probably great, and would seem from the evidence of the inclosing rocks to be largely defined by the depth of the original old hollow in the Archæan surface. The thick smoke which was so prevalent during the summer, made it impossible to make a satisfactory series of soundings, but at a point about two miles and a half south-west of Livingston Point, a depth of over four hundred feet was found. The water everywhere in the main lake is very clear and cold, though every stream of any considerable size entering the lake is quite dark in colour. This dark colour extends only for a short distance out in the immediate bay into which each of these streams empties, the churning of the waves apparently bringing about a bleaching which within a short distance renders the water colourless.

"About the southern and south-western shores, the traps form most of the points and border many of the bays, rising in high, abrupt cliff-faces from the shore-line, and reaching heights of over 500 feet above the water-level.

Rocks exposed.

"Nowhere about the lake are the sedimentary rocks of the Nipigon series seen in any great volume. The mass of the strata exposed about the shores and forming the high bordering hills, is trap, with only here and there a thickness of from six to fifteen feet of limestone or sandstone underlying it at about the water-level. On the southern and south-western sides of the lake, limestones are the only sediments met with, and on the southern and north-eastern sides, highly siliceous red and white sandstones (which become, locally, quartzites), take the place of the limestone under the trap. These sandstones lie directly upon the Archæan gneiss and seem to be littoral beds which mark the shore limit, in this direction, of the basin in the deeper part of which the limestones were deposited.

"Along the northern and eastern sides of the lake, the immediate shores are occupied largely by the gneisses, schists and greenstones of the Archæan, which everywhere show the highly altered character and nearly vertical attitude so generally characteristic of these rocks elsewhere. Along the eastern shore, alternating broad bands of Laurentian gneiss and Huronian (Keewatin) schists and greenstones, strike north-easterly. They are not continuously exposed, the trap still

covering them in many places and forming most of the prominent points, underlain at a number of places, as far south as the south side of Livingstone Point, by the flat-lying sandstones of the Nipigon series. Ontario—*Cont.*

"No minerals of economic value were found in commercial quantities. On the east shore, near Poplar Point, a fibrous form of serpentine, approaching asbestus, occurs in very much broken veins, cutting intrusive serpentinous rock of the Huronian, but where seen it was not commercially valuable. Some of the sandstones, limestones, &c., about the lake would afford good building stone. Evidences of glaciation are well marked and widespread about the lake. Polished and grooved surfaces are very common and indicate two periods of glaciation, an earlier from north to south, and a later from east to west, or in places from north-east to south-west. That this westward-moving glacier was the later of the two, is clearly shown in many places by the striæ and grooving of the one overriding and planing out those of the other, and leaving only isolated patches of striæ on a few protected surfaces. Glaciation.

"Land suitable for cultivation is found about the heads of many of the bays on the south side, notably McIntyre's Bay, where, at the English Church mission, the Indians have several acres under cultivation, and successfully grow potatoes of fair quality. At Jackfish Island, near the west shore, the Indian school master, who is an enthusiastic horticulturist, succeeds very well with all the common garden vegetables. Arable land.

"There is little good timber in the immediate vicinity of the lake, though an area of good pine is reported on Pijitiwabikong Bay, and white spruce of fair size is sparsely scattered about the shores of the lake almost everywhere.

"The Nipigon River has long been famous as a trout stream. The brook trout are probably unexcelled anywhere for size and numbers, running up to weights of five to seven pounds and over. They are not confined to the river, but are caught in the main lake itself, a fact which renders their extermination by legitimate fishing in the river practically impossible In addition to brook trout the principal food fishes of the lake are lake trout, pike and white-fish, all of which are abundant. Fish.

"The scenery along the river is grand and varied, and the stream is easy of ascent by canoe, with rapids and falls at intervals along its course, which are wild enough to make a summer excursion interesting without being dangerous."

Cost of the season's explorations, $981.57.

Ontario—*Cont.* District of Algoma. Work by Dr. Bell.

Dr. R. Bell was engaged during the summer in geologically examining the country to the north of Lake Huron. The objects in view were to complete the delineation of the boundaries between the various classes of rocks within the limits of sheet 129, or the "North Shore Sheet," and, if time permitted, to determine certain points about which some uncertainty existed in reference to some of the geological boundaries in sheet 128, or the "St. Mary's River sheet." Dr. Bell makes the following preliminary report on this work :—

"Owing to the delay in obtaining funds, it was the 16th of July before I left Ottawa, and on the 17th I reached Spanish River, which I again made my basis of operations for sheet 129, and later in the season I proceeded to Sault Ste. Marie. On my arrival at Spanish River I was joined by Mr. H. G. Skill and Mr. R. W. Brock, who were again to act as my assistants. Owing to the smallness of the fund placed at my disposal, I was only able to engage, in addition to these gentlemen, a cook and one or two canoemen, from time to time, as they were required.

Boundaries to be ascertained.

"It was stated in my summary report for last year, that the northern part of sheet 129 was occupied by a continuation of the red granite, which is so extensively developed in the western part of the Sudbury sheet; but part of the boundary within the present sheet between this granite and the other rocks to the south of it remained undefined. One of our first objects was, therefore, to endeavour to complete the tracing out of this boundary. The geological age of the granite in question has not been definitely settled. A discussion of the relative ages of the granites and the banded Huronian rocks with which they are here in contact, would be out of place in the present report. While the granites may have received their present condition or form subsequently to the consolidation of the stratified Huronian rocks, they nevertheless appear to be continuous with and to merge into the recognized Laurentian gneisses and granites occupying the great region to the northward.

"In 1893, I had ascertained that the quartzites and other Huronian rocks extended for about fifteen miles to the northward of Ten-mile Lake, which is in township 156. What appeared to be an extension of these rocks to the eastward was met with in township 139, leaving a tongue or spur of the granite between them and the main area of the Huronian to the southward. In order to ascertain whether any of the Huronian rocks were to be found still further north, I sent Mr. Brock with an Indian guide, from Massey, with instructions to trace it out and to go, if necessary, as far north as Lac aux Sables. He explored the ground all the way to this lake and found everywhere only

the same red granite. The country occupied by this rock is here, as elsewhere, extremely rough, rocky and bouldery, with swamps between the ridges, and the woods were everywhere difficult to penetrate. Ontario—*Cont.*

"The region along the northern line of the sheet is all of the character just described. No roads or trails have been cut into it and it is almost inaccessible by canoe from the south. From what I had heard of the country lying between it and the Canadian Pacific Railway, I thought it likely that the district on or near the above line might be reached by following a canoe-route from Biscotasing through the upper waters of the Mississagui River. Accordingly I proceeded to Biscotasing, where I obtained a canoe from Mr. T. C. Rae of the Hudson's Bay Company, and after some difficulty I succeeded in engaging two canoe-men, one of whom knew a part of the route I proposed to follow. Leaving the above station on the Canadian Pacific Railway, I proceeded southward, ascending at first Spanish River waters, which were of a dark colour, and then crossing a watershed I continued my course in the same direction, descending numerous clear-water lakes with their connecting streams, all forming part of the head-waters of the Mississagui, until I reached a lake which touches the north line of sheet 129, about thirty miles west of its north-eastern corner. From this lake the general course of my route, which followed the main Mississagui River, was westward at no great distance north of the above line until I had passed the north-west corner of the sheet, when it turned to the south and then to the south-east, traversing the south-western part of its area. I made a careful track-survey of the whole of my route from Biscotasing to the shore of Lake Huron at the mouth of the Mississagui River. Route by Mississagui River.

"Between the Canadian Pacific Railway and Old Green Lake post, lakes were numerous on our route and also in the country on either side of it. Immediately below Old Green Lake and its connecting ponds and marshes, we passed through a lake five miles in length, and then the general descent of country became more rapid and no more lakes occurred on the course of the Mississagui, which increased constantly in volume by the falling in of numerous branches.

"The rocks on the above route, all the way from Biscotasing to a point on the Mississagui a few miles above Salter's base-line, where we entered upon the great belt of the Huronian series, consist of the red granite already described, and there is no doubt that the whole of the northern part of sheet 129 is occupied by this rock. After coming upon the stratified Huronian rocks at the above point, they were examined all along, and numerous notes recorded in regard to them, in addition to the facts mentioned by the late Mr. Alexander Murray of Great area of red granite.

Ontario—*Cont.*

this Survey, who had ascended the river this far. The red granite area traversed on the above journey and which, as already stated, occupies the northern part of the sheet just referred to, must be of great extent. It is known to extend from the northern and western parts of the Sudbury sheet through the region explored last summer to the Goulais River, and it may connect with the granite areas near the eastern border of Lake Superior.

Projections of granite mass.

"In the centre of sheet 129, a tongue of the red granite runs westward from the main body to the middle of the line between townships 156 and 157, where it terminates. The southern boundary of this tongue has been traced almost continuously from the above termination eastward into township 118, where the Huronian rocks end, having the granite to the north, south and east of them. From this point their southern margin runs westward as far as township 155, from which the boundary drops southward nearly to the eastern part of Lake Lauzon, from which it turns eastward or parallel to the lowest stretch of the Serpent River. A second and wider tongue or promontory of the granite is thus formed, also extending westward from the main mass.

"A third promontory of granite, also pointing westward, occupies the peninsula between Lake Huron and the lower part of Serpent River, with the exception of a narrow belt of gray crystalline schists running along the bottom of the valley in which the river itself flows. This granite differs from most of that to the northward in being finer grained and gray in colour.

"In the south-eastern quarter of the sheet, the granite is much mixed with greenstones. In some sections about one-half of the rock consists of the latter, so that it is sometimes difficult to say whether these should be considered as granite mixed with greenstones or *vice versa*. Wherever the greenstone areas are sufficiently large, they will be shown in their own colour on the map, but otherwise the mixture will be indicated by notes on the granite colouring.

Investigations near Sault Ste. Marie.

"Sheet 128 belongs to the same range as sheet 129 and abuts it on the west. It covers that part of the great Huronian belt, which had been the most carefully worked out by Mr. Murray. Some geological work had also been done within this area by myself in various years since Mr. Murray's operations had ceased. Combining these results, it appeared that the geology of this sheet was pretty well finished, with the exception of that of a small tract north of Sault Ste. Marie. In order to complete this work, I proceeded to the Sault, with Mr. Skill as already stated, in the beginning of September.

"One of the principal points to be determined was whether the gneissic area between the St. Mary's River and Goulais Bay con-

stituted a promontory of the granitic tract to the north-eastward or formed an isolated mass. Our investigations proved the latter to be the case. We found a considerable breadth of quartzites, grauwackes, conglomerates, schists, &c., running north-westward through the township of Jarvis and the north-eastern part of Aweres, connecting the Huronian of Garden River with that of Goulais River and Batchawana Bay. The accomplishment of this work appeared to be all that was necessary in order to render sheet 128 ready for publication in as complete form as is possible at present, or in order that it may compare favourably with the other sheets on the same scale showing the geology in similar regions. Ontario—*Cont.*

"*Economic Minerals.*—I was shown small specimens of galena and plates of mica said to have been found within sheet 129, but I could obtain no definite assurance that they occurred in economic quantities. Gold was also said to have been found by private assayers in samples of quartz taken from veins in different parts of the sheet, but no reliable particulars could be obtained. But I know of no reason why this metal may not exist in promising quantities in such veins, particularly in those which occur among the mixed granite and greenstone rocks. Economic minerals.

"The old Borron Location on the Mississagui River, which was laid off before the township surveys were made, is situated in the southern part of the township of Gould, being in what are now the first and second concessions. On the west side of the foot of the first chute at the head of the Long Portage, on this location, a vein of quartz three and a half feet wide cuts the 'slate conglomerate,' which here forms the country-rock, but which at the head of the next chute, a short distance below, is associated with crystalline greenstone. The vein runs N. 65° W. and carries promising quantities of copper glance, of which a few tons, mined just before my visit, were piled beside a prospecting pit. Two or three smaller veins in the vicinity carried a little copper pyrites.

"After having expended my appropration for the season's operations, before leaving the field, a short time in camp was devoted to compiling and mapping our results, and I was assisted in this work by Mr. Skill. I returned to Ottawa on the 25th of October."

Cost of the season's explorations, $955.25.

Mr. A. E. Barlow, during January and February last, was granted permission to carry on his work in Montreal, where he had the advantages of the co-operation of Dr. F. D. Adams, in the comparative study of the Archæan rocks, of which many interesting and difficult varieties Work by Mr. Barlow.

Ontario—*Cont.*

occur in the region being investigated by him. During this time, over 200 thin sections of these were microscopically examined.

On his return to Ottawa, this petrographical work was continued at intervals, in association with Mr. W. F. Ferrier, and considerable progress has been made in the examination of the one hundred and fifty slides of both typical and unusual rocks within the area included in the Nipissing and Temiscaming sheets (Nos. 131 and 138 respectively) of the Ontario series of geological maps. The remainder of the time before field work was commenced in July, was occupied in reducing and compiling the surveys made chiefly by Mr. J. F. C. Johnston during the previous summer, in which Mr. Johnston assisted.

In regard to the summer's exploration, Mr. Barlow reports as follows :—

Nipissing and Temiscaming sheets.

"I left Ottawa on July 5th, with instructions to collect the geological and topographical details necessary for the completion of the Nipissing sheet (No. 131, Ontario) and to prosecute as much work as possible on the Temiscaming sheet, (No. 138) situated immediately north of the last. A few days were spent at Mattawa examining the numerous rock-cuts necessary for the construction of the new Temiscaming branch of the Canadian Pacific Railway. The mineral cyanite, which had been found in 1890 for the first time in Canada 'in situ,' near Wahnapitae station, was observed to be an abundant constituent of the gray gneissic rocks exposed on this line of railway in the neighbourhood of Les Erables Rapids and Snake Creek.

"Fort Temiscaming, an abandoned Hudson's Bay Company's post, was made our headquarters for the season. Here I was joined by Mr. A. M. Campbell of Perth, who for several years past has proved an energetic and valuable assistant in the summer's exploration.

Lake Temiscaming.

"The country between Lakes Temiscaming and Keepawa was examined, and micrometer surveys were made of a number of lakes and streams, which will materially aid in filling in the topographical features of this strip of country. Soundings were taken to determine, with some degree of accuracy, the depth of Lake Temiscaming, concerning which very many exaggerated statements have been made. The deepest place ascertained by our soundings was about one mile and a quarter south of the mouth of the Keepawa River, where the lead reached bottom at four hundred and seventy feet. The lake maintains a rather uniform depth of a little over four hundred feet from McMartin's Point to within a mile of the Montreal River, where owing to the accumulation of sand and gravel, it is only about three

hundred feet deep. Above this it again deepens to four hundred feet, and opposite Quinn's Point is three hundred and seventy feet in the middle. The bottom of the lake is covered with a very soft clay or mud, into which the lead sinks very readily, except off the mouth of the Montreal River and from McMartin's Point to the Opimika Narrows, where the bottom is covered with sand, or a mixture of sand and gravel with some boulders. Ontario—*Cont.*

"The season's work was confined to such geological detail as was necessary for the completion of the Nipissing sheet (No. 131), the geographical position and limits of which have been described in the Summary Report of 1892. Only such topographical surveys were undertaken as seemed necessary for the adequate representation of the geological features. The region to the south-west of the Opimika Narrows, was examined, as well as the townships of Gladman, Hammell, Notman and Lyman. During the latter part of August, the southern part of Lake Temagami was also examined, for the purpose of obtaining greater geological detail than was possible during its topographical survey in 1887. The early part of September was spent in mapping out with greater precision the Silurian (Niagara) outlier exposed on the shores and islands of the northern portion of Lake Temiscaming, and the season was concluded with an examination of the townships of Grant, Field and Badgerow. While absent on this latter exploration, Mr. Campbell made an examination of the Manitou and Goose Islands in Lake Nipissing. The geological and topographical data at hand are now considered sufficient for the completion of the Nipissing sheet, and the Temiscaming sheet is about half finished." Surveys accomplished.

Mr. Barlow returned to Ottawa on October 4th, and has since been engaged in preparing the material for his report and map, and in further petrographical examinations of the specimens from the districts above alluded to.

The cost of the field work was $874.66.

QUEBEC.

(With adjacent parts of Ontario.)

The winter of 1893-94 was devoted by Dr. R. W. Ells to writing his report on the geology of the area north of the Ottawa and east of the Gatineau, and to the compilation of the map of that district. (Sheet No. 121.) Work by Dr. Ells.

On the field work accomplished during the past season, chiefly in the counties of Ottawa, Pontiac and Carleton, Dr. Ells reports as follows :—

Quebec—Lower Ottawa.

"During the season of 1894, a few days were spent in June in the examination of certain points along the lower Ottawa, more particularly with reference to the character of the rock masses known as Mounts Calvaire and Rigaud, on either side of the Lake of the Two Mountains. The former of these was found to consist principally of reddish syenite, with masses of a greenish gabbro rock, the latter of syenite and felsite, in places porphyritic, and apparently intrusive through the Calciferous rocks which surround it.

Upper Ottawa.

"On July 10th, the examination of the Upper Ottawa was commenced, canoes being put in at Britannia, and a careful study of the rock sections along the river was made as far west as the Rapides des Joachims, fifty miles west of Pembroke. The country to the north, in Ottawa and Pontiac counties, was examined to a distance inland of from ten to forty miles, and surveys were made of the greater part of the roads in that section. In September and a part of October the country in the more immediate vicinity of Ottawa city was examined. In this I was assisted by Mr. N. J. Giroux, whose field of work adjoins on the south the map-sheet of the Upper Ottawa, the junction of several map-sheets being in the vicinity of this city.

"Comparatively little has been added to our knowledge of the geological structure of the Ottawa River region for many years. In 1853, Mr. James Richardson made an examination of the country along the south side, from Pembroke eastward to Point Fortune, the results of which were incorporated in the large geological map of 1866. In 1876 Mr. L. R. Ord made surveys of a number of roads north of the Ottawa extending west from the Gatineau River to the Coulonge, and Mr. H. G. Vennor also made several traverses in this section, both to the north and south of the river, the report on which is contained in the volume for 1876-77.

Sections along the river.

"The river affords excellent sections of the various formations from the Laurentian to the top of the Trenton, and in many places the intricate admixture of the crystalline limestones and grayish gneisses with the intrusive syenitic, pyroxenic and dioritic rocks can be well studied.

"Between Britannia and the Chats Falls, which forms the first break in the navigation, the rocks along the south shore are divisible into Calciferous and Chazy. The former of these constitutes a belt nearly six miles in breadth, between Britannia and Berry's Wharf, the rock being chiefly a buff-weathering dolomitic limestone. The limestones cross the river and show along the beach on the north shore for several miles above the town of Aylmer, where they are overlaid by green-gray Chazy sandstones and shales. On the south side, these latter extend from below Berry's Wharf to Fitzroy Harbour at the

foot of the Chats Falls, capped on the tops of the hills inland by Chazy limestone, which also appears along the shore in the township of Torbolton, about Buckhams Bay, where the rock has been extensively quarried for building stone. Quebec—*Cont*

"Further inland, the Calciferous rests upon and passes into the Potsdam sandstone. This flanks, on the north and east, a long tongue of Laurentian gneiss and limestone, which extends south and east from Fitzroy Harbour to within ten miles of the city of Ottawa. These crystalline rocks have associated with them large areas of intrusive syenite and diorite which have broken through the crystalline limestone and associated gneiss.

"At the Chats, the falls and rapids extend for about three miles. They are caused by a heavy dyke of reddish syenite, which here crosses the river as a spur from the great mass on the north side. At their head, the waters of the Chats Lake begin, and from this, with the exception of the small rapid known as the Chenaux, the navigation is uninterrupted to the village of Portage du Fort. The rocks between Fitzroy Harbor and Arnprior, on the southern side of the river, are mostly crystalline limestones of Laurentian age, cut by numerous dykes and masses of reddish syenite and diorite. A band of crystalline dolomitic limestone, with mica, chlorite and hornblende-schists, also cut by diorites, crosses the river in the vicinity of Arnprior and has a breadth westward of several miles. These are a portion of the 'Hastings series,' now recognized as Huronian, and can be traced north of the river to the Bristol Iron Mines, beyond which they are concealed by sandy drift. Portions of their area are also overlaid by thin beds of Calciferous limestones, on the north shore opposite Arnprior and Braeside. Above this, to Portage du Fort, the rock where exposed is mostly Laurentian limestone, forming a series of synclinals, underlaid by rusty gneiss, the whole cut by frequent intrusions of syenite and diorite. Much of the surface north of this, in Bristol and Clarendon, is covered with sand, outcrops of rocks, generally syenite, being rarely seen. At the Portage du Fort village, there is a great development of the crystalline series, the intrusions being particularly well seen, and their action upon the limestone being marked by their alteration of this rock into marble. From certain beds of this locality the marbles employed in the interior of the houses of Parliament in Ottawa were obtained. Chats to Portage du Fort.

"From Portage du Fort to Bryson, a portage of nine miles by road is necessary, the river being broken by rapids and falls. The rocks along this portion of the river consist principally of limestone, but with much syenite intermixed. East of Bryson, a considerable area of the latter Portage du Fort to Allumette Island.

Quebec—*Cont.*

rock occurs, and of Calumet Island, which separates the Bryson Channel from the Roche Fendue, the eastern half is nearly all syenite, except a narrow margin along the river.

"From Bryson west to Coulonge, the north channel shows but few rock outcrops. The banks of the river are composed of sand and clay, while the channel itself is often shallow with numerous shifting sand-bars. These sandy deposits continue up to the Paquette Rapids, which are at the foot of Allumette Island.

"The Roche Fendue Channel, on the south side of Calumet Island, is very rocky, broken by numerous heavy rapids and chutes. The rocks are limestone, underlaid by rusty, gray gneiss, but the syenitic and dioritic intrusions are frequent and masses of the limestone are often caught in the intrusive rocks. The rock on the north side of the Ottawa, between Bryson and the foot of Allumette Island, is mostly syenite. Occasionally small bands of limestone and gneiss are seen, but their area is small as compared with the syenite portion, and they are much broken up.

Allumette Island.

"Allumette Island, and the south shore of the river opposite, are occupied largely by Chazy rocks. The typical Black River occurs at Paquette Rapids, many of the beds being filled with fossils of that formation, which are beautifully preserved. Much of the island, however, is low, and large areas of sand and bog occur inland. The north-west portion is mostly syenite. In the north or Culbute Channel, a heavy rapid is overcome by a lock, while in the south or Pembroke Channel, the navigation is interrupted by the Paquette and Allumette Rapids, the latter about three miles below the town of Pembroke. These, however, can be traversed by steamboats at certain stages of the water.

Des Joachim.

"From Pembroke to Rapides des Joachim the navigation is unimpeded. The surface of Allumette Lake is broken by numerous islands, all of which are of syenite, generally reddish, and this is the only rock seen on either side to the Des Joachim, where our examination ended in this direction for the season.

"The south shore of the lake between the mouth of the Petewawa and Sturgeon Bay, which is at the mouth of Chalk River, is all sand, the banks being in places twenty-five to thirty feet high. The Ottawa for thirty miles below Des Joachim is called the 'Deep River.' The hills on the north are bold, the channel often narrow and apparently very deep. The country in this direction is all syenitic, often without foliation, though this structure is seen in many places. The only trace of limestone seen in this portion of the river, was a thin

crushed band above the narrows about one mile below the mouth of the Swego River, some thirty-five miles above Pembroke. Quebec—*Cont.*

"Some interesting points of structure were observed at various places. While it is very evident that the syenites or granites as a whole, in this section are intrusive in the crystalline limestone, some portions of them are of comparatively recent date. Thus about six miles above the Coulonge, they have apparently disturbed the usually horizontal beds of Calciferous and Chazy, the latter in one place being pushed up along the contact to angles of 36° and 40°; while in the townships of March and Nepean these granites, seen in a cutting on the Arnprior and Parry Sound Railway, have penetrated and altered the Potsdam sandstone of that area. It would almost appear, therefore, that these intrusions do not differ greatly in range of time from those of Mounts Calvaire and Rigaud on the lower Ottawa. Age of intrusions.

"Throughout this district mineral occurrences are rare, or at least have not been developed to any great extent. The Bristol iron mine, in the northern extension of the Hastings rocks, has been idle for some years, though the supply of ore is abundant and the quality good. It resembles very much in character and association the iron ores in the vicinity of Calabogie Lake to the south of Renfrew, which also occur in the rocks of the Hastings group. In character these rocks are almost identical with those found in the Pre-Cambrian range of the Sutton Mountains in the Eastern Townships. On Calumet Island, lots 10 and 11, range IV., there is a very considerable deposit of blende, in places mixed with galena. The ore occurs in connection with diorite which cuts rusty gneiss. Several hundred tons have been extracted, and are piled for shipment, but the force now working is small. Iron ore.

"On the large island below Galetta (Laflamme's Island) a deposit of galena in calcite has been opened up by several shafts. The ore is found in close proximity to a granite dyke which cuts the crystalline limestone, but the mine has been closed for several years. Galena.

"At Quio, on the property of David Ross, lot 7, range III., Onslow, a deposit of ochre occurs, of very good quality, and of considerable extent, furnishing an excellent material for paint. Ochre.

"Mica deposits are found at several places, but generally not of sufficient value to warrant outlay in the extraction of this mineral. At the outlet of Moose Lake, north of Coulonge, several openings have been made in a pyroxene dyke cutting gneiss, but the crystals are very dark coloured and badly shattered. In the vicinity of Carp village, and in the diorites of the Laurentian in the eastern part of March, several of these deposits of dark-coloured mica occur, but the greater number at least are of little value. Mica.

Quebec—*Cont.* Molybdenite.

"A considerable deposit of molybdenite was noticed on the land of Mr. John Gow, south half lot 6, range II., March, in a dyke of felspar which cuts crystalline limestone. A pit eight to ten feet deep has been dug, and specimens of the mineral are seen scattered about the surface. Small quantities of galena are also found in the limestone of this place.

Galena, blende and silver.

"Specimens of galena have been examined by Mr. Hoffman from the townships of Litchfield and Onslow, from the Coulonge and from Calumet Island. That from the Lorne Mine, at the last-named place, yielded 11·666 oz. silver to the ton of 2,000 lbs, and small quantities of native silver also occur in specimens procured from Mr. Russell, the owner of the mine. These come from the quartz and diabase rock at the base of the blende deposit. A specimen of the blende (see p. 63) immediately overlying this, was found to contain a very distinct trace of gold and silver at the rate of 18·229 oz. to the ton. The proportion of silver in specimens from other localities mentioned was unimportant. On the western end of Calumet Island, a band of limestone traversed by a pyroxene dyke carries scattered crystals of apatite, and at a few points traces of asbestus were observed in serpentine, but in none of these was the quantity sufficient to be of economic value.

Great syenite ridge.

"One of the most prominent geological features in the country north of the Ottawa, is the great ridge of red syenite, composed in places almost entirely of flesh-red felspar, which cuts across the strike of the gneiss and limestone from King's Mountain in Hull, north of Ottawa, to beyond the Quio village. This great ridge rises like a wall fronting the Ottawa River to a height of 800 to 1,000 feet, and has a breadth of from six to eight miles, extending almost to the Pêche River in the township of Masham. The syenite is generally massive, without stratification and very often even without foliation. The exposed breadth of the limestone area thus cut off by this mass, is from eight to ten miles, extending from east of Fitzroy Harbour to beyond Arnprior. After passing the great wall of syenite, the limestone comes in again on the Pêche River in Masham township, and continues in a broad uninterrupted belt along the Gatineau River for over one hundred miles to the north. Other areas of syenite and granite, of greater or less extent, also intersect the great belt of limestone, but do not present such prominent physical features as that just described."

Cost of the explorations during the summer, $470.13.

North-East Territory.

(With adjacent parts of Quebec).

Work by Mr. Low.

Early in June, 1893, Mr. A. P. Low left Ottawa for the purpose of exploring the interior of the great Labrador Peninsula, and in this

work, he with his assistant Mr. Eaton, were continuously engaged till September last, when he returned to the office. In the last Summary Report, a letter received from Mr. Low, dated Rigolet, October 5th, was published. This gave a very brief outline of the explorations completed during the summer of 1893. Mr. Low has since prepared the following preliminary account of the results of the expedition, embracing the work of 1893 and 1894 :— Labrador Peninsula—

"In accordance with instructions, and for the purpose of carrying out the work with which I had been entrusted, I left Ottawa on the 3rd of June, 1893, accompanied by Mr. D. I. V. Eaton as assistant and topographer. Arriving at Montreal the same day, final arrangements were there made for the shipment of supplies and provisions to Fort Chimo on Ungava Bay, where it was proposed that the party should winter if found convenient, in order to continue the exploration inland early the following summer. Here also, through the kindness of Mr. C. C. Chipman, Commissioner of the Hudson's Bay Company, and of Mr. Peter McKenzie, I was furnished with circular letters to the officers in charge of the posts in Labrador, enabling me to obtain the necessary supplies, information and aid to carry out the work in hand. I may here state, that at all the posts visited, the party met with kindness and attention, and everything possible was done by the officers of the company to assist the expedition. The success of the undertaking has been in great measure due to this assistance. Preparations.

"Two days were spent in Quebec obtaining final supplies, and then we proceeded to Lake St. John, where canoes, provisions and equipment had already been sent. As it is impossible to obtain provisions or supplies of any kind at the Hudson's Bay posts in the interior, and as all the able-bodied men are at this season away to Hudson Bay, engaged bringing in the next season's supplies to the posts, a quantity of provisions sufficient for the whole season had to be taken from Lake St. John, and four men engaged for the entire trip. To transport the provisions, six canoes were found necessary, and four of these were hired by contract by Mr. J. C. Cummins, who also kindly assisted in engaging the other men.

"Lake St. John was left on 17th June, and the Ashuapmuchuan River was ascended to its forks, where the Chef River was followed a few miles to the Sapin Crôche Branch, and that stream to its head in File-axe Lake near the height of land. From there a number of small lakes were passed through in crossing the watershed between the St. Lawrence and Hudson Bay, and then the Perch River, a small stream, was descended to the south-west bay of Lake Mistassini, reaching there 2nd July. The only new exploration along this part of the route Lake St. John to Mistassini.

Labrador Peninsula—*Cont.*

was from the forks of the Ashuapmuchuan River to File-axe Lake, some sixty miles, the lower part having been examined for the Geological Survey by J. Richardson in 1870, and the upper part by W. McOuat in 1871.

"The new portion passed through is traversed by low ridges of gneiss, with small lakes and swampy land filling the valleys between the ridges. The country is half burnt and partly grown up with black spruce, banksian pine, aspen poplar and white birch. Where unburnt the same trees are found, along with birch and balsam spruce.

"From Mistassini the eight men, with their canoes, returned to Lake St. John, and in consequence we had to depend on the natives of Mistassini to aid us in transporting our provisions. Two old men and a boy were found willing to go some distance with us, but on trial one man and the boy were found too feeble to carry, on the portages, and were soon discharged. The other old man had many years before made a trip to Nichicoon and he was taken along as guide.

Mistassini to East Main River.

"At Mistassini, a small rough sketch-map was procured, of the route up the East Main River to Nichicun, from Robt. Moore, a servant at Mistassini and formerly employed at Nichicun. This map was our only guide for some two hundred and fifty miles, as the 'guide' had forgotten the route and proved utterly useless.

"Lake Mistassini was left 5th July and, as in 1892, the North Branch of the Rupert River was descended some fifty miles, and then a portage route of fifty miles through chains of small lakes was followed to the East Main River. This stream was then ascended to the place where the survey of the previous year terminated, reaching there 15th July.

Upper East Main River

"From this point the micrometer survey was continued up the East Main River, one hundred and four miles, to where the route to Nichicun leaves the main stream to follow a small branch flowing in from the north-eastward. The general course of the river for this distance is slightly north of east. The river is very rough and rapid, with sixteen portages past chutes and rapids, besides a number of places where lightened canoes were tracked up. The valley of the river is shallow, and often the stream flows almost on the level of the surrounding country, widening into a number of lake expansions along its upper parts. The average breadth is four hundred yards, and it is often quite shallow. Two large branches come in on the south side, and one on the north side, together with a number of smaller ones. Along the lower part of the river, the country on both sides is quite low, with rounded hills running east and west. Thirty miles above the commencement of the survey, the country becomes higher, and to the sixteenth mile the river follows a valley between rough syenite hills that rise from two

to five hundred feet above its level. Beyond that point the hills become lower and the valleys wider, and they are occupied by sharp ridges of sandy till, seldom over one hundred feet high. Above where the route leaves the main river, the country continues comparatively flat in the directions of the base of the mountains some thirty miles distant. Labrador Peninsula—*Cont.*

"The trees along the East Main River are generally small, and only at favourable places along the bottom lands, do larch and spruce grow to eighteen inches in diameter at the base, where the country is unburnt. The highest hills are all wooded to their summits. Black spruce is the most abundant tree, being found everywhere, after which, in order of importance are larch, banksian pine, balsam spruce and white birch, the last being very small and not plentiful.

"The rocks along the river are composed of various gneisses and schists, together with syenites.

"The branch by which the Nichicun route leaves the East Main River is quite small. It was followed for thirty-two miles, where a two-mile portage leads through a number of small lakes into a larger one that empties by another branch of the river. Following this lake five miles, to its head, a short stretch of river leads to another large lake from which a portage was made into a chain of small lakes, discharging by still another branch, and so on into Kawachagamak Lake, which may be taken as the source of the East Main River. This lake is about ten miles long and has numerous deep bays running off on both sides. From its head, a half-mile portage leads to a small lake from which the height of land, separating the waters of the East Main and Big Rivers is crossed. East Main to Big River.

"The general direction of the route from the East Main River to the height of land, is nearly north-east, and the distance, roughly, seventy miles. The country is generally low, with ridges of rock and drift running east and west, with a few hills rising three hundred feet above the general level. The trees are smaller and more stunted than along the river and over ninety per cent is black spruce, the remainder being larch with an occasional small clump of white birch. Much of the country has been burnt over, and the time required for a second growth appears to be very long.

"From the watershed, a small lake was passed through, and then another, five miles long, with a portage at its outlet, where it discharges into the Big River. The river below this point alternates between lake expansions, and narrows where it has a swift current and is about two hundred feet wide, It comes from the the southward, where it rises in a number of lakes on the northern slopes of the mountains about sixty miles distant. Having descended the river ten miles, we

Labrador Peninsula—*Cont.*

then passed through a large body of water called Back Lake, a short rapid was descended and the Hudson's Bay Post on Lake Nichicun was reached 4th August. Here we were hospitably received by Mr. J. Iserhoff, and through his kindness obtained much valuable information about the surrounding country, and also a guide to Lake Kaniapiscow, on the Koksoak or Ungava River.

Nichicun.

"Lake Nichicun is about thirty miles long and in its widest part over five miles across, with a number of deep bays. It is surrounded by rocky hills, from three hundred to six hundred feet high.

"Lake Nichicun was left on the 7th August, by following the middle one of its three discharges, in a northward direction, some twenty-five miles. Then, turning more eastward, the route ascended a small branch for thirty-five miles, passing through a chain of lakes on this stream. Thence a narrow height of land was crossed, and a small stream connecting two small, and one large lake, was descended to Lake Kaniapiskau.

Lake Kaniapiskau.

The country between Nichicun and Kaniapiskau is higher and more rocky than any previously passed through. The tops of the higher hills are barren, and the trees in the valleys consist of small black spruce, larch and a few scattered white birch. The rocks are almost wholly syenite with few exposures of bedded gneiss

Begin descent of Koksoak or Ungava River.

"Lake Kaniapiskau was entered at its north end, opposite its discharge. It is said to be over forty miles long, with a narrow part near its middle. Here our guides left us, and shortly afterwards we had the misfortune to upset one of the canoes in a rapid, and lost all of its contents that would not float. For fifty miles below Lake Kaniapiskau the river flows north-west, running nearly on the level of the surrounding country, in a succession of lake expansions connected by short rapids.

"The surrounding country is low and comparatively flat, with low rounded ridges at intervals. Towards the lower end of this part of its course, the river begins to fall quickly in heavy rapids and small chutes. Turning abruptly to the east, it then enters a narrow valley, with rocky walls increasing in height from two hundred to five hundred feet as the river descends ten miles of heavy rapids, where its breadth varies from one to two hundred yards. For twenty miles below, there is a succession of rapids, and the stream widens to nearly half a mile and is very shallow. The hills on both sides continue high, with barren tops, and are covered with small black spruce on their sides. Veering again to the northward, the river continues with the same character for over fifty miles, while the surrounding country gradually lowers until the river is only slightly below its level. A large branch called Sandy River, from the south-east is passed, and then the river

again contracts as it falls over a number of ledges of syenite and passes through a low gorge fifty yards wide and a quarter of a mile long. Two miles below, it again contracts and passes into a crooked cañon about three hundred feet deep and one hundred feet wide. Here, in a mile, the river falls nearly three hundred and fifty feet, after which it is two hundred feet below the general level of the country. Labrador Peninsula—*Cont.*

"Below these falls the river is narrow and rapid for five miles, but gradually widens to nearly half a mile and again becomes a succession of rapids with smooth stretches between.

"Passing a fall of eighty feet, the river again contracts to about one hundred yards, and runs for nearly twenty miles with a strong current in a narrow crooked valley, with often perpendicular rocky walls rising over a thousand feet above it. After issuing from this valley, the stream widens out and becomes shallow, and soon enters Cambrian Lake, over twenty-five miles long and from two to five miles wide, surrounded by sharp rugged mountains. At the upper end of the lake, a large branch, called Death River, flows in from the westward, and Ice-dam River, from the same direction, enters about five miles below the lake. The rocks are all Laurentian, to about four miles below the upper branch, where these rocks pass under, and are partly covered by an unconformable series of sandstones, slates, shales and limestones. The overlying formation is highly charged with iron, and thick beds of hæmatite ore are met with in a number of places along the river lower down, where this series of rocks is passed through for a hundred and twenty miles. Millions of tons of iron ore must be in sight along the river, while still greater quantities of it, form sharp mountain masses on both sides. Fall of eighty feet. Cambrian rocks. Iron ore.

"Five miles below the Ice-dam River, there is a chute of sixty feet, with a large branch, named Swampy-bay River coming in from the eastward six miles below it, or about one hundred and twenty miles above Fort Chimo. Below, the river runs nearly north for seventy miles to where it is joined by the Still-water River, a very large branch from the westward. Between the Swampy-bay and Still-water rivers, the river flows in a wide valley, bounded by sharp hills and varies in width from a quarter of a mile to two miles, the average being about half a mile. Four miles above the Swampy-bay River it passes through a narrow gorge two miles and a half long. The only other obstructions between the forks, are two falls of sixty and eighty feet. Lower part of river.

"Below the Still-water River the Koksoak widens to over a mile, has a swift current and is very shallow with numerous bars. There are wide intervals of low land between the river and the hills on either side.

Labrador Peninsula—*Cont.*

These hills run in sharp ridges from north to south and slope gently towards the east, while they present perpendicular faces on the opposite side.

"The bedded series of limestones and shales gives place to Laurentian gneisses about twenty miles below the Still-water River, and Laurentian rocks are seen at intervals along the river thence to its mouth. On entering the Laurentian area, the hills gradually fall and retreat, leaving a wide flat valley. The river here varies from two to five miles in width and has many large flat islands of drift, to within five miles of Fort Chimo, where the rocky hills again close in, and the stream is obstructed by a number of high rocky islands that extend to within two miles of the post. The banks continue high and rocky to the mouth of the river, some twenty miles below the fort. The largest trees found along the Koksoak River, grow along the shores of Cambrian Lake, where white spruce eighteen inches in diameter is not uncommon. Balsam poplar is also seen along that part of the river, together with black spruce, larch and white birch, all much larger than along the upper part of the river. Beyond the valley, on the sides of the hills, the timber is small and stunted, and the summits are bare. Below the Still-water River the trees again become small, and about Fort Chimo only stunted black spruce and larch are found, growing in protected valleys.

Reach Fort Chimo.

"Fort Chimo was reached on the 27th August, and our canoe trip of over twelve hundred miles across Labrador completed. Of this distance four hundred and fifty miles had been previously surveyed, leaving seven hundred and fifty miles for the season's work. By working hard, early and late, wet days and Sundays, Fort Chimo was reached at least twenty-five days sooner than it would have been under ordinary conditions of canoe travel.

Famine among the Natives.

"At Fort Chimo we were kindly received by Mr. Duncan Mathewson, and soon learned that a great famine had prevailed during the past winter among the Indians trading at this post, whereby nearly two-thirds of them, or upwards of one hundred and sixty persons died of starvation. This calamity was due to the failure of the reindeer to follow their accustomed routes of migration during the preceding autumn, when they did not cross the Koksoak River in great bands as usual. In consequence, the Indians who depend upon the reindeer for both food and clothing, were soon reduced to starvation, and being unable to obtain other supplies, died off by families during the winter. About twenty-five Eskimo also perished from the same cause. The surviving Indians having been in a state of constant starvation throughout the past year, and consequently being unable to trap furs and so pay their debts, were at the time of our visit in an abject state

of poverty. A collection was taken up among the white people here and the officers of the steamer 'Eric,' and sufficient was obtained to partly clothe the naked children and widows whose husbands had died the last year. Labrador Peninsula—*Cont.*

"On hearing of the distress among the Indians, the Indian Department placed a sum of money at the disposal of the Hudson's Bay Company this year, and a recurrence of such a disaster will be impossible in future.

"The supply of pork at the Hudson's Bay post was too small to provide sufficient for the party if they remained at Fort Chimo, and as the risk of leaving provisions unprotected up the river, among starving Indians would be very great, it was deemed advisable not to winter at Fort Chimo, as originally intended; especially when it was learned that the work in hand could be carried on more advantageously from the head of Hamilton Inlet.

"Passages having been secured in the Hudson Bay Company's steamer 'Eric,' Fort Chimo was left on the 10th September for Rigolet, on Hamilton Inlet. On the way the Hudson's Bay posts at George River, Nachvak and Davis Inlet were visited, and such observations on the geology were made at each, as circumstances permitted. Rigolet was reached on the 1st October, and arrangements were made with Mr. J. A. Wilson for the transfer of provisions and outfit to Northwest River post, near the head of Hamilton Inlet, where we proposed wintering in the company's buildings, made available for that purpose by Mr. Wilson, who on this and later occasions materially assisted us in every way in his power. Provisions and outfit having been forwarded in a small schooner, the party proceeded in canoes to Northwest River post, following the north shore of the inlet. Voyage to Hamilton Inlet.

"From here immediate preparations were made for despatching the men inland with the canoes. They left on 23rd October, and succeeded in ascending the Hamilton River one hundred and twenty miles before they were stopped by ice, where they remained until the river was wholly frozen up, and then returned to Northwest River, arriving there on 29th December. Mr. Eaton and myself remained at the Hudson's Bay post, where Mr. Cotter kindly shared his house with us and did everything in his power to make our winter pleasant and comfortable. Provisions sent inland.

"During November and December, we were employed writing up the notes of the previous season, plotting the surveys and developing photographs. I left Northwest River for Rigolet on the 21st December with a dog-team, to secure men to aid in hauling provisions inland, and returned with eight men on the 17th January. Four men

Labrador Peninsula—*Cont.*

were engaged at Northwest River, and these with our own men, left on the 19th in charge of Mr. Eaton, each man hauling two hundred pounds of provisions along with the necessary extra clothing and outfit.

"This party succeeded in reaching the foot of the Gull Island Rapids, where they were obliged to câche their loads and return, owing to the rough ice in the rapids and the impassable country on both sides. During their absence I accompanied Mr. Wilson to Rigolet and from there to Sandwich Bay, in order to obtain as much information as possible of the country along the route.

Start for the interior.

"I returned to Northwest River on the 12th February, and remained there until the end of the month awaiting a sufficient fall of snow to render the rough ice passable. On the 29th, Mr. Eaton with two men left in advance, to carry on the micrometer survey, and on the 6th March the main party of thirteen men left for the interior.

"The câche where the loads previously taken in had been stored, was reached on the 10th, where four of the extra men turned back, being unable to stand the hard work. Continuing on with increased loads, some twenty miles of very rough ice was passed, and without further difficulties Muni Rapids, about ten miles below Lake Winokapau was reached. Here the river was found open and impossible to pass with loaded sleighs. A câche was made here, and the combined party returned to the first câche for the remainder of the provisions. Everything, including the canoes, was brought to the foot of the open water, where the canoes were loaded and then tracked or poled up to Lake Winokapau—very hard and disagreeable work with the thermometer below zero, and large quantities of anchor ice running down stream.

"The extra men were sent back from Lake Winokapau on the 1st April. From here everything had to be moved by our small party of six men, necessitating at first four and later three loads, and thus the same ground was traversed from five to seven times. As a consequence, the onward progress was very slow, and the Big Hill portage, one hundred miles above Lake Winokapau, was not reached until the 28th.

Character of Hamilton River.

"The Hamilton River flows in at the south-east corner of Goose Bay at the head of Hamilton Inlet. From its mouth to the Minipi River, one hundred miles above, the course is about west-south-west. At its mouth the river is nearly three-quarters of a mile wide, but soon it widens out, and averages a mile in width as far as the Muskrat Fall, twenty-eight miles above. Along this stretch, the river is very swift and shallow at ordinary stages of the water, and has scarped banks, that increase gradually in height as the stream is ascended, and are cut

out of sands that floor a wide valley between the rocky hills on either side. Labrador Peninsula—*Cont.*

"The valley is well wooded with white, black and balsam spruce, larch, balsam poplar and white birch, much of the timber being sufficiently large to be cut for commercial purposes. The Muskrat Fall, or more correctly 'chute,' is about five hundred yards long, and the drop is seventy feet. From here to the Gull Rapids, thirty-two miles, the character of the river remains the same as below, and it varies in width from one-third of a mile to a mile. The sandy banks are often high and well terraced.

"At the Gull Rapids the hills approach, and narrow the valley to less than a quarter of a mile, while the rocky walls rise directly from the water to heights varying from three hundred to nine hundred feet above it.

"To the mouth of the Minipi River, a branch from the southward, the valley continues deep and narrow with the river rushing through it in a deep channel.

"From the Minipi River, the general course of the main stream to the Grand Falls is about north-west. A short distance above the Minipi River, the valley gradually widens out, and five miles higher up, it becomes again from one to two miles broad, between the hills. The river now averages half a mile in width for over twenty miles, when it again contracts to less than a quarter of a mile, and continues for twenty miles in a sharply defined rocky valley to the outlet of Lake Winokapau. The upper ten miles is a constant succession of heavy rapids.

"Lake Winokapau is forty miles long and averages one mile and a half in breadth, it is simply a portion of the ancient river-valley, which from some unknown cause has not been partly filled by glacial drift. The waters are deep to the base of the high rocky cliffs that bound the valley on both sides. Soundings made in the centre gave four hundred and sixteen feet, and within fifty feet of the shore a depth of eighty feet was obtained. Towards its upper end the sand brought down by the river has greatly decreased the depth, and a number of low islands and shoals obstruct navigation. Lake Winokapau.

"Above the head of the lake, the river continues to flow in a slightly narrower valley, partly filled with drift; and except at a few short rapids, is easily navigable to the Big-hill portage, fifty miles above the lake.

"Extensive fires, during recent summers, have burnt almost the whole of the timber in the valley and on the surrounding table-land, from the Gull Rapids to beyond the Grand Falls. The small patches

Labrador Peninsula—*Cont.*

remaining show that the trees in the valley were of fair size, while the table-land is covered only with small black spruce and larch.

"Leaving the greater part of the supplies at the Big-hill portage, we followed up the valley some fifteen miles, to where the river enters it by a deep narrow cañon, coming into the main valley at a right angle on its north side. The main valley was seen continuing north-westward some twenty miles beyond this point. Above the portage the valley varies from a quarter of a mile to a mile in width, and as the grade is heavy, the river rushes through it as an almost continuous heavy rapid, which does not freeze over. Only a narrow margin of ice was found along the shore, and over it travel was slow and difficult.

"Where the main stream issues from the cañon, it is not over one hundred feet wide, and there was no ice along the foot of the perpendicular cliffs that rise seven hundred feet above the foaming water. In consequence, progress up the gorge was impossible, and a climb of seven hundred feet was made out of the valley on to the table-land above. Travelling overland, some five miles in a straight line, the place where the river precipitates itself off the general level was reached on the 3rd May.

The Grand Falls.

"Here the river was found to leave a small lake expansion, and narrowing to less than two hundred yards in width, falls two hundred feet in less than four miles rushing along in a continuous heavy rapid. In the last quarter of a mile, it narrows to less than one hundred yards as it sweeps downwards with huge waves over a number of rocky ledges preparatory to its plunge of three hundred feet, as the Grand Falls, into a circular basin about two hundred yards wide at the head of the cañon below. From this basin it passes out by a channel less than fifty feet wide, at right angles to the falls, and thus pent up in this narrow channel it rushes on in a zigzag course from five to seven hundred feet below the general level until it issues into the main valley below. The distance in a straight line from the falls to the mouth of the cañon is not much over five miles, but owing to the crooked nature of the cañon the river, with a fall of over three hundred feet, probably flows more than twice that distance before it reaches the main valley.

"After examining the falls and photographing them from above and below, the course of the river was followed to the small lake above, and from there the portage route was traced back through a number of small lakes to the Big-hill portage, at the foot of which the extra loads had been left. From the river, the portage rises abruptly seven hundred feet in less than a quarter of a mile. Three

days were occupied in carrying the provisions and outfit up the hill through snow and slush, after which everything was advanced by short stages until the 19th May, when owing to the rotten state of the ice in the small lakes sleigh work had to be abandoned, and a camp was formed, where everything was put in order for the summer canoe work. Labrador Peninsula—*Cont.*

"The small lakes of the portage route being sufficiently clear of ice, camp was broken on the 30th and the main river reached next day. The river was found, however, to have only partly opened and to be full of large masses of floating ice over four feet thick, with the water between these, covered with slush holding long needle-like crystals of ice. The ice continued to pass down the river from the lakes above for ten days, not only greatly retarding the progress of our canoes, but also proving a source of considerable danger to them. Opening of navigation.

"We were now fortunate in securing an Indian, as guide, who was acquainted with the routes to Lake Michikamau and to Mingan. He remained with us during the rest of the season and proved very useful.

"On account of the large supply of provisions, double loads were made to Sandgirt Lake, fifty-seven miles above the spring camp, where we arrived on the 15th June. This lake is very conveniently situated as a base from which to explore the surrounding country, the two main branches of the river flow into it, and the route to Lake Michikamau also passes through it. A câche to contain the extra provisions and outfit was here made on an island, and everything not immediately required was stored in it. Depôt at Sandgirt Lake.

"Above the Grand Falls, the character of the river changes completely, and instead of flowing steadily in a deep well defined valley, it here runs almost on a level with the surrounding country, without any valley proper, but spread out into lake expansions and numerous channels separated by large islands, so as to occupy all the lower lands of a wide tract of country through which it flows. From the Falls to Sandgirt Lake, the general course continues about north-west, or parallel to the general trend of the low ridges that cross the country in that direction. The country surrounding the river is rolling, with rounded hills seldom rising more than three hundred feet above the general surface. Between the hills are wide valleys occupied by lakes or swampy land. The trees are small and black spruce predominates, with larch, balsam and white spruce and a few white birch. River above Grand Falls.

"The first lake expansion above the falls is about six miles long, with the river flowing in at its head by a number of channels from the second or Flour Lake, some nine miles above. This lake is over ten miles long and is full of islands; at its head the river again splits into

Labrador Peninsula—*Cont.*

a number of channels, the most southern of which was followed to Sandy Lake, where the river has three outlets.

Ashuanipi Branch.

"It was decided to first explore the west or Ashuanipi Branch of the river, and with a month's supply of provisions, Sandy Lake was left on the 18th June. As our guide had never traversed this part of the country, we experienced considerable trouble in finding the main channel owing to the bewildering lakes and islands. The branch flows into Sandgirt Lake from the north-west, and for thirty-eight miles averages a quarter of a mile in width, as it flows along with a swift current, between low sandy banks. In two places it widens into small lake expansions, and is often divided by large islands. Birch Lake was then entered, and its south shore followed for nine miles to where part of the river flows in, the remainder of it enters a bay on the north side. The south channel was ascended some ten miles to another long lake expansion out of which both channels flow. This lake was followed fifteen miles to its north end, where a short narrows connects it with Lake Petitsikapau.

Maze of lakes.

"This is a large irregular body of water with numerous long narrow bays, where a week was spent looking for the river, before it was discovered that it had turned southward before entering the lake. Returning to the last lake, three large irregular lakes, connected by short rapids, were passed through, and in all one hundred and twenty miles of survey was made while looking for the river. From the upper lake the ascent of ten miles of rapids brought us into a long straight lake to the south-west, lying nearly north-and-south, and varying from one to three miles in width. This was followed southward thirty-five miles, and then the crooked, rapidly flowing river was ascended in the same direction fifty-five miles, when owing to failure of provisions it was found advisable to stop work and return to the câche on Sandgirt Lake, where we arrived on the 17th July.

Cambrian rocks.

"From the mouth of the Hamilton River to within a short distance below Birch Lake, the route passes over a great area of Laurentian gneiss, along with syenite and intrusive basic rocks. There are followed at Birch Lake by an extension of the iron-bearing or Cambrian rocks met with the previous season along the Ungava River, and from there almost to the end of the survey on this branch these rocks are met with.

"On entering the Cambrian area, the physical aspect of the country changes. Sharp, parallel ridges running north-north-west, and rising from three hundred to six hundred feet above the general level, are seen in all directions, with wide valleys between them occupied by long narrow lakes and bays or channels of the river.

There is also a marked improvement in the size of the trees, due to a richer soil covering this area; and along the river and in the valleys, white, black and balsam spruce are frequently met with over twenty four inches in diameter three feet from the ground. White birch also grows larger and more abundantly than elsewhere. Unfortunately these large trees do not grow high, but branch out close to the ground, so that timber made from them would be full of large knots, and probably of little value. Labrador Peninsula—*Cont.*

"The summits and northern slopes of the higher hills are barren showing the rigorous conditions of climate. Iron ores similar to those of the Ungava River are frequently met with in abundance.

"An exploration of the country northward to Lake Michikamau was next made. The route from the câche passes northward to the end of Sandgirt Lake, where a channel of the river was descended into a large lake, which was crossed. Thence, three other large lakes full of rocky islands, and connected by a small branch, were passed through to a low height of land, with a mile portage, separating the Hamilton from the Northwest River. At high water there is an overflow from Lake Michikamau at this place, thus giving an outlet to that great lake by the Hamilton as well as the Northwest River. Route to Lake Michikamau.

"From the portage, the route leads through another long island-covered lake, and by a short stretch of river into a bay of Michikamau, which indents the main body of the lake on its southwest side near the middle of its length. From Sandgirt Lake to this place the general course is slightly east by north; the distance to the mouth of the bay being sixty-eight miles.

"Lake Michikamau is the largest body of fresh water in eastern Labrador, and is second only to Lake Mistassini, if it does not surpass that lake in area. The main body of the lake is fifty-five miles long from south-east to north-west, and in its widest part exceeds twenty miles across. There are few islands except along its southern and western shores, the water being remarkably clear and deep. Size of the lake.

At the south-east end, are two long, narrow bays, which we were unable to explore, and along the south-west side there are a number of others, also unexplored. The Northwest River flows out on the north side, about twenty-five miles from the south end. The shores are often rocky and the lake is surrounded by barren rocky hills from two hundred to seven hundred feet in height.

"As the route is followed from Sandgirt Lake, the trees become very small and stunted, and about Lake Michikamau grow only on the lower lands and in protected valleys, leaving the hills and uplands bare.

Labrador Peninsula—*Cont.*—

"An outlier of Cambrian rocks, represented by lower beds of conglomerate and sandstones, occupies the body of the lake, and it is surrounded by hills of syenite and gabbro, the latter often in the form of large masses of precious labradorite. The country between Sandgirt Lake and Michikamau is wholly underlain by Archæan gneisses cut by masses of syenite and diorite or gabbro.

Attikonak Branch.

"Having made a circuit of the lake, the route was retraced southward to Sandgirt Lake, where the party again arrived on the 30th July. Two days later the câche was finally left, and the party started southward by the east or Attikonak Branch of the Hamilton River, which flows into the south part of Sandgirt Lake. This stream was ascended twenty-five miles to Osokmanuan Lake, which is about fifty-five miles long, but does not average more than four miles in width. Its surface is broken by many islands, a number of them being large. There is a second outlet on the east side not far from the south end, where a large stream flows out and finally joins the main river in the valley at the foot of the cañon. Ascending a stretch of five miles of river, a lake five miles long was passed through, and again the river was ascended about twenty-five miles to Lake Attikonak at its head. This

Height of land.

is another large irregular body of water, with deep bays and dotted with innumerable islands. Its eastern shore was closely followed for forty-five miles, to the head of the south-east bay, where a small stream connecting two small narrow lakes, was ascended a few miles to the watershed between the Hamilton and Romaine Rivers. Crossing this, the Romaine River was soon reached, and its descent commenced. The country from Sandgirt Lake to the height of land is generally low, and broken only by occasional ridges of low rounded hills; much of the land is swampy and the timber small.

Romaine River.

"Where we reached the Romaine River, it is about one hundred feet wide, flowing between low banks for nine miles to the Burnt Lakes. The upper and largest of these is twenty-four miles long; it is separated from the middle lake by a short, heavy rapid. This lake is two miles and a half long, with one mile of rapid between it and the lower lake, which is ten miles long. These lakes are surrounded by low hills totally burnt over.

"Leaving this lake by a heavy rapid, the river was followed southward sixty-eight miles, through a distinct wide valley. As the river descends it is augmented by a number of small branches and is about a quarter of a mile wide along the lower courses. The hills surrounding the valley increase gradually, and finally rise from four hundred to seven hundred feet above it, and are almost wholly burnt. The current is swift, but broken by three rapids where portages are necessary.

"The river was left by a small stream within one hundred miles of the coast, and following up this branch, a chain of lakes on it and small branches of St. John River, were passed through to the last-named river. This route is over seventy miles long and traverses a high range of hills. The Romaine River, below this point is said to be impassable and must be very rough indeed to induce the Indians to use the present portage route, which is the hardest and roughest in my experience. The St. John River flows in a valley from one to two miles wide, bounded by high hills. In this valley the river descends rapidly, as it winds from side to side, and only one portage was made, to its mouth, seventy-five miles below where we first entered it, we reached the mouth of the river on the 22nd August. Labrador Peninsula—*Cont.* St. John River.

"On the route from Sandgirt Lake to the Gulf of St. Lawrence, only Archæan rocks were met with. Several large areas of gabbro or anorthosite were found, notably along Osokmanuan and Attikonak Lakes, below the Burnt Lakes on the Romaine River, and forming the high hills along the portage route to the St. John River and along that stream to within a few miles of its mouth.

"Proceeding next day to Mingan, our guide was discharged, and Quebec reached via Gaspé. Here the remaining men were paid off and sent home to Lake St. John. Reach Mingan.

"Mr. Eaton and myself reached Ottawa on 1st September. The total distance travelled by the party from Lake St. John to Mingan, was approximately 5,660 miles, as follows:—

Distance travelled.

	Miles.
By canoe, Lake St. John to Ungava	1,100
By steamer, Ungava to Rigolet	1,000
By canoe, Rigolet up Hamilton River	220
By dog sleigh, Northwest River, to and from Rigolet and Cartwright	500
On foot with sleighs, Northwest River to Grand Falls	1,000
By canoe, Hamilton, Romaine and St. John Rivers.	1,640

"Micrometer surveys of 1,099 miles, and track surveys of 940 miles were made as follows:— Surveys accomplished.

	Miles.
Micrometer survey, Upper East Main River	104
Micrometer surveys, Hamilton, Romaine and St. John Rivers	995
Track-survey from East Main to Ungava	600
Track-survey, Sandgirt Lake to and around Michikamau Lake	269
Track-survey, Lower St. John River	72

Labrador Peninsula—*Cont.*

General results.

"As a result of this work, the courses of the East Main and Hamilton Rivers will be laid down on the map from actual survey, where previously the only information concerning them was obtained from Indian sketches. The course of the Ungava, or Koksoak River and the position and shape of Lake Michikamau are also ascertained; and a line of exploration has been carried from south to north through the interior of Labrador, while the line from east to west is broken only by a distance of less than one hundred miles in the middle, between the head-waters of the Hamilton and East Main Rivers.

"These explorations will give a good idea of the physical aspect and climate of the interior, about which very little was previously known by the public, and will correct the popular idea that the Labrador Peninsula is a waste, barren region totally unfit for habitation.

"From the notes and observations made, the distribution of the forest trees may be laid down on the map, together with the southern limits of the semi-barren and barren lands. A collection of one hundred and twenty species of flowering plants were brought home from the Upper Hamilton River. These are valuable an an index to the climate of the region; and as most of them grow in Northern Quebec, the climate of the interior differs slightly from portions of the country at present under cultivation.

"Collections of birds, birds' eggs, butterflies, and beetles were also made and prove to be of considerable scientific interest.

Great abundance of fish.

"All the lakes and rivers of the interior were found well stocked with fish, those of the eastern watershed especially so. During the summer of 1894, the party lived almost exclusively on fish caught in nets or with lines. The net was nightly set at random and never failed to give a supply in the morning. Lake trout, often of large size, brook trout up to seven pounds weight, large white-fish and pike, land-locked salmon and two kinds of sucker were all taken almost everywhere.

"Meteorological observations were regularly kept three times a day, as well as notes on the thickness of ice, amount of snowfall and other points bearing on climate.

Geological information obtained

"The most important geological information obtained is the discovery of a great and hitherto unknown area of Cambrian rocks, extending north-north-west from north latitude 53° to beyond the west side of Ungava Bay. These rocks are made up of a great thickness of conglomerates, sandstones, slates, shales and limestones, together with intrusive igneous rocks. Their chief economic value is due to the immense amount of bedded iron ore found along with them.

The ores are chiefly specular and red hæmatite, together with beds of siderite or carbonate of iron. Thick beds of fine ore associated with jasper, were met with in many places, on both the Ungava and Hamilton Rivers; and the amount seen runs up into millions of tons. Owing to their distance from the seaboard, these ores at present are of little value, but the time may come when they will add greatly to the wealth of the country. Labrador Peninsula—*Cont.* Iron ores.

"Frequent observations on the direction of the glacial striæ, show that the ice during the glacial period flowed off in all directions from a central area south of Lake Kaniapiskau and between the headwaters of the Hamilton and East Main Rivers. Along the upper part of the East Main River, the ice moved nearly due west, and it also flowed in that direction near Nichicun Lake. The striation is very indistinct and the evidence of motion of the ice-mass is not definite from here to Lake Kaniapiskau. This portion of the country is covered by immense quantities of subangular blocks and boulders of local rocks, often perched on the very summits of the rocky hills and not uncommonly found resting on other blocks beneath, in such a position that the least movement would displace them. Glacial striation.

"Erratics are very rare, and everything points to but a slight amount of movement of ice in this vicinity. At Lake Kaniapiskau the direction of the striæ show the ice flow to have been towards N. 60° E. while down the Ungava River it was more nearly north, corresponding with the general slope of the country. In the valley of the Hamilton River, only the south side is glaciated, and the direction of the striæ follows that of the axis of the valley. On the table-land above the Grand Falls, the direction of the striæ is very persistent, being constant over hill and valley, with a general direction of south-east.

"Near Lake Petitsikapau, the direction quickly changes to N. 50° east, apparently due to a change in the general slope. About Lake Michikamau the general direction is nearly due east. Passing southward to the Romaine River, and along it, the direction of the ice movement varies from east-south-east to south-east. On the St. John River the striæ are irregular and mostly follow the valley.

"A marked feature of the interior is the sharp ridges of drift that lie parallel to the direction of the striæ. These ridges are chiefly composed of fine material, with well rounded small boulders, of which a large percentage are far travelled. Where cut by the streams these ridges sometimes show indistinct signs of stratification and may be called eskers. In detail their contour is most irregular, forming a perfect network of sharp ridges joining one another from all directions, Ridges of drift.

Labrador Peninsula—*Cont.*

with the material lying at very high angles impossible to obtain under water. They greatly resemble moraines formed by the melting of drift-laden ice at rest, and are indiscriminately scattered over the country.

Terraces

Terraces were observed on the sides of hills along both branches of the Hamilton River. These terraces rise to over one hundred feet above the present water-level and are so placed that they could only be formed along the shore of a lake or lakes formed by ice barriers.

"Almost continuous terraces were traced along the sides of the deep valleys of the Hamilton and Ungava Rivers from their mouths, for over 200 miles inland. The post-glacial elevation on the Atlantic coast of Labrador, as shown from terraces and raised beaches, was not over 200 feet at Hamilton Inlet, and gradually decreases northward.

"The depth of Lake Winokapau, 416 feet, would indicate that the elevation of the land in pre-glacial times was much greater than at present, and that the valley of the Hamilton River has since been filled up with glacial drift, out of which the river is again cutting a channel; but owing to the less elevated state of the land it will probably not again reach the depth that it had previous to the glacial period."

Cost of exploration, 1893-94, $5,857.95.

New Brunswick.

(With adjacent parts of Quebec and Nova Scotia.)

New Brunswick.

Mr. R. Chalmers spent the winter of 1893-94 in the preparation and completion of a report on the surface geology of those portions of eastern New Brunswick, north-western Nova Scotia and Prince Edward Island, embraced in the three quarter-sheets No. 2 S.E., No. 4 N.W. and No. 5 S.W. (New Brunswick series). Mr. Wilson, who assisted Mr. Chalmers, was engaged, during the same time, in compiling and arranging the data for the maps and in getting them ready for the engraver.

Work by Mr. Chalmers.

On the field work done during the past summer, Mr. Chalmers makes the following report:—

"According to instructions I left Ottawa on the 10th of July to continue investigations in the surface geology of New Brunswick. Owing to the lateness of the time of starting, the limited amount of exploration funds at my disposal, and to the want of an assistant, Mr. Wilson having been kept in the office all summer, my work was of a more or less cursory character, and consisted partly in a revision of certain portions of that of previous years, and partly in preliminary

investigations in the north-western part of the province. A number of points were re-examined in the region around the Bay of Fundy, both in New Brunswick and Nova Scotia, and several questions elucidated from the additional facts obtained. The work in progress during the two years previous, along the valley of the St. John and in north-western New Brunswick, was continued, and some new and interesting data collected, especially as regards the glaciation, the dispersion of boulders, the formation of river-terraces, etc. The great development of terraces in this valley affords excellent facilities for studying them, and for tracing their relation to the glacial deposits. In the investigation of these questions, certain problems respecting the source of the Pleistocene ice which occupied the district, and of the boulders strewn over it to the north of the main granite belts traversing the province, presented themselves for solution. These problems seemed to render it necessary to extend our inquiries somewhat beyond the limits of the region specially investigated. Accordingly, towards the close of the season a short time was devoted to an examination of the contiguous parts of the province of Quebec and of the State of Maine. New Brunswick—*Cont.*

"The first two or three weeks after my arrival in New Brunswick, were spent collecting Pleistocene marine shells, etc., my intention being to catalogue, at a future day, if possible, the Post-Tertiary fossils of the Maritime provinces. The Leda clays and Saxicava sands of the New Brunswick coast, especially in the Baie des Chaleurs and Bay of Fundy districts were searched, and also the boulder-clay in several localities, and a considerable number of species obtained. Pleistocene fossils.

"Early in August I proceeded to the upper St. John, and Lake Temiscouata, a region presenting very interesting features as regards its surface geology. Temiscouata Lake lies in a great valley of denudation, extending transversely across the Notre Dame Range. Its surface is only 467 feet above the sea (Geology of Canada, 1863) and its depth in the centre, at Mount Wissick, is upwards of 200 feet. Since the erosion of the valley orogenic displacements have occurred, and these together with glacial action have produced a catchment basin for the drainage of a considerable region here, resulting in the formation of this lake. From the great bend in the lake, the Pleistocene ice seems to have moved northward and southward. Temiscouata.

"Temiscouata Lake has, however, been much larger at one time than now, indeed most of our lakes stood higher and occupied a much larger area in early post-glacial times. In regard to the body of water of which Lake Temiscouata then formed a part, evidence is accumulating tending to show that it not only occupied a large portion of the drainage-basin of the existing lake and of Madawaska River, but

New Brunswick—*Cont.*

also the St. John valley as far south as Grand Falls. It is possible however, that the sea invaded these valleys at the above mentioned date, from the St. Lawrence, for though no marine fossils have been found in the deposits, granite and gneiss boulders, which look as if they might be from the Laurentides, occur on the shores of Lake Temiscouata, and, moreover, the level of these valleys is very nearly as low as the marine terraces which skirt the St. Lawrence River.

Grand Falls of the St. John.

"At the Grand Falls of the St. John, some remarkable phenomena showing the action of river ice came under notice. As the ice which covers the river immediately above the 'falls' every winter melts away, it moves down in a body, sliding over the surfaces of the ledges along shore. No distinct grooves or striæ are made, but the surfaces are eroded, planed and stossed, and have the appearance of being heavily glaciated.

"The limestone ledges above the 'falls' contain pot-holes. Though quite numerous, these are not as large or deep as the pot-holes in the gorge below the 'falls.' As there has been no cutting down of the rocks here by a water fall, the banks consisting wholly of boulder-clay, the question of the origin of these pot-holes is an interesting one. Two explanations are suggested; either the border of the Pleistocene ice lay here for some time, and the waters from its melting, producing these pot-holes, or there was a water fall or series of rapids over the boulder-clay bank, referred to during the period of its erosion.

"Observations were made on the Grand Falls itself, and on the gorge below in regard to their origin and the cause of the diversion of the river, by which they were produced. It would seem that while the damming of the river-valley by glacial drift is the apparent cause, it is probable that there has also been a transverse dislocation of the limestone strata here, in the early Post-Tertiary period, as a primary cause.

Granite boulders.

"Distributed over that part of New Brunswick lying north-west of the granite hills which traverse it from the Baie des Chaleurs to the Maine boundary at the Cheputnecticook Lakes, are of granite boulders, gneiss, etc., which must have their source northward and westward beyond the limits of the province. Many of these resemble rocks along the International boundary between Maine and Quebec, but the precise locality of the parent rocks, and the manner of their distribution, have not yet been satisfactorily determined.

"On the 4th of September I went to Nova Scotia to re-examine some of the doubtful points in the surface geology of the western end of the Cobequids, and study some features of the glaciation and boulder dispersion along the North Mountain, Annapolis Valley, etc.

"The differential uplift of the post-glacial marine shore-line in the Cobequid Pass, through which the Springhill and Parrsboro' railway runs, was traced out and more carefully levelled, and found to be higher than the shore-lines on either side of the mountains. There is also a difference between the height of the post-glacial shore-lines along Northumberland Strait, and those bordering Minas Channel and Minas Basin. Nova Scotia.

"The glacial phenomena of the north-west coast of Nova Scotia, from Minas Basin to Yarmouth, was investigated in a cursory manner, and it was discovered that this part of the peninsula shed the Pleistocene ice, north-westward into the Bay of Fundy depression. The ice overrode North Mountain, carrying granite boulders from the South Mountain, and strewing them over the former, down to the shores of the bay. Heavy striation and stossing, showing the direction of the ice movement, were observed in a number of places. Another fact in this connection was noted, however, viz., the occurrence of Triassic trap boulders on the South Mountain derived from the North Mountain. The north-west brow of the South Mountain was examined in a cursory manner for striæ and stossing, but none were discovered showing distinct south-eastward ice movement. How then did the trap boulders referred to, reach their present situation? To answer this question it seems necessary to suppose (1) that the Triassic rocks were originally laid down upon the north-west flank of the South Mountain, and (2) that the existing valley (Annapolis, etc.) between the two mountains is one of subsequent erosion. On this view Digby Gut is part of the old valley of Bear River, cut down through the Triassic rocks during the period of erosion. The boulders of Triassic trap met with on the South Mountain may, therefore, be simply remnants of the original overlapping rocks, left there as denudation proceeded backward from that mountain, just as the Carboniferous sandstones which formerly transgressed upon the crystalline rocks on the north side of the Cobequids left boulders, etc., on the slope and summit of these mountains as they were denuded. Glacial phenomena of north-west coast.

"The courses of striæ referred to, while trending north-westward, or nearly at right angles to the coast, along the North Mountain as far west as St. Mary's Bay, seem to swerve more and more to the west and south as we approach the western end of the peninsula. At Yarmouth the ice closely followed the courses of the estuaries, and moved nearly due south. Vicinity of Yarmouth.

"The facts taken altogether demonstrate that Nova Scotia has been glaciated entirely by ice which gathered upon its own surface, and afford no evidence of a great ice sheet crossing the Bay of Fundy and overriding that peninsula.

New Brunswick and Maine.

"On the 22nd of September I went into Albert County, N.B., for a few days to re-investigate some critical points in the surface geology along Demoiselle Creek, etc., and on the 27th I proceeded to St. John and spent a day examining the boulder-clay bank at Negrotown Point, collecting some shells from the glacial deposits of that locality. From St. John I went to northern Maine and south-eastern Quebec, for the purpose of observing the relation between the surface geology in these places and that of north-western New Brunswick.

Courses of striæ.

"At Moosehead Lake, Me., the glacial striæ trend S. 25° E., S. 11° E., S. 9° E., S. 5° E. and S. 30° W.,* the last course being the latest. No boulders from the International boundary or Notre Dame Mountains were observed here.

"A terrace about sixty feet in height above the surface of Moosehead Lake, borders it, showing that at one time in its post-glacial history this lake stood that much higher than its present level.

"At Lowelltown, Me., just south of the boundary, heavy glaciation is exhibited on the slopes of the ridges there, many of which have been overrun by forest fires, leaving the rocks bare. The courses of the striæ are S. 65° E., S. 69° E., S. 73° E., S. 80° E. and S. 86° E., the principal sets being S. 73° E. and S. 80° E. This is at the headwaters of Moose River which flows into Moosehead Lake. Mountains and valleys trending nearly east and west, have here formed a gathering ground for the ice which flowed in the direction above indicated. The hillsides are all heavily stossed on the west. So far as I could observe, the ice did not come through the transverse gaps of the divide. The upper parts of the rivers all flow eastward, and it is not improbable that a portion of the ice which collected on the south-east side of the boundary, moved in the direction of the upper St. John, as ice from the north-west side seems also to have done. Granite boulders from local sources are quite abundant, and similar granite boulders were noted in the upper part of the St. John valley.

Quebec.

"On the north side of the boundary line, the character of the surface is entirely different, especially along the Canadian Pacific railway. Instead of glaciated ledges and bare hills, there is an immense sheet of superficial materials, mantling, and almost everywhere concealing, the rocks from view. The evidence of a northward movement of drift in the Lake Megantic district is, however, unquestionable. Only in one spot were striæ observed, and these were on a flat surface; but boulders derived from the granite area to the south are very abun-

* All courses of striæ and bearings are referred to the true meridian, the variation of the compass being 15° to 16° W. in the Eastern Townships and at the International boundary, and 18° to 22° W. in the lower St. Lawrence valley.

dant. The descent from the boundary to Megantic Lake is quite rapid, being more than 500 feet along the Canadian Pacific railway in the intervening sixteen miles. Quebec—

"At Scotstown, several sets of striæ were observed, the most distinct being N. 35° W., N. 45° W. and N. 63° W. A second set trends about S. 65° E. Other ice-movements have also left their record on the rocks here, stossed faces being presented to the west, east, etc. These divergent courses may be due to ice which accumulated here from the north and from the south, and sought outlet by the lowest levels. Courses of striæ.

"At Cookshire, well marked striæ were noted, trending in several courses between S. 48° E. and S. 58° E., the stoss-side being clearly to the north-west.

"At Sherbrooke, striæ, with courses bearing S. 48° E., S. 52° E. and S. 54° E. were met with, the ice apparently following the valley of the St. Francis River up stream. It will be noticed that the striæ at Cookshire and Sherbrooke have the same bearing, and were doubtless produced by the same body of ice. This was land-ice which probably came from the Sutton Mountain range, the north-eastward extension of the Green Mountains.

"Along the Quebec Central railway, there is evidence of an ice flow off the whole Sutton Mountain range south-eastward. Whether or not this ice crossed the valley of the Chaudière River and the International boundary reaching the valley of the St. John River, etc., is a question that can only be decided by further investigation.

"A great post-glacial lacustrine area lies to the south-east of the Sutton Mountain range, in the valley along which the Quebec Central railway runs, and the lakes seen there now are merely remnants of a former large lake or series of lakes.

"Granite and other crystalline boulders become numerous along the Quebec Central railway east of Weedon; and as we reach that part of the valley of the Chaudière lying below the level of the marine terraces, many boulders occur which are undoubtedly Laurentian. Granite boulders.

"Between St. Charles station, Intercolonial railway, and Pointe Lévis, striæ were found running S. 63° W., stoss-side to the north-east. Height 145 feet. Striation, indicating ice-movements in the same direction, has been met with at Montreal by Sir J. W. Dawson, and also along the south side of the St. Lawrence below Lévis, viz., at Rivière du Loup, Trois Pistoles, Bic, etc. These may for the present be attributed to the action of floating ice, as in the other instances just mentioned. Pointe Lévis.

Quebec—*Cont.*

"Granite, gneiss and other boulders from the Laurentian region are here plentifully strewn over the surface of the great marine plain of Pleistocene age on the south side of the St. Lawrence.

Courses of striæ on Lower St. Lawrence.

"At St. Thomas, Q., striæ were seen on the west ends of a number of long ridges lying parallel to the St. Lawrence, trending N. 67° E., N. 62° E. and N. 72° E., which are due to land-ice. At St. Francis station, Intercolonial railway, similar ridges are glaciated on both the east and west ends, the result probably of land-ice moving eastwardly at one time, and of floating-ice moving westwardly, at a subsequent date.

"The foot-hills of the Notre Dame Mountains here present perpendicular, or very steep faces towards the St. Lawrence, in some places with a *talus* at the base; while the summits are glaciated by land-ice which flowed northward or north-eastward. Evidently no ice from the Laurentian Mountains impinged against these foot-hills. The streams also run down the hillsides in repeated cascades, and it would seem as if there must have been recent uplifts in these foot-hills.

"Going along the Temiscouata railway from Rivière du Loup, a well marked marine shore-line was observed at a height of 418 feet above mean tide level.

"At Trois Pistoles, Bic, Ste. Flavie, etc., additional observations were made respecting the glaciation. Numerous sets of striæ occur in these places ranging in direction from N. 5° E. to N. 40° W., the dominant courses being N. 2° E. and N. 30° W. Deep grooves are common. Other divergent striæ trend N. 58° W. and N. 74° W. All these have been produced by land-ice flowing from the Notre Dame Mountains into the estuary of the St. Lawrence. Another light, irregular set ranging from S. 70° W. to S. 85° W. is supposed to be due to floating ice-masses driven up stream. These striæ are the latest, in proof of which it may be stated that the boulder-clay resting upon the glaciated surfaces is charged with Laurentian boulders which seem to have produced them, borne thither by this ice-driftage. The whole is capped with Leda clay and Saxicava sand, containing shells.

"The evidence of Pleistocene ice having moved northward from the Notre Dame Mountains into the St. Lawrence valley as far west at least as Lévis, may now be considered conclusive.

Metis to Metapedia.

"The Intercolonial Railway route through the Notre Dame Mountains was followed from Metis to Metapedia, but no evidence of ice from the Laurentian region having crossed the watershed was found. At Metapedia Lake, striæ occur trending in the direction of the valley, about S. 60° E.

"The remainder of the season, viz., from the 11th till the 29th of October, was spent in York county and along the South-west Miramichi valley. New Brunswick.

"In regard to the agricultural character of the country examined it may be remarked that the north-western part of New Brunswick comprises some tracts of the best arable lands of the province. The valleys of the St. John River and its tributaries, the Meduxnakeag, Tobique, Madawaska, etc., contain strips of bottom land of greater or less width which form excellent soil. Between Grand Falls and Edmundston the bottom land obtains considerable width, and in this part of the St. John Valley there are many excellent farms. Not only are the meadow lands noteworthy in this respect, but the uplands of Carleton, Victoria and Madawaska counties are also of remarkable fertility,—a fact to which the rapidly increasing settlement of this section of the country bears witness. Since the opening up of north-western New Brunswick by the Canadian Pacific and Temiscouata railways, marked progress has taken place in its agricultural condition, as well as in other respects. Agricultural land.

"A good deal of attention was devoted to the forest growth of the province during the season, and, in addition to the usual notes on the size and species of trees, in the locality more particularly investigated in north-western New Brunswick, some general information was obtained concerning the rate of growth of the woods of commercial importance, and on their preservation and replenishment in depleted districts. An examination of the trees now growing upon the area overrun by the great Miramichi fire of 1825 was made. Several localities within the burnt area, where it was known no forest fires have occurred since that date, were selected, and the girths of all the trees measured just above the roots. The following figures give the maximum measurements of the girth of a great number of trees of each species and show their rate of growth on a given soil (Middle Carboniferous or Millstone grit) during the sixty-nine years which have elapsed since the date of the fire:— Rate of growth of timber.

Poplar *(Populus tremuloides)*	51	inches
White spruce *(Picea alba)*	54	"
Black " *(Picea nigra)*	48	"
Fir *(Abies balsamea)*	40	"
Red pine *(Pinus resinosa)*	52	"
Paper birch *(Betula papyrifera)*	44	"
Sugar maple *(Acer saccharinum)*	35	"
Swamp maple *(Acer rubrum)*	24	"
Beech *(Fagus ferruginea)*	24	"
Hackmatack *(Larix Americana)*	31	"

New Brunswick—*Cont.*

"In addition to the above species there are a few rowan trees, ash, alders, willows, viburnums, etc., of small growth.

"Of the trees enumerated, the red pine and black spruce are by far the most abundant and grow in such dense clumps on the drier spots as to exclude every other tree. The hemlock, black and yellow birch, cedar and white pine have not grown again since the fire.

"On limestone areas overrun by the Miramichi fire, the white spruce, paper birch, beech, etc., have grown rather larger than upon the Millstone grit, the girths of these exceeding the above measurements from one to five inches. In districts, too, where the woods are comparatively thin, *i. e.*, less dense than where I measured them, the trees show a tendency to be thicker and shorter.

"The foregoing data give some idea of the length of time our timber trees take to grow to become of economic value, when the forests are once destroyed.

Growth of spruce timber.

"From information obtained from New Brunswick lumbermen, it appears that they usually re-cut the logs off their spruce timber limits every ten or twelve years. Under the existing Crown Lands Regulations, no spruce or pine trees are allowed to be cut which will not make a 'merchantable log' 18 feet in length and 10 inches in diameter at the small end. If, therefore, timber of this size, or larger, can be cut off the forest lands every ten years or so, it seems reasonable to assume that, with a proper enforcement of these regulations and the preservation of the forests from fires, they might be conserved, and a growth of trees of commercial value ensured for generations to come.

"No new minerals or materials of economic importance were met with during the past season. Those which occur in western and north-western New Brunswick were recorded in the Report of Progress of the Geological Survey for 1882-83-84, part GG, and in reports by Prof. Bailey and Mr. McInnes.

"In Ryan's brickyard at Fredericton a fossil fish about 18 inches in length was discovered during the past summer by Prof. L. W. Bailey. It is reported to have been embedded in stratified clay at a depth of twenty-seven feet below the surface of the ground. The specimen is now in the Museum of the University of New Brunswick."

The cost of the season's explorations was $473.64.

Nova Scotia.

Nova Scotia—Work by Mr. Fletcher.

Part of the winter after the 31st December, 1893, was spent by Mr. H. Fletcher in plotting his surveys, in revising plottings of surveys made by his assistants during the previous summer, and in cor-

recting proofs of Nos. 30 to 36 of the Nova Scotian series of maps; but the greater portion of his time was occupied in compiling the map, on a scale of one mile to an inch, from these surveys, from Church's county maps and from plans made in the Nova Scotian government departments of Crown Lands, Mines and by the Provincial Engineer. Nova Scotia—*Cont.*

He left Ottawa on June 4th, 1894, to resume field work in Nova Scotia, to examine the geology of the district west of that described in last Summary Report and to work out in greater detail the geological structure of certain portions already surveyed. Nearly all the geographical surveys were made by his field assistants, M. H. McLeod and T. S. McLean, who were employed for four months, and surveyed the Herbert, Meander, St. Croix, Avon, Halfway and Gaspereaux Rivers, the shore, and the roads between Windsor, Laurencetown and Port George.

Mr. Fletcher reports on the work done, as follows :—

"The new district comprises the western portion of Hants county, north of the gold-bearing rocks, also part of the counties of King's and Annapolis south of North Mountain and east of Inglisville, which is not yet, however, finished. It is mostly low, well cultivated and especially adapted to fruit growing. Ship-building and lumbering are carried on to a small extent, and within it are the important quarries of gypsum at Newport Station, Wentworth and Windsor and the iron mines at Torbrook and Nictaux. Districts surveyed.

"The geological formations recognized are Triassic, Carboniferous limestone, Devonian, Silurian, Lower Cambrian and igneous. Large deposits of drift, carried apparently both from the north and from the south, conceal in places the underlying rocks, making land which would otherwise have been barren, fertile; while rounded and striated rocks are found at many points, and clays used for making bricks at Avonport and elsewhere. Geological formations.

"Triassic sandstone and conglomerate occur on the shore west of Avonport. The greater part of the North Mountain is composed of trap and allied igneous rocks of this period.

"The Carboniferous limestone occupies the eastern part of the district. A characteristic section of its gypsum, limestone and marls, on the Avon River at Windsor, has been described by Sir J. W. Dawson (Acadian Geology, page 558) and these rocks are also seen on the road from Scotch Village to Woodville, on Herbert River above and below that road, and in many streams of the neighbourhood. On Walton River, not far below the confluence of Shields Brook, pits have been dug in a reddish, greenish and gray, mottled, impure and concretionary lime-

Nova Scotia—*Cont.*

stone, resembling the Tennycape manganiferous belt, containing small vuggs lined with dog-tooth spar, limonite and hæmatite. The greater part of the river is occupied by this formation. On a branch of the North-east Tennycape River, on the south side of the brook, at the contact of this 'mineralized zone' (as the lowest limestone, the horizon of the Tennycape Mine, and of other mineral deposits in Nova Scotia is called by Mr. Poole) with the Devonian, Captain Scott, Mr. Wright and others have sunk a shaft thirty feet deep, and obtained a small quantity of good pyrolusite. Gray and rusty, soft, thick-bedded sandstones, with a low northerly dip overlie the limestone and gypsum of Kennetcook River and the barrens north of it between Upper Kennetcook and Kennetcook (Burlington). These sandstones have been quarried for railway-bridges and other purposes, although said to be too soft and full of 'shakes' for grindstones; they are also seen in Cockmagun and Tomcod Rivers and resemble the coal-bearing strata of Stewiacke River. They contain plants of coal formation genera and a small seam of coal, (Acadian Geology, page 268; Summary Report for 1889, page 30), have the aspect of true coal-measures, and are commonly supposed to be productive. These may belong to the Millstone grit, but are quite distinct from the grit, sandstone and shales of Five-mile River (Summary Report for 1893, p. 41) and the Gore, which have also been prospected for coal, but underlie the limestone unconformably.

Beds below Carboniferous limestone.

"At some points the Carboniferous limestone rests directly upon the gold-bearing series, but at others these lower plant-bearing strata intervene. They are well exposed at Horton Bluff (Acadian Geology, page 253), and along the shores between Avonport and the mouth of Halfway River. Where they succeed quartzite and staurolite-schist in the brook from which Windsor is supplied with water, they consist of whitish-gray and rusty, fine and coarse quartzose grits, coherent or loose in texture, dipping N. 22°, W. $<$ 27°, interstratified with thick bands of blackish, shiny, bituminous shales, like those of Hallowell Grant and East Bay, Cape Breton, some of which will burn and have been mined for coal, while others, full of rootlets, constitute true under-clays. Overlying these beds are reddish and gray sandstone and coarse grits—the whole resembling the more southerly arenaceous rocks of Horton Bluff.

"West of Gaspereaux River, these rocks are apparently replaced by older strata. In the branch of this river from which water is taken for the town of Wolfville, gray shales and dark micaceous flags with impressions of fossil plants, are associated with whitish quartzose sandstones, containing 'bulls' of rusty-weathering, greenish, pyritous, cohe-

rent sandstone, and with red argillite, including cream-coloured and greenish layers, mottled with rusty and hæmatitic spots, and underlaid by steel gray and blackish nacreous slates of the auriferous series. Nova Scotia—*Cont.*

"In the large branch of Kennetcook River, which comes in from the south at Riverside Corner, whitish, crumbly, coarse sandstone, gray flaggy sandstone and reddish and greenish, somewhat coherent marls, very like the Devonian of Five-mile River, are interstratified with blackish grit, containing broken carbonized matter and indistinct *Cordaites*. Fine exposures of Carboniferous limestone are, in the Herbert River, underlaid by a narrow belt of gray, fine, micaceous sandstone and whitish coarse granitic grit, which is itself underlaid immediately by the auriferous series, as described by Mr. Faribault.

"Silurian rocks, holding marine fossils, are found in the hill country of New Canaan, Nictaux and Inglisville, associated with others perhaps older, and also with a series supposed by Sir J. W. Dawson to be Oriskany. Interstratified with the last is the hæmatite bed of Torbrook, six feet thick, (from which about 35,000 tons of iron ore are annually extracted for use in the furnaces at Londonderry and Ferrona), and the iron ores of Nictaux and Cleveland, not worked at present. A collection of fossils from these beds, made last smmer by Dr. A. H. McKay, of Halifax, Mr. John E. Leckie, of Torbrook, and myself, has been given to Dr. Ami for comparison with those found by Dr. Bailey at Nictaux (Summary Report for 1892, p. 57) and with others in the Survey museum. Silurian rocks.

"The most important masses of crystalline rocks are the granites and diorites of the South Mountain, of Silurian age or older, and the trap of North Mountain which is Triassic. Crystalline rocks.

"Several weeks were also spent by me, assisted by Mr. M. H. McLeod, in a re-examination of the Devonian rocks of Riversdale and Lower Five Islands, at Calvary Stream, the Black, Salmon and North Rivers, Penny's Mountain, Union, the West, Middle and East Rivers of Pictou, Stewiacke River, Five Islands, South Maitland, Knoydart and the Strait of Canso, which has confirmed the conclusion arrived at after the first examination in 1884, in company with Dr. Ells, viz., that they underlie the red rocks of Union, which in turn lie unconformably beneath the Carboniferous limestone, as stated in previous reports,* and have been metamorphosed by the syenite and other plutonic rocks of the Cobequid Hills. It seems probable that the dioritic and felsitic schists of these hills as well as those of Moose River, and the Garden of Eden have originally been igneous rocks, which are elsewhere represented by massive forms. Devonian strata.

*Annual Reports Geological Survey of Canada (N.S.) Vols. II., IV. and V.

Nova Scotia—*Cont.*

"Some investigations were also made of certain doubtful points in the geology of the country represented on the sheets of Antigonish and Pictou counties, now being engraved and in an unsuccessful search for fossils in the rocks there met with, which are believed to be of Cambro-Silurian age. Mr. McLean also spent a few days in the Pictou coal field to add to the topography of the large map of that district.

Iron mining.

"Work has been vigorously prosecuted by the Pictou Charcoal Iron Company, and by the New Glasgow Iron, Coal and Railway Company at their iron mines at Bridgeville, where explorations are being made to find ore at the contact between the Carboniferous limestone and Devonian on the opposite or left bank of the East River. By the latter company, mines were opened on the Trunk Road hæmatite bed and on those of Doctor's Brook in Antigonish county; while work done by the company on the Big Blanchard bed has shown that, instead of being from thirty to one hundred feet thick, as its superficial appearace would indicate, it is only four feet and a half thick, bent horizontally on a roll. The display of Nova Scotian minerals and products of the mines, now being prepared by Dr. Gilpin, inspector of mines, for the Imperial Institute, London, is to include iron ore, fluxes, fuels, and pig iron, made by this company at Ferrona, also rails, shafting, &c., made at Trenton by the Bessemer process from their iron.

Coal.

"The amalgamation of most of the collieries in the Sydney coal-field by the Dominion Coal Company, has stimulated prospecting, and valuable discoveries of coal have been reported. Recent work at the Richmond coal mines throws no new light on the relation of that coal to the gypsum and limestone. From a deposit of fine sand found near River Denys station, a paste or bathbrick has lately been manufactured in Pictou for use on the Intercolonial and Canadian Pacific railway. Associated with it is a quantity of excellent clay, said to be adapted for fire-bricks and tiles.

"Further examinations have been made of the strata overlying the coal measures in Pictou county. Two bore-holes were put down by the diamond drill in search of coal—one at Abercrombie, 350 feet deep, passed through gray sandstone; the other at Poplar Hill, 214 feet deep, through alternations of red shale, gray sandstone and coarse concretionary grit or limestone-conglomerate, the gray beds containing carbonized plants. At Sundridge, on the farm of Mr. Robert Macdonald, are pits, not before mentioned, on one of the deposits of copper ore so characteristic of this formation (Annual Report Geological Survey, Vol. V. (N.S.), Part P, p. 186). Chalcocite occurs in a gray and reddish flaggy sandstone, and still more abundantly in layers of concretionary limestone-conglomerate, like that of the Poplar Hill

bore-hole. It is mixed with carbonized plants, as in the case of similar deposits on French and Waugh Rivers and elsewhere. Before the land was cleared, the spot at which it has been opened is said to have been barren." Nova Scotia—*Cont.*

Cost of the season's explorations and surveys, $725.

Mr. E. R. Faribault reports on the work accomplished by him during the year as follows:— Work by Mr. Faribault.

"According to instructions received, all the time at my disposal during the past summer was devoted to the further mapping and study of the gold-bearing Cambrian rocks of the Atlantic coast of Nova Scotia.

"After the close of field operations of 1893, the winter months, from the 15th of December until the 1st of June, were chiefly occupied, as in the previous year, in compiling the map of the area previously surveyed. This work, included the plotting of the instrumental surveys made during the summer, the revising of plotting done by the assistants, the reduction of plans from the Admiralty charts, the Crown Land Department and other sources; the compilation and adjustment of these various surveys on the projection prepared by the late Mr. Scott Barlow on the scale of one mile to one inch, the laying down of the geological lines and other data gathered in the field; and finally, the study of the geology of the area laid down on the map and the making out of the structure of the numerous folds into which these gold-bearing rocks have been thrown; especial attention being paid to the study of the anticlinal axes and their intimate relation to the auriferous belts. Progress of the maps.

"A final decision having been arrived at to continue the publication of the Nova Scotia maps on the scale of one mile to one inch in the same style as those already published, a considerable amount of time was taken up in preparing the manuscript maps for sheets Nos. 27, 28, 29, 30, 36, 37 and 38, a few alterations in, and additions to, the topography and geology being also made from supplementary notes taken the previous summer, in order to bring the maps up to date. I also attended last winter to the correction of proofs of sheets Nos. 25, 26, 27, 28, 29 and 30, and last summer while in the field to the correction of proof of sheet No. 36.

"Transverse structural sections were also prepared for sheets Nos. 27, 28, 29, 30 and 37, to be engraved on the margin of each sheet.

"Since my return this fall, a section for sheet No. 38 has been prepared, and corrections of proof of sheet No. 37 made. Sheets Nos.

Nova Scotia—*Cont.*

36, 37 and 38 are still in the hands of the engravers. These sheets, together with those previously mentioned and those prepared by Mr. Hugh Fletcher, are the fourteen first sheets of Nova Scotia proper, excepting sheets Nos. 22 and 24, which were published with the Cape Breton series. The fourteen sheets are numbered from 25 to 38 inclusive, covering the eastern part of the province extending from Cape Canso westward to Beaver Harbour on the Atlantic and Barney's River on the Strait of Northumberland. The country covered by these sheets has been fully reported on by Mr. Fletcher and the writer, in the Annual Report for 1886 (Part P), with the exception, perhaps, of sheets Nos. 37 and 38, which still require some further detailed explanation.

Gold mining.

"Although drawn on the small scale of one mile to an inch, the above mentioned sections give a good idea of the general structure of the plications of the rocks, and will show to a certain degree the intimate relation of the quartz veins, auriferous or not, to the anticlinal saddle. It is believed that the future of deep and permanent gold mining in Nova Scotia, depends greatly on the proper understanding by miners of this mode of structural occurrence of the quartz veins. The system of deep mining employed in Australia and more especially in the Bendigo gold field, where the quartz reefs occur very much in the same manner, might be adopted with advantage in Nova Scotia. Most of the mining there is carried out by means of perpendicular shafts sunk along the anticlinal axis, with cross-cuts and levels, which cut and afford the means of working out the quartz in interbedded veins (most of which curve around the anticlinal saddle and do not outcrop at the surface) to depths ranging from a few feet to 2,850 feet in the famous Lansell's 180 mine. That system could be applied also, in most cases, to quartz mining in Beauce district, in the province of Quebec, where the rocks are exactly similar.

Districts examined in 1894.

"I left Ottawa on the 1st of June for Nova Scotia, to commence the season's field work, and returned to the office on the 15th of September. The greater part of the summer was spent, assisted by James McG. Cruickshank, re-examining the gold-bearing rocks of that part of the province comprised between the East River Sheet Harbour, Gay's River, Stewiacke River, and the Atlantic shore, in the counties of Halifax and Colchester. The anticlinal folds were followed along their course, and the structure of each one carefully studied wherever possible, in order to locate any elevation of the axis forming a dome, having the characteristic structure of a gold district. Several such domes were located, and their eastern or western dip will indicate the probable pitch of the pay streak of gold in the quartz veins. Numerous

faults of more or less magnitude, affecting the structure of these rocks, were also found. One of these, having over one mile of a thrust, has been traced thirty-two miles up the West River Sheet Harbour to the Carboniferous basin of the Musquodoboit River. Nova Scotia—*Cont.*

"The boundaries of the Lower Carboniferous basins of the rivers of Musquodoboit, Stewiacke, St. Andrew's and Gay's have also been delineated. Some extensive deposits of fire-clay have been discovered in the valley of the Musquodoboit River. Specimens submitted to Mr. G. C. Hoffmann, the chemist of the Survey, were pronounced on a preliminary examination to consist of a mixed material. Mr. Hoffmann says of them: 'Although apparently uniform (by reason of the whole being more or less coated with ferric hydrate) I found that some of the fragments when freed from this were fairly whitish in colour, and when burnt remained so, while other pieces were of a uniform grayish colour throughout, and when burnt assumed a reddish-brown colour. A mixture of equal parts of the two kinds might be expected to burn pale reddish-brown, but possibly one or the other kind may predominate in the deposit.' For the purpose of ascertaining this, larger specimens were collected, and these will afford material for further and more satisfactory experiment. Fire-clay.

"The field investigations and mapping of the topography and structural geology of the nine sheets Nos. 39, 40, 41, 42, 48, 49, 50, 51 and 52, have thus been brought to a close, and the preparation of these sheets for the engraver will be completed in the course of about two months. The four adjacent sheets, Nos. 53, 54, 55 and 56 require still some further study in the field of the structural geology. A detailed report to accompany the above thirteen sheets and part of sheets 37 and 38, all contained in the counties of Halifax and Colchester, has been commenced, and will be finished in the course of the winter. Most of the topography and part of the geology have been done for sheets Nos. 65, 66, 67, 68 and 73, in the counties of Hants and Halifax. The roads traversing the areas of sheets No. 69, 70, 71 and 72 have been surveyed by odometer. Further work required.

"Mr. A. Cameron was engaged surveying with the odometer, and plotted 296 miles of roads in Lunenburg, 23 miles in Hants, 49 miles in King's, and 42 miles in Annapolis counties:—a total of 410 miles, to be used as tie-lines in next year's contemplated topographical work, most of which is included in sheets Nos. 85, 86, 87, 88, 96 and 97."

Cost of the explorations of the season, $715.16.

Chemistry and mineralogy.

CHEMISTRY AND MINERALOGY.

Reporting on the work of this division, Mr. Hoffmann says :—"The work carried out in the chemical laboratory during the past year has been, conformably with the practice of former years, almost exclusively confined to the examination and analysis of such minerals, ores, &c., as were considered likely to prove of economic value and importance. It embraced :—

Analyses made.

"1. Analyses of coals and lignites.

"2. Analyses of mineral and other waters from localities in the provinces of New Brunswick, Quebec, Ontario, Manitoba, North-west Territories and British Columbia.

"3. Analyses of iron ores, from the provinces of Nova Scotia, New Brunswick and Quebec.

"4. Analyses of numerous samples of pyrrhotite for nickel and cobalt.

"5. Assays of a large number of ores for gold and silver from numerous localities in the provinces of Nova Scotia, New Brunswick, Quebec, Ontario, North-west Territories and British Columbia.

"6. Miscellaneous examinations. These include the partial analysis or testing, as the case might be, of brick, and pottery clays, manganese ore, iron sands, barytes, chromic iron ore, graphite, carbonaceous shale, sandstone, marls, etc.

Mineral specimens examined.

"The number of mineral specimens received, during the period in question, for identification, examination, or analysis, amounted to six hundred and ninety-four. A large proportion of these were brought by visitors desirous of obtaining information in regard to their economic value, and this was in many instances communicated in the course of a personal interview. In other instances, those where a more than cursory examination was called for, or a partial or even complete analysis was deemed desirable, as also in the case of those 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 one hundred and sixty-eight, and the number of those received to sixty-six.

Work by Messrs. Johnston and Wait.

"Messrs. R. A. A. Johnston and F. G. Wait, assistants in the laboratory, have both rendered excellent service. The former, in addition to the carrying out of a lengthy series of gold and silver assays, has made numerous analyses of important minerals, and also conducted a great variety of miscellaneous examinations, in all of which work he has displayed both ability and skill; whilst the latter has been engaged in the analysis of mineral and other waters, iron-ores, marls, the estima

tion of nickel in samples of pyrrhotite, and has also made some miscellaneous examinations. Chemistry and Mineralogy—*Cont.*

"The regular annual report 'Chemical Contributions to the Geology of Canada,' has been written, and is now in course of publication. In the work in connection with the mineralogical section of the museum, I have been diligently assisted by Mr. R. L. Broadbent. Apart from the general museum work, such as the labelling and cataloguing of all newly received specimens, and the maintaining of the collection generally in an orderly condition, he has numbered and prepared a manuscript catalogue of the now somewhat extensive collection of foreign minerals, *i.e.*, minerals from localities outside the Dominion, and also arranged and made a list of the contents of the drawers under the wing-cases. Museum.

"Fifty-two photographs, the greater number coloured, fourteen inches by ten, mounted and framed, representing views of mines and views illustrating structural geology, have been arranged over the central table-cases in this section of the museum.

"Many of the mineral specimens have been replaced by more characteristic ones, and the collection augmented by the addition of some one hundred and fifty others, as follows:— Contributions to museum.

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

1. Adams, F. D.:—
   Nephelite and sodalite, from York River, near side-line between lots 12 and 13, range XI. of the township of Dungannon, Hastings county, Ont.

2. Ami, Dr. H. M.:—
   (*a*) Crystals of pyrite, from the township of Wakefield, Ottawa county, Que.
   (*b*) Calcite, from Crystal cave, Mount Stephen, Rocky Mountains, B.C.
   (*c*) Crystal of pyrite, from six miles north-east of Illecillewaet, West Kootenie district, B.C.

3. Bailey, Professor L. W:—
   (*a*) Stilbite, sixteen specimens, from North Mountain, Annapolis county, N.S.
   (*b*) Mesolite, twenty-four specimens, from Murphy's Cove, Digby Neck, and North Mountain, Annapolis county, N.S.
   (*c*) Heulandite, one specimen from Digby Neck, and another from North Mountain, Annapolis county, N.S.

Contributions to museum—*Cont.*

(*d*) Quartz, seven specimens, from Johnson's and Nichol's mines. and Petite Passage, Digby county, N.S.

(*e*) Agate, twenty-six specimens, from Johnson's and Nichol's mines, Digby Neck, N.S.

(*f*) Martite, ten specimens, from Nichol's mine, Digby neck, N.S.

(*g*) Magnetite, five specimens from Mink Cove, Digby county, N.S.

(*h*) Hæmatite, a specimen from Torbrook, Annapolis county, N.S.

(*i*) Selenite, six specimens from Elmsdale, Hants county, and one from Blomidon, Kings county, N.S.

(*j*) Gypsum, fibrous, eight specimens from Blomidon, King's county, N.S.

(*k*) Siderite, one specimen from St. Mary's Bay, Digby county, N.S.

(*l*) Magnetite, from Nichol's mine, Digby Neck, Digby county, N.S.

4. Brumell, H. P. :—

(*a*) Crude petroleum, from Lyppswell, lot 8, range I. of Gosfield, Essex county, Ont.

(*b*) Chabazite, six specimens; pyroxene, four specimens; scapolite, one specimen; titanite, three specimens; biotite, three specimens—all from lots 24 and 25, range VI. of Monteagle, Hastings county, Ont.

(*c*) Apatite, from lot 26, range VI. of Monteagle, Hastings county, Ont.

(*d*) Molybdenite, from lots 26 and 27, range VI. of Monteagle, Hastings county, Ont.

(*e*) Apatite, from lot 22, range XIV. of Cardiff, Haliburton county, Ont.

(*f*) Apatite, from the township of Faraday, Hastings county, Ont.

(*g*) Sodalite, five specimens; lepidomelane in sodalite, three specimens; nephelite, one specimen—all from lot 25, range XIV. of Dungannon, Hastings county, Ont.

(*h*) Magnetite, from lot 25, range XIV. of Dungannon, Hastings county, Ont.

(*i*) Graphite, disseminated, from lot 28, range XIII. of Dungannon, Hastings, Ont.

(*j*) Muscovite, six specimens; perthite, twelve specimens, from lot 20, range X. of Dungannon, Hastings county, Ont.

Contributions to museum—*Cont.*

(*k*) Magnetite, from the west-half of lot 19, range I. of Belmont, Peterborough county, Ont.

(*l*) Lithographic stone, from lots 7 and 8, range III. of Marmora, Hastings county, Ont.

5. Dawson, Dr. G. M. :—

(*a*) Strontianite, from Horsefly River, Cariboo district, B.C.

(*b*) Stibnite (in a gaugue of dolomite and barite) from the Rosebush claim, near the mouth of Copper Creek, Kamloops lake, B.C.

(*c*) Leucite rocks, from the Horsefly River, Cariboo district, B.C.

(*d*) Sphærosidesite in basalt, Horsefly River, Cariboo district, B.C.

(*e*) Opal, common, Horsefly River, Cariboo district, B.C.

(*f*) Gold, native, from the Horsefly mine, Horsefly River, Cariboo district, B.C.

(*g*) Platinum, native, Horsefly River, Cariboo district, B.C.

(*h*) Copper, native, from the same locality as the preceding.

(*i*) Aragonite, Mussel Creek, Horsefly River, B.C.

(*j*) Barite, crystallized, in lignite, from Horsefly River, Cariboo district, B.C.

(*k*) Gold, native, from Quesnel River, B.C.

6. Faribault, E. R. :—

Clay, from McKenzie Brook, Middle Musquodoboit, Halifax County, N.S.

7. Ferrier, W. F. :—

Pearl-spar, a specimen of, from the corporation quarry, Outremont, near Montreal, Que.

8. Fletcher, H. :—

Clay iron-stone, from the Albion mines, Pictou county, N.S.

9. Giroux, N. J. :—

Infusorial earth, from Trompe Souris,, north of St. Justin village, Maskinongé county, Que.

10. Lambe, L. M. :—

Iron-sand, Cap à l'Aigle, Charlevoix county, Que.

11. Low, A. P. :—

(*a*) Magnetite, four specimens ; magnetite with hæmatite and red jasper, magnetite in garnetiferous granite ; magnetite with brown jasper ; magnetite with ankerite ; hæmatite and magnetite with red jasper—all from Ungava River, Labrador.

(*b*) Magnetite in quartz ; hæmatite and magnetite, with red jasper ; anthraxolite—from Hamilton River, Labrador.

Contributions to museum—*Cont.*

12. McConnell, R. G. :—

Pyrargyrite, from the Dardanelles claim, Kaslo-Slocan mining district, West Kootanie, B.C., and other specimens, which are under examination.

13. Prest, W. H. :—

Agate, and Banded jasper, from Johnson's mine, Digby Neck, Digby county, N.S.

14. Selwyn, Dr. A. R. C. :—

Limestone showing cone-in-cone structure from the north-east corner of the district of Athabasca, N.W.T.

The following were obtained by Dr. Selwyn for the Museum, at the World's Columbian Exposition, Chicago :—

(*a*) Silver ore, from the Broken Hill, New South Wales, Australia.

(*b*) Alunite and alum, from Bulladella, New South Wales, Australia.

(*c*) Rose garnet, from Xalostoc, Mexico.

(*d*) Magnesite, from Mantudi, Greece.

(*e*) Chalcopyrite with pyrrhotite, from the Atlantic mine, Deer Lodge county, Montana, U.S.A.

(*f*) Silver ore, from the Daly mine, Park city. Summit county, Utah, U.S.A.

15. Weston, T. C. :—

Nodular pyrite, from Point Lévis, Lévis county, Que.

16. Willimott, C. W. :—

See further on.

"(B.) Received as presentations :—

1. Cameron, Robert, Almonte, Ont., per J. F. Whiteaves :—

Limestone concretions, from Sault Ste. Marie, district of Algoma, Ont.

2. Constantine, Charles, Inspector North-west Mounted Police :—

(*a*) Coal from stream flowing into the Yukon River, east side, three miles above Forty-mile creek.

(*b*) Vivianite, Yukon river valley, about forty miles above Forty-mile creek.

(*c*) Copper, native, from near the head of Copper River, Alaska.

3. Fairbairn, David, North Wakefield, Ottawa county, Que. :—

Argentiferous galena, from the Ottawa and Wakefield claims Kaslo-Slocan mining district, West Kootanie, B.C.

4. Fournier, Xavier, Murray Bay, Que., per Dr. H. M. Ami :—

Muscovite (crystal), from Lac au Pied des Monts, Charlevoix county, Que.

Contributions to museum—*Cont.*

5. Hayden, Dr., Canmore, N.W.T. :—
   Semi-anthracite, showing cone-in-cone structure, from Canmore, district of Alberta, N.W.T.
6. Jaques, Capt. Josiah, Victoria, Vancouver Island, B.C. :—
   (*a*) Ilvaite, from Barclay Sound, Vancouver Island, B.C.
   (*b*) Chalcopyrite, from the same locality as the preceding.
7. Kirkpatrick, A. K., Smith's Falls, Ont., per H. P. Brumell :—
   Marl, from White Lake, township of Huntingdon, Hastings county, Ont.
8. Koksilah Quarry company; Victoria, B.C. :—
   A block of dressed stone from a quarry on the bank of Koksilah River, two miles south of Koksilah station, on the Esquimalt and Nanaimo railway, thirty-five miles north of Victoria, B.C.
9. Lanigan, R., Calumet, Pontiac county, Que. :—
   Kaolinite, from lot 5, range VI. of Amherst, Ottawa county, Que.
10. McVicar, D. W., Tenycape, Hants county, N. S. :—
    Pyrolusite, Tenycape Manganese mines, Hants county, N.S.
11. Montpetit, A. N., Ottawa, Ont. :—
    Chromic iron ore, from block A. and B. Black lake, Coleraine, Megantic county, Que.
12. Nellis, T. F., Ottawa, Ont. :—
    Phlogopite with actinolite, from lot 10, range XII. of the township of Hull, Ottawa county, Que.
13. New Glasgow Iron, Coal and Railway Co,. Ltd., Ferrona, Pictou county, N.S., per R. E. Chambers :—
    Numerous specimens of limonite, manganese ore and barytes.
14. Ogilvie, William, Ottawa, Ont. :—
    A group of calcite crystals from the Arctic coast, immediately west of the Mackenzie river delta. Collected by Count E. de Sainville.
15. Scott, Walter, Illecillewaet, B.C., per Dr. H. M. Ami :—
    (*a*) Steatite with dolomite, from near Ross Peak, six miles east of Illecillewaet, West Kootanie district, B.C.
    (*b*) Actinolite, from Illecillewaet, West Kootanie district, B.C.
16. Topley, H. N., Ottawa, Ont. :—
    Garnet crystals from Queen Charlotte Islands, B.C.
17. Wertheim, E., Coleraine, Que., per Dr. R. W. Ells :—
    Aragonite on chrysotile, from lot 27, range B. of Coleraine, Megantic county, Que.

Contributions to museum—*Cont.*

18. Willimott, C. P., & Co., Ottawa, Ont. :—

(*a*) Garnet, from Wakefield, Que., two specimens, cut and polished.

(*b*) Vesuvianite, from Harrington, Que. Two specimens, cut and polished.

(*c*) Tourmaline, from Wakefield, Que. Two specimens, cut and polished.

(*d*) Apatite, from Portland, Que. One specimen, cut and polished.

(*e*) Amethyst, from Lake Superior, Ont. One specimen, cut and polished.

19. Wilson, J. A., Hudson's Bay Co., Rigolet, per A. P. Low.

A specimen of labradorite, from Isle St. Paul, Labrador.

Educational collections supplied.

"Mr. C. W. Willimott's time has been largely occupied in making up collections of minerals for various Canadian educational institutions.

"The following is a list of those to which such collections have been sent :—

1. High School, Meaford, Ont	consisting of	139	specimens.
2. Collegiate Institute, Goderich, Ont	"	139	"
3. Cowansville Academy, Cowansville, Que	"	100	"
4. High School, Windsor, Ont	"	139	"
5. Grammar School, Woodstock, N.B	"	100	"
6. High School, Fredericton, N.B	"	139	"
7. Academy of Bedford, Bedford, Que	"	100	"
8. Collegiate Institute, Woodstock	"	139	"
9. High School, Orangeville, Ont	"	136	"
10. Model School, Magog, Ont	"	100	"
11. High School, Welchpool, Campobello, N.B.	"	139	"
12. McMaster University, Toronto, Ont	"	185	"
13. Moulton Ladies College, Toronto, Ont	"	100	"
14. St. François Xavier College, L'Islet, Que	"	136	"
15. Woodstock College, Woodstock, Ont	"	139	"
16. St. Mary's Girl School, Halifax, N.S.	"	100	"
17. Superior School No. 5, Gaspereaux Forks, N.B		136	"
18. Public School, Bathurst, N.B.	"	100	"
19. Couvent des Sœurs de la Présentation de Marie	"	100	"
20. Grammar School, Sheffield, Sunbury county, N.B	"	100	"
21. Dunham Academy, Dunham, Que	"	100	"
22. Collegiate Institute, Collingwood, Ont	"	136	"
23. Sisters School, Chatham, Miramichi, N.B.	"	100	"
24. Public School, Olinda, Ont	"	100	"
25. Grammar School, St. John, N.B	"	136	"
26. Commercial College, St. Joseph de Lévis, Que	"	135	"
27. Belleville Institute, Belleville, Que	"	136	"
28. Public School, Scarborough Junction, Ont.	"	100	"
29. Academy, Port Rowan, Ont	"	100	"
30. Superior School, Bloomfield, King's Co., N.B.	"	136	"
31. Lachute Academy, Lachute, Que	"	100	"
32. Convent Museum, St. Laurent, Que	"	100	"

Educational collections supplied.

33. High School, Wardsville, Ont	consisting of	136	specimens.
34. Institut Canadien, Ottawa, Ont	"	136	"
35. Superior School, Dorchester, N.B	"	135	"
36. High School, Milltown, Charlotte Co., N.B.	"	134	"
37. Superior School, Tracadie, N.B	"	135	"
38. Alexandria Public School, Halifax, N.S.	"	100	"
39. Collegiate Institute, Galt, Ont	"	133	"
40. Young Men's Academy, Sherbrooke, Que	"	103	"
41. Normal School, Ottawa	"	135	"
42. Normal School, Toronto, Ont	"	100	"
43. Collegiate, Institute, Ottawa, Ont	"	136	"
44. Collegiate Institute, Strathroy, Que	"	136	"

"Collections have also been prepared and forwarded to:—

Banff Museum, Banff	consisting of	200	specimens.
Mid-winter Fair, California	"	81	"
St. Mary's Academy, Ogdensburg, New York State, U.S.A.—by special request	"	103	"
State University, Munich, Germany—Prof. Groth; in exchange	"	82	"

"Making a total of 5,830 specimens, aggregating over two tons in weight of material.

Collecting of minerals.

"In addition to the foregoing work, Mr. Willimott visited, during the latter part of the summer, with the object of procuring further material for the making up of collections, and simultaneously, cabinet specimens for the Museum—the townships of Wakefield, Hull, Templeton, Portland, Augmentation of Grenville, Harrington, Bolton, Coleraine, Ireland, Thetford, and Broughton, in the province of Quebec; Sebastopol, Dungannon and Herschell, in the province of Ontario.

"In the prosecution of this work he has succeeded in collecting a large and varied assortment of minerals, and at the same time made many interesting and useful observations in regard to their mode of occurrence. The collection comprised:—

	Specimens.	Weight.
Actinolite	20	
Apatite, crystals	87	
Apatite in calcite	77	
Biotite	40	
Bornite	10	
Chrome garnet in diopside and calcite	20	
Chromite	5	150 pounds.
Chlorite	30	
Chloritoid schist	10	50 "
Chrysotile	40	
Chrysotile in serpentine	3	60 "
Diorite	65	
Epidote with garnet	70	
Garnet	100	
Garnetiferous gneiss	50	

Collecting of minerals.

	Specimens.	Weight.
Gneiss	57	
Grossularite	100	
Idocrase	125	
Limestone, crystalline	80	
Magnesite	3	100 pounds.
Orthoclase	24	
Phlogopite, crystals	98	
Phlogopite with calcite, etc	50	
Rutile	60	
Serpentine, from Bolton	40	
Serpentine, from Coleraine	1	100 "
Scapolite	67	
Sodalite	120	150 "
Strontianite	53	
Wernerite	50	
Wollastonite in calcite	80	
Miscellaneous	100	
Total specimens collected	1,735	

" Amongst the foregoing were many exceptionally handsome cabinet specimens."

LITHOLOGY.

Lithology.

Mr. W. F. Ferrier, lithologist, reports on the work of the past year as follows :—

" Early in January, the special stratigraphical collection of Canadian rocks prepared for the Chicago Columbian Exposition was returned, unpacked, and placed in cases in the museum. This involved some labour, as the old museum cases were removed and replaced by those used for the special collection at Chicago, which are of better pattern. At the same time the collection of rocks already in the museum was thoroughly gone over, and a great many duplicate specimens removed. We now have an excellent series of Canadian rocks from the lowest Archæan to the Post-Pliocene, the Archæan being especially well represented. The printed catalogue prepared for the Chicago collection adds largely to its usefulness, permitting of a ready reference to any rock in this collection.

" Reports have been prepared for publication on the microscopical character of a large series of Archæan rocks collected by Mr. Tyrrell from the vicinity of Lake Winnipeg, and on the rocks collected by Dr. Dawson in the Kamloops district, British Columbia. Additional sections have been made of the rocks of the Sudbury district collected by Mr. A. E. Barlow, and it is hoped soon to have the notes on these completed, and added to those already prepared. Work has also been commenced on the series of rocks collected by Mr. Barlow from the

regions covered by the Nipissing and Temiscaming sheets, Nos. 131 and 138 respectively, of the Ontario geological maps. Lithology—*Cont.*

"The work on Mr. Ingall's rocks from Ottawa county is also proceeding, and will soon be brought to completion, while the collections of rocks brought in by Mr. Low from Labrador have been looked over, and some thirty of the more interesting ones have been selected to be cut and examined.

"A collection of Canadian rocks is being prepared for McGill College, also a small series of typical Archæan rooks for Prof. H. A. Nicholson, of the University of Aberdeen. A few specimens of lithographic stone and other rocks have been sent to the Director of the Geological Survey of Newfoundland at his request, for comparison with similar specimens there. Prof. Groth, of Munich, having presented a valuable named series of about 100 German and Austrian rocks, a collection of Canadian Archæan rocks is being prepared for him in exchange. These foreign rocks are especially useful for reference in the determination of Canadian specimens, as the majority of them are from typical localities, and their stratigraphical and petrographical relations have been fully described in various publications.

"As usual, much work of a miscellaneous character has been carried out, including microscopical and blowpipe examinations of various building stones, clays, sands, gravels and minerals handed to me from time to time during the year.

"Owing to the rapid increase in the collection of thin sections of rocks, it has become desirable to arrange these in such a way as to be readily accessible to any one wishing to consult them. With this end in view, I have commenced to re-label and arrange these sections, giving to each a number, by which it can at once be identified. When the work is completed, they will be placed in a special cabinet and a catalogue prepared."

MINING AND MINERAL STATISTICS.

Mr. E. D. Ingall, reports as follows on this work, under his charge, which, since the report for last year has been prosecuted on the usual lines. Mineral statistics.

"The earlier months of 1894 were occupied with the collection of statistical and other data for the report on mining in Canada during 1893, including the compilation and revision of a very large amount of scattered material and its concentration in the final form in which it appears in the report.

Mineral statistics—*Cont.*

"A preliminary summary of the mineral production for 1893, was prepared by the 5th April, and issued shortly afterwards.

"Owing to the lack of funds, the usual field work could not be undertaken. So that proposed investigations of a number of important mining experiments which were being prosecuted in various parts of the Dominion had to be postponed. The same cause further delayed the printing of the report for 1892. This was, however, accomplished later and the proof-reading connected therewith was done during the latter months of the year.

"Much of the time which would under ordinary circumstances have been devoted to field work, was employed in the classification of our reports, plans and other available information relating to individual economic mineral deposits throughout the Dominion. This has been largely accomplished, and we have now the nucleus of a series of records of mines and mineral deposits, which can be continually added to, arranged for easy and ready reference.

"In July I attended the combined meeting of the Quebec and Nova Scotia Mining Associations held at Sydney, Cape Breton, and was hereby able to extend my personal acquaintanceship with the mining districts and operations. Visits were made to a number of the collieries as well as to the Coxheath copper mines.

"In the latter part of the year, the usual preparations were begun for issuing the circulars, &c., necessary for the collection of information of mining operations.

"As in past years numerous memoranda were prepared in answer to the inquiries of correspondents, some of which, from their wide scope took much time.

"Messrs. H. P. Brumell and L. L. Brophy, have, as heretofore, rendered efficient assistance in various branches of the work above referred to."

PALÆONTOLOGY AND ZOOLOGY.

Palæontology and zoology.

Mr. Whiteaves reports as follows upon the work done in these branches of the department:—

"The letterpress of the second part of the third volume of 'Palæozoic Fossils,' referred to in the Summary Report of 1893, as having been commenced, has been completed and is now ready for publication. The part, as completed, is a monograph of the fossils of the Guelph formation of Ontario, consisting of about seventy pages of closely written foolscap, and will be illustrated by seven full page lithographic plates,

which have been drawn on stone by Mr. O. E. Prudhomme, from original drawings made by Mr. L. M. Lambe. Palæontology.

"Through the kindness of the President and Fellows of the Geological Society of London, the Cretaceous fossils collected by Sir James Hector, in various parts of Manitoba, the North-west Territories and British Columbia, during Captain Palliser's exploring expedition in 1857–60, have been lent to the writer for examination and study. A paper, in which the species represented in these collections are identified in accordance with the present state of our knowledge of the fossils of the Cretaceous rocks of North America, has been prepared for publication in the Transactions of the Royal Society of Canada for 1894. Sir J. Hector's fossils.

"In 1883, Mr. Walter Harvey, of Comox, V.I., made an unusually interesting collection of fossils, from the Cretaceous rocks of Hornby and Denman Islands, in the Strait of Georgia, which has been acquired by the Natural History Society of British Columbia. This collection has been lent to the writer by the society's curator, Mr. John Fannin, and Mr. Harvey has supplemented it by the loan of an additional collection made by himself in the fall of 1874, at Hornby Island. A paper descriptive of some of the more important species in these collections, has been written for the current volume of Transactions of the Royal Society of Canada, and specimens of each of the previously undescribed forms have been presented to the museum of the Survey. Dr. C. F. Newcombe, of Victoria, B.C., has kindly sent to the writer an interesting series of Cretaceous fossils collected by himself at the Sucia Islands in the spring of 1894. This collection contains a few forms that are either new to science or new to the Cretaceous fauna of these islands, especially a fine new species of *Cypræa*, and a list of the (thirty-four) species represented has been made and forwarded to Dr. Newcombe. The information gained from an examination and study of all these collections will be incorporated into the fourth and concluding part of the first volume of 'Mesozoic Fossils,' which is intended to consist of a revision of the fauna of the Queen Charlotte and Vancouver groups of islands, and which, it is hoped, will be completed in the spring. A preliminary examination has also been made of some Triassic fossils recently collected by Dr. G. M. Dawson, at several localities in British Columbia, and of small collections of Tertiary and Post-tertiary fossils made last summer by Dr. Newcombe at Carmanah Point and Sooke, V.I., and at the Sucia Islands. Fossils from British Columbia.

"As will be seen by the detailed list which follows, the number of additions to the zoological series in the museum during the past year has been unusually large. Among them, are a good example of Zoological collections.

Zoological collections.

the wapiti, two tusks of the narwhal, and a magnificent specimen of a large and probably undescribed alcyonarian, nearly three feet in height, collected at Work Inlet, near Port Simpson, B.C., and presented by Mr. O. J. Klotz. At the close of 1893, the Survey's series of the eggs of Canadian birds numbered not quite 100 species. Professor Macoun's extensive collections of this year in Assiniboia, have increased this number by sixty-four, and, in exchange for some of his duplicates, eggs of some thirty-five additional species have been obtained from Mr. Walter Raine. Mr. Low, also, during the spring of 1894, obtained an interesting series of bird's eggs from the Hamilton River, Labrador, including those of the American merganser, black duck, spruce partridge, osprey and Canada jay. The whole series, which now consists of upwards of 200 species, has been classified and labelled so as to be available for reference. In the fall, Professor Macoun made collections of the land and fresh water mollusca, but more particularly of the Unionidæ, of south-western Ontario. Since receiving these, the writer has prepared a systematic list of all the recent Unionidæ in the museum of the Survey, for publication in the 'Canadian Record of Science.' It gives the names of all the species known to occur in the Dominion, and to ensure as much accuracy as is attainable, specimens of most of the nominal species of *Anodonta*, and a few of the more critical forms of *Unio* have been kindly compared by Mr. Charles T. Simpson, with Dr. Lea's types of North American Unionidæ in the United States National Museum at Washington. The whole of the Survey's rather extensive collection of Canadian land and fresh water shells, too, has been re-labelled in accordance with the latest nomenclature. While attending the meeting of the American Association for the Advancement of Science, at Brooklyn, about eighty species of shells were obtained for the museum, in exchange for some of its duplicates. Two mammals, forty-seven birds, two turtles, and one snake, have been mounted by Mr. S. Herring, who has, as usual, gone over and cleaned all the mounted vertebrates in the museum. The collection of mounted birds and mammals which has been in course of preparation for the museum in connection with the Rocky Mountain Park at Banff, is now nearly completed and will shortly be despatched to its destination. It consists of eight specimens of Canadian mammals, and 259 Canadian birds, and a turtle, all of which have recently been mounted upon suitable stands and properly labelled.

Work by Mr. Weston.

"Mr. T. C. Weston, from the first of January to the seventeenth of March (when he received his leave of absence) was occupied in museum work in the palæontological and ethnological collections, in labelling and arranging new specimens, in checking off

the specimens and models of gold returned from the World's Fair at Chicago, and reproducing such models as were not returned, in making numerous microscopic sections of rocks and fossils, &c. Previous to his superannuation on the first of August, he was granted four months leave of absence, and during most of this time he employed himself in collecting numerous fossils for the museum, from the Quebec group in and near Quebec city. Palæontology.

"The greater part of Dr. Ami's time has been occupied in determining the numerous collections of fossils brought in by officers of the department and others. Lists of the organic remains found associated with the ores of the Trunk Road Iron mine at Arisaig, Antigonish county, and those of the Nictaux iron ore district in Annapolis county, Nova Scotia, were prepared to supplement geological investigations recently carried on by Mr. Hugh Fletcher and Dr. L. W. Bailey in that province. A palæontological appendix to Dr. Ells's report on the geology of the south-western portion of the province of Quebec has been almost completed. This will contain lists of the species contained in the collections made by Dr. Ells, Dr. W. E. Deeks, Messrs. J. F. Whiteaves, T. C. Weston, the late James Richardson and others, from the Eastern Townships, between Lake Champlain, Lake Memphremagog and Montreal. Work by Dr. Ami.

"Early in the year some 300 specimens of Canadian and foreign fossils were determined and labelled for the authorities of the museum of St. Laurent College, Montreal. A smaller collection sent by Mr. H. H. Blanchet was also determined and returned during the past year. The contents of the unclassified boxes of duplicate specimens in the largest room in the basement have been arranged chronologically and according to the provinces in the Dominion, and not much less than one thousand specimens of fossils were placed in the drawers of duplicate specimens (available for collections), which are fast being exhausted. Lists have been prepared of such of the fossils in the museum as are still unlabelled. A manuscript bibliography of Canadian palæontology has been continued, which will soon be completed and brought up to date. Records of additions to the palæontological and ethnological collections have been kept.

"Systematic lists of fossils were prepared as follows: Lists of fossils prepared.

For Dr. R. W. Ells:—Specimens from nine localities in the south-western portion of the Province of Quebec.

For Mr. T. C. Weston:—Specimens from several localities in or near the City of Quebec.

For Mr. McInnes:—Specimens from Campement d'Ours, Lake Huron.

Palæontology —*Cont.*

For Dr. R. Bell :—Specimens from fourteen localities in the Manitoulin Islands and Georgian Bay, Ont.

For Mr. N. J. Giroux :—Specimens from thirteen localities in the vicinity of Joliette, Que.

For Mr. Hugh Fletcher :—Specimens from six localities in various parts of Nova Scotia.

For Dr. L. W. Bailey :—Specimens from eight collections in the Nictaux and Moose River districts of Nova Scotia.

Some miscellaneous collections from twenty-four localities in Ontario, Quebec, New Brunswick, Nova Scotia and Newfoundland.

"A preliminary study has also been made of the large collection of Silurian fossils collected by Mr. A. E. Barlow at Lake Temiscaming, of several collections of graptolites from the Eastern Townships, Rocky Mountains, Lower St. Lawrence, &c., collected by officers of the Survey and others.

Collections of fossils supplied.

"Collections of duplicate fossils have been sent to the following educational institutions in the country, or in exchange for other specimens :

1. Montreal High School, Montreal, Que. Collection of fossil plants from the coal formations of Canada.
2. Michigan University, Ann Arbor, for Dr. Carl Rominger. Specimens of *Prototaxites Logani*, Dawson.
3. Provincial Museum of British Columbia. 169 specimens.
4. Prof. S. Calvin, State Geologist, Iowa. 156 specimens of Canadian fossils, in exchange for Devonian fossils received.
5. Mount St. Louis Academy, Montreal, Que. General collection 247 specimens.
6. Clarenceville Academy, Clarenceville, Que. General collection 220 specimens.
7. Shelburne Academy, Shelburne, Nova Scotia. General collection 320 specimens.
8. Peter Redpath Museum, McGill University, Montreal, Que. Middle Cambrian fossils from British Columbia, 23 specimens.
9. Rocky Mountain Park Museum, Banff, Alberta. Collection of Rocky Mountain fossils from Mt. Stephen and Anthracite. 23 specimens.
10. Museum of the Provincial University of Manitoba, Winnipeg, Man., 156 specimens, chiefly Devonian fossils from Lake Winnipegosis.

"The collection of fossils prepared last year for the World's Columbian Exposition, Chicago, was this year forwarded to the Ontario School of Mining, Kingston. Palæontology —*Cont.*

"Collections have been submitted during the year to the following gentlemen for examination:—

"A series of sixty-one specimens of Canadian Palæozoic Ostracoda to Prof. T. Rupert Jones, F.R.S., London, the best authority on these minute organisms; a collection of fifty specimens of Pleistocene plants submitted to Sir J. W. Dawson, F.R.S., of Montreal, and a few specimens to Prof. C. D. Walcott and T. W. Stanton, Washington, D. C.

"During the past year Mr. Lambe has concluded a detailed study of the recent marine sponges of the North Pacific coast of America from British Columbia to the Arctic Ocean. These studies, begun in 1892, were mainly based upon collections made by Dr. Dawson in British Columbia and Behring Sea and recently supplemented by important material from Alaska, &c., collected by Dr. W. H. Dall and loaned by the Smithsonian Institution, and by some specimens obtained by Professor Macoun in 1893 off the coast of Vancouver Island. Two papers descriptive of the species represented in Dr. Dawson's collections, have been published in the Transactions of the Royal Society of Canada for 1892 and 1893, and this year these have been supplemented by a paper descriptive of the sponges collected by Dr. Dall, which will appear in the current volume of the same publication. This last paper consists of detailed descriptions of twelve apparently new species, and determinations of twenty others from seventy-one localities. The paper is illustrated by three quarto plates. Work by Mr. Lambe.

"He has also been engaged in assisting the writer in ascertaining the characters and relations of certain fossils from the Guelph formation of Ontario and of some fossils from the Cretaceous rocks of the Pacific Coast, and in making drawings of some of them to illustrate the reports or papers already mentioned.

"In October last, at the writer's suggestion, he began a study of Canadian fossil corals, having for its object a revision of this important and imperfectly understood group, and the discovery of any new facts that may throw light upon stratigraphical problems or be of interest to the systematic palæontologist.

"The following is a list of specimens collected by officers of the Survey during the year 1894:— Contributions to Museum.

Dr. G. M. Dawson:—

About forty specimens of Triassic fossils, fifty of Tertiary plants, eighteen of Tertiary insects, from British Columbia, and a few fossils from the Laramie of Highwood River, N.W.T.

Contributions to museum—*Cont.*

A number of Indian arrow and spear heads from British Columbia. Indian pipe from Nicola, B.C.

Professor Macoun :—

1,000 eggs of sixty-four species of Canadian birds, over 300 skins of birds and small mammals, about twenty species of fishes, a large series of reptiles, twenty-seven species of butterflies, and twenty-five species of land and fresh water shells from western Assiniboia, also a large series of land and fresh water shells from south western Ontario.

Dr. R. W. Ells and N. J. Giroux :—

Twenty-seven species of fossils from the Township of Nepean, Carleton, Ont., nineteen from the Trenton limestone at Hull, Que., thirty from the Trenton limestone at Hog's Back, Nepean, Ont., and three small slabs of fossils from Gloucester Township, Ont.

Hugh Fletcher :—

Seventeen specimens of Silurian fossils from the Trunk Road Iron Mine, Arisaig, N.S. About twenty specimens of Cambro-Silurian fossils from McNeil's Brook and Doctor's Brook, Arisaig, N. S.

R. Chalmers :—

Eighty specimens, representing about twenty species, of shells from the Leda Clay of the Baie des Chaleurs region. About a dozen specimens of four species of shells from the boulder clay at Negrotown Point, St. John, N. B.

A. P. Low :—

Eggs of fourteen species of birds from the Hamilton River, Labrador.

Two nests and eggs of Canada jay from Hamilton Inlet.

One skeleton each of the wolverene and lemming, three skins of the jumping mouse, one skin and skeleton of field mouse, twenty bird skins, and two skins of the land-locked salmon; all from the Hamilton River.

Collection of shells from Hamilton Inlet.

Seven small species of fossiliferous, bituminous and shaly limestone from Port Burwell, Cape Chidleigh, Labrador (loose).

J. McEvoy :—

Two stone pestles from Kamloops, B. C.

T. C. Weston :—

One hundred specimens of fossils from the *Shumardia* limestones at Point Lévis, Que., and one hundred and fifty from the limestones at Québec city.

Contributions to museum—*Cont.*

Dr. H. M. Ami :—

About sixty specimens of fossils from Sargent's Bay, Lake Memphremagog, fifty from the Trenton quarries at Hull, Que., and twenty specimens of *Scolithus* from the Potsdam sandstone of Carleton, Ont. A collection of Pleistocene shells from the railway cutting near Gilmour's grove, Chelsea, Que.

Specimen of the Jumping Mouse (*Zapus Hudsonicus*), from Tuck's Landing, Lake Memphremagog.

Dr. H. M. Ami and L. M. Lambe :—

About one hundred specimens of fossilferous nodules from Besserer's wharf, near Ottawa, Ont.

L. M. Lambe :—

One specimen of a star-fish from the Trenton limestone of the Ottawa district.

A. E. Barlow :—

500 specimens of Silurian fossils from the shores and islands of Lake Temiscaming.

One arrow head from Lake Temiscaming.

Hugh Fletcher and Dr. Bailey, per Dr. A. H. McKay :—

Fifteen collections of fossiliferous rocks and fossils from the Nictaux iron ore district, Annapolis county, N.S.

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

"*By presentation* :—

Sir J. W. Dawson, Montreal :—

Five specimens of *Pupa vetusta* and one of *Pupa Bigsbyi* from the South Joggins, Nova Scotia.

Five photographs of Carboniferous land shells from Canada and the United States.

Specimens of five species of *Naiadites* and *Anthracomya* from Nova Scotia and Cape Breton.

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

Thirty-one specimens of fossils from the Clinton and Niagara formations at Hamilton, Ont.

Thos. G. Connon, Brocton, N.Y. :—

Fine specimen of *Orthoceras Scammoni*, McChesney, from the Guelph formation, Elora, Ont.

Contributions to museum—*Cont.*

J. A. Valin, Ottawa :—

Two pyritized *Orthoceratites* (probably *Endoceras proteiforme*) from the Utica shale, near Ottawa.

C. Constantine (Mounted Police) :—

Molar of Mammoth, from the Yukon river, near Nulatto.

J. A. Dresser, B.A., Aylmer, Que. :—

Three fragmentary specimens of *Pentamerus Knightii*, from Dudswell, Que.

Otto J. Klotz, Ottawa :—

Tooth of Killer whale.

Four species of Cretaceous fossils, from Moose Jaw or Great Bend Creek, Manitoba.

Fine specimen of an Alcyonarian, from Work Inlet, near Port Simpson, B.C.

Dr. C. F. Newcombe, Victoria, B.C. :—

Two rare species of Cretaceous fossils, and five from the Pleistocene of the Sucia Islands, Gulf of Georgia.

Walter Harvey, Comox, B.C. :—

Five species of Cretaceous fossils, from Hornby Island, B.C.

One rare species of Buccinum, from Alert Bay, B.C.

W. A. Fraser, Toronto, Ont. :—

Specimen of *Placuna placenta*, from Trincomalee.

Twenty specimens of Burmese shells.

W. E. Saunders, London, Ont. :—

One female Musk Turtle (*Aromochelys odoratus*), and one small Map Turtle (*Malacoclemys geographicus*) from Rondeau, Ont.

Fine living example of the "Blowing Viper" or Hog-nose Snake (*Heterodon platyrhinus*, Latreille), from London, Ont.

Richard Lake, Grenfell, Assa. :—

Eggs of fifteen species of Canadian birds, from Assiniboia.

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

Fine specimen of *Zirphœa crispata*, L., from Tacoma, Wash.

W. Borthwick, Ottawa :—

Live specimen of a scorpion, found among bananas.

Alex. Crowe, Ottawa :—

Nest and one egg of Chimney Swift (*Chœtura pelagica*), from near Ottawa.

A. G. Kingston, Ottawa :—

Nineteen specimens of eggs of ten species of Canadian birds.

Contributions to museum—*Cont.*

A. McL. Hawks, Tacoma, Wash. :—

Three fine specimens of *Zirphœa crispata*, from Tacoma, Wash.

Ambroise Charbonneau, Hull, Que. :—

Two enteroliths from gut of Sucker caught in the Madawaska

Jean Parent, Billing's Bridge, Ont. :—

One young Red-tailed Hawk (*Buteo borealis*).

James Fletcher, Ottawa :—

Three specimens of *Planorbis nautileus*, var. *cristatus*, from ponds at St. Louis dam, Ottawa.

C. Esdale, Ottawa :—

Albino European House Sparrow (*Passer domesticus*) from New Edinburgh.

John McMenomy, Jun., Metcalfe, Ontario :—

Male American Hawk Owl (*Surnia ulula caparoch.*)

Dr. C. J. H. Chipman, Ottawa :—

Saw-whet Owl *(Nyctale Acadica).*

Duncan Mathewson, Ungava Bay, per A. P. Low :—

Two tusks of the Narwhal.

Collection of Eskimo carved ivory.

J. A. Wilson, Rigolet, per A. P. Low :—

Skin of Ivory Gull.

H. M. S. Cotter, North-west River, Hamilton Inlet, per A. P. Low :—

Collection of Esquimaux carved ivory.

Model of Eskimo kayak.

Two bird skins.

Joseph Michelin, North-west River, per A. P. Low :—

Skin of Jumping Mouse.

Skin of Flying Squirrel.

John Grey, Pembroke, Ont. :—

Indian spear head of white jasper, from the Petewawa River.

C. D. Graham, Ottawa :—

Iron axe head and iron ramrod, Grand Lake, Gatineau valley.

John Perry, Aylmer, P.Q. :—

Arrow head found above Aylmer.

A. B. Clark, Shuswap, B.C. :—

Mortar, found in bank of South Thompson River.

Pestle, South Thompson valley.

Contributions to museum—*Cont.*

Capt. Bloomfield Douglas :—

Stone arrow-head found near Forteau Bay, Labrador.

J. S. Larke, Commissioner for Canada, World's Columbian Exposition, Chicago :—

Ancient Indian pottery from Kansas, U.S.A.

J. Ballantyne, Ottawa :—

Stone gouge, found in Graham's brick yard, Ottawa.

Rev. D. Jennings, M.A., Port Essington, B.C. :—

Medicine man's charm.

By Exchange :—

Eggs of thirty-five species of Canadian birds.

Eighty species of exotic shells.

By Purchase :—

Twenty Cretaceous fossils from the North-west Territories.

NATURAL HISTORY.

Natural history.

Under this head Professor Macoun reports as follows :—

"After the date of my last summary report, I was for some time occupied in completing the examination of the collections made on Vancouver Island and in bringing up to date the catalogue of Canadian birds, which was accomplished before I took the field last May.

Fauna and flora of the North-west.

"It was decided that the past summer should be the first of several seasons devoted to field work on the fauna and flora of the North-west, where many gaps in our knowledge remain to be filled, before it will be possible to give a collective account of the natural history of that great country. With this purpose in view, Mr. William Spreadborough was instructed to proceed to Medicine Hat, Assiniboia, on the first of April, and commence work by securing skins of the birds which pass that point during their spring migration. Mr. Spreadborough is well fitted for this work, as in addition to his previous knowledge of birds he had acted as field assistant for me every season since 1889. In 1891 he was stationed at Banff early in the season, in 1892 at Indian Head, and if possible it is intended to station him at Moose Jaw or some other suitable point in the spring of 1895. When this work has been completed, it will be possible to trace the main lines of migration of the various species as well as their distribution in longitude.

"On May 30th I joined Mr. Spreadborough, and after a few days spent in the vicinity of Medicine Hat and Lethbridge, we, on June 8th, moved camp to Crane Lake, eighty miles to the eastward. Crane

Lake was chosen as a collecting and observing point because of the numerous lakes and marshes in that vicinity about which many species of water-fowl and waders were breeding. Within a radius of ten miles, we collected the eggs of sixty-four species of birds and made notes of their nesting habits. A complete list of the plants growing in that neighbourhood was also made, and specimens of over 300 species were collected. Fourteen days were spent in this work and on June 22nd, we drove out to the North Branch of Swift Current Creek, in Cypress Hills, a distance of twenty miles, and collected there until the 30th, when we returned to Crane lake. Here I found, to my great regret, instructions waiting me to close the field work and return to Ottawa, which was accordingly done. Natural history—*Cont.*

"My collections for the season consisted of over 500 species of plants, about 1000 eggs, and over 300 skins of birds and small mammals; about twenty species of fishes, and twenty-seven species of butterflies. All but the bird skins, which were collected earlier in the season, were the result of five weeks work. Further collections, including one of 550 species of plants, were made in the vicinity of Ottawa during the latter part of the summer. Collections made.

"During the spring of this year, I examined collections of plants made by Mr. Jas. Tyrrell in the Barren Grounds, Mr. James Bain at Laggan in the Rocky Mountains, Mrs. Brodie in the neighbourhood of Quebec and Toronto, and by Mr. John Moser in New Brunswick, besides many smaller collections. This autumn I have examined and named over 1,000 species of our own collecting, those collected by Mr. A. P. Low, in Labrador, a collection from the region of the Canada-Alaska boundary made by Mr. Otto Klotz and one of his assistants Mr. Canavan, and a collection from Niagara Falls by Mr. Roderick Cameron. Collections of plants examined.

"For some years past the greater part of the work connected with the determination of flowering plants and their arrangement in the herbarium has been in charge of my assistant Mr. James Macoun, but during his absence on special service in connection with the Behring Sea Commission this work fell considerably into arrears. On his return to this Department in July, 1893, most of the collections of 1891 and 1892 had still to be worked over, and this occupied the greater part of the winter months. A certain number of duplicates were also arranged by him for distribution. Two of the herbarium cases were also re-arranged in a permanent manner. This work will be continued as time permits. Herbarium.

"Since December 31st, 1893, 2,808 sheets of botanical specimens have been sent to scientific institutions and individuals, for the most

Natural history—*Cont.*

part in exchange for specimens received for our herbarium. The herbaria to which the largest number of specimens were sent, are :—

British Museum	379
United States National Museum	260
University of California	358
Kew Gardens	177
Harvard University	451
Columbia College	349
San Francisco Academy of Sciences	200

Exchanges of plants.

"Specimens have been received from all the institutions mentioned above with the exception of the British Museum and Kew. In addition to these, many valuable contributions have been received from individuals and institutions not included in the above list. Among the more important of these is an almost complete series of the flowering plants of Norway, consisting of 1,257 species from the Botanical Museum at Christiania; more than 1,000 species of cryptogams from the herbarium of the distinguished bryologist, Dr. Lindberg; a full set of the algæ of Greenland, from the University of Copenhagen, which completes the collection of the flora of Greenland, sent us from Copenhagen; 400 species of fungi from Dr. Ellis, and smaller collections from New South Wales and Natal. It still remains to supply Canadian specimens in exchange for most of the above collections, and until this has been done I cannot avail myself of further advantageous offers of exchange, received.

"The arrangement of the collections of plants and birds intended for the museum of the Rocky Mountain Park, at Banff, Alberta, has also occupied some time. These collections constitute an almost complete representation of the birds and flowering plants found within the limits of the park."

Report by Mr. J. Fletcher.

Mr. James Fletcher, in charge of the entomological collections, makes the following report upon them :—

"I have to report that the collections are all in an excellent state of preservation, and that valuable additions have been made during the past year. The most important of these are the following :—

1. A collection of Coleoptera containing many rare and little known species from the Queen Charlotte Islands and the adjacent part of British Columbia. This collection was made by Rev. J. H. Keen, of Massett, Q.C.I., and contains over two hundred species, most of which are worked out and mounted ready for the cabinets.
2. A general collection of insects made chiefly by Mr. Otto Klotz; but also by other members of the Canada-Alaska boundary survey.

3. Collections of Lepidoptera made by Prof. Macoun and Mr. J. McEvoy, in Assiniboia and the Kamloops district of British Columbia respectively. Entomological collections.
4. A collection of Lepidoptera and Coleoptera, made by Mr. A. P. Low, in Labrador. This is a small collection, but contains some very interesting species.
5. A small collection made by J. C. Gwillim, at Moose Jaw, N.W.T., and Wabigoon, Ont.

" With the exception of a few of the specimens in Nos. 1 and 2, in the above list, all of the insects in these collections have been identified and listed, and are ready for arrangement in the cabinets.

" In addition to the above, type specimens of three new species of Orthoptera have been received from Mr. A. P. Morse, of Wellesley, Mass., viz., *Spharagemon æquale*, Say sub-sp. *Scudderi*, Morse ; *S. saxatile*, Morse, *S. bolli*, Scudder."

MAPS.

Mr. James White was, on April 9th last, placed in charge of the mapping and draughting work, as successor to the late Mr. Scott Barlow, although not formally appointed till Oct. 26th. Much of his time has been occupied in rearranging the maps and plans in the office, but this cannot be successfully completed till such time as it may be possible to index and catalogue the whole. The ordinary routine work in connection with the laying down of projections and supervising the draughting generally has also been attended to. In addition, some progress has been made toward the completion of an index of altitudes throughout Canada. Maps.

In the subjoined list, it will be observed that a number of the maps given in the corresponding list of last year as incomplete or ready for the engraver, reappear in the same condition, while considerable numbers have been added as ' ready for engraving.' This results chiefly from the small amount of money, in proportion to the work, which it has been found possible to devote to map engraving and printing during the past year. The accumulation of unpublished material of this kind is becoming a source of embarrassment and must be regarded also as a loss to the public. In addition to the maps enumerated below, there are several others which have already been compiled, but which it has not been decided to publish in their present form. There are also some for which the whole of the material has been collected, but of which it has not yet been possible to complete the compilation and draughting. Delays in publication.

Maps.

Maps in course of preparation and published during the past year :—

	Area Sq. Miles.
British Columbia, Kamloops sheet (Dr. Dawson), in hands of engraver. Scale 4 miles = 1 inch	6,400
British Columbia, Shuswap sheet (Dr. Dawson), in progress.. Scale 4 miles = 1 inch	6,400
British Columbia, West Kootanie sheet (Mr. McConnell), in progress. Scale 4 miles = 1 inch	6,400
British Columbia, exploratory survey of the Finlay and Omenica rivers (Mr. McConnell), ready for engraver. Scale 8 miles = 1 inch	7,000
Athabasca Territory and British Columbia (three sheets), to illustrate the work of Mr. McConnell, 1889-90, and extending from longitude 110° W. to 120° W. and latitude 54 N° to 60° N., ready for engraver. Scale 8 miles = 1 inch	150,000
North-eastern Manitoba, Lake Winnipeg, (Mr. Dowling), ready for engraver. Scale 8 miles = 1 inch	20,000
North-western Ontario, Sheet No. 6, Seine River Sheet, (Messrs. Smith and McInnes), ready for engraver. Scale 4 miles = 1 inch	3,456
North-western Ontario, Sheet No. 9, Lake Shebandowan sheet, (Mr. McInnes), ready for engraver. Scale 4 miles = 1 inch.	3,456
North-western Ontario, Lake Nipigon, (Messrs. McInnes and Dowling), in progress. Scale 4 miles = 1 inch	3,900
Ontario, Sheet No. 129, Mississagui River sheet, (Dr. Bell), in progress. Scale 4 miles = 1 inch	3,456
Ontario, Sheet No. 126, Manitoulin Island sheet, (Dr. Bell), in hands of engraver. Scale 4 miles = 1 inch	3,456
Ontario, Sheet No. 125, French River sheet, (Dr. Bell), ready for engraver. Scale 4 miles = 1 inch	3,456
Ontario, Sheet No. 131, Lake Nipissing sheet, (Mr. Barlow), ready for engraver. Scale 4 miles = 1 inch	3,456
Ontario, Sheet No. 138, Lake Temiscaming sheet, (Mr.Barlow), nearly ready for engraver. Scale 4 miles = 1 inch	3,456
Ontario, Kingston and Pembroke mining district, (Mr. White), ready for engraver. Scale 4 miles = 1 inch	1,700
Quebec, Lièvre River and Templeton phosphate mining district, 2 sheets, (Messrs. Ingall and White), in hands of engraver. Scale 40 chains = 1 inch	220
Quebec, N. W., quarter sheet-Eastern Townships map (Messrs. Adams and Giroux), in progress. Scale 4 miles = 1 inch.	7,100

Maps—*Cont.*

	Area Sq. Miles.
Quebec, S.W., quarter sheet, Eastern Townships map, (Dr. Ells) in hands of engraver. Scale 4 miles = 1 inch.....	7,100
Quebec, sketch map of part of Berthier, Joliette, L'Assomption, Terrebonne, Montcalm, Argenteuil and Ottawa Counties, (Dr. Adams), in progress. Scale 8 miles = 1 inch.....	3,600
Quebec, township of Brandon (Dr. Adams), ready for draughtsman. Scale 2 miles = 1 inch.....	90
Quebec, Lake St. John district (four sheets), (Mr. Low), in progress. Scale 4 miles = 1 inch.....	13,824
Quebec and North-east Territory, Labrador Peninsula, extending from the Atlantic Ocean to Hudson Bay and from river St. Lawrence to Hudson strait (Mr. Low), in progress	525,000
Quebec and North-east Territory, Labrador Peninsula (Mr. Low). Scale 150 miles = 1 inch. Published herewith.	
New Brunswick, surface geology (Mr. Chalmers), quarter-sheet 1 N. W., in progress. Scale 4 miles = 1 inch.....	3,456
New Brunswick, surface geology (Mr. Chalmers) quarter-sheet, 2 S. W., in progress. Scale 4 miles = 1 inch.....	3,456
New Brunswick, surface geology (Mr. Chalmers), quarter-sheet, 2 S. E., ready for engraver. Scale 4 miles 1 = 1 inch...	3,456
New Brunswick and Prince Edward Island, surface geology (Mr. Chalmers), quarter-sheet 5 S. W., ready for engraver. Scale 4 miles = 1 inch.....	1,500
New Brunswick and Nova Scotia, surface geology (Mr. Chalmers), quarter-sheet, 4 N. W., ready for engraver. Scale 4 miles = 1 inch	3,456
Nova Scotia, Eight sheets, Nos. 25, 26, 27, 28, 29, 30, 31 and 32, Antigonish and Guysborough Counties, (part) (Messrs. Fletcher & Faribault), were published in 1894. Scale 1 mile = 1 inch	2,304
Nova Scotia, Six sheets, Nos. 33, 34, 35, 36, 37 and 38, Antigonish and Guysborough counties, part (Messrs. Fletcher & Faribault), will be published about March, 1895. Scale 1 mile = 1 inch.....	1,738
Nova Scotia, Fourteen sheets, Nos. 39 to 52 (incl) Pictou and eastern part of Colchester and Halifax counties (Messrs. Fletcher & Faribault), ready for engraver. Scale 1 mile = 1 inch.....	3,024

Maps—*Cont.*

	Area Sq. Miles.
Nova Scotia, Twenty-one sheets, Nos. 53 to 69 (incl) 76, 82, 100 and 101, Halifax, Colchester, Cumberland and Hants counties (part) (Messrs. Fletcher & Faribault), nearly ready for engraver. Scale 1 mile = 1 inch.....	4,536
Nova Scotia, sketch map of South-western part of Nova Scotia. Prof. Bailey. Scale 8 miles = 1 inch. Published in 1894.	6,400

LIBRARY.

Publications distributed and sold.

Dr. Thorburn, Librarian, reports that during the year ending 31st December, there were distributed 5,666 copies of the Survey publications, comprising reports, special reports and maps, of these 4,077 were distributed in Canada and the balance, 1,589, were sent to other countries. It will be seen that there is a large falling off in the number distributed this year as compared with the previous year when the number sent out was 12,891. This is to be accounted for by the fact that, last year, a considerable number of certain publications were distributed gratuitously at the Chicago Exhibition, and to the further fact that no copies of the Report, Vol. VI., 1892-93, have been sent this year to our general exchange list, the printing of that volume being as yet incomplete.

Sales of publications by the Librarian during the year, including reports and maps numbered 1,707, the amount received therefor being $245.79.

Publications received.

During the year 1894, the number of publications received as donations or exchanges was 2,403, the number purchased 36, and the periodicals subscribed for, 32.

The letters received in connection with the distribution of the publications were 658, besides 784 acknowledgments.

The number of letters sent out from the library was 605, and in addition to these 615 acknowledgments were sent to our exchanges and to others from whom publications were received.

Library.

The number of books bound during the year was 99.

It may be stated that there are now in the library about 10,500 volumes, being largely of a technical character, relating to geological, mineralogical, palæontological, zoological and botanical subjects.

The annex added to the library in 1892, has been nearly filled up with books and there seems no way of further enlarging the accommodation for the library in the present building. Library.

The library is open to the public for reference during office hours, but books are not allowed to be removed from the building.

VISITORS.

During the past year, the number of visitors to the museum has been greater than ever before, amounting to 26,000, an increase of 5,000 over 1893. These include many strangers from almost all parts of the world and it is to be regretted that the dimensions and character of the present building does not admit of a more adequate and striking representation of the mineral wealth of the country. Visitors.

STAFF, APPROPRIATION, EXPENDITURE AND CORRESPONDENCE.

The total present strength of the staff, including all employees, professional and ordinary, is 51. Staff.

During the calendar year the following changes in the permanent staff have taken place :

Mr. Scott Barlow, died.

Mr. W. R. McEwan, died.

Mr. A. S. Cochrane, died.

Mr. T. C. Weston, superannuated.

Mr. James White, appointed chief draughtsman and geographer, vice Mr. Scott Barlow.

Appropriation and expenditure.

The funds available for the work, and the expenditure of the Department during the fiscal year ending 30th June, 1894, were :

——	Grant.	Expenditure.
	$ cts.	$ cts.
Civil list	50,732 50	
Geological Survey and Museum appropriation	60,182 50	
Civil list, salaries		49,212 33
Exploration and survey		36,773 84
Wages of temporary employees		17,276 19
Boring operations, Deloraine		132 00
Printing and lithography		4,856 19
Purchase of specimens		51 51
Purchase of books and instruments		834 78
Purchase of chemicals and laboratory apparatus		265 41
Stationery, mapping materials and Queen's Printer		617 35
Columbian Exhibition		2,947 45
Incidental and other expenses		1,430 42
Advances to explorers on account, 1894-95		214 63
		114,612 10
Less—Paid in 1892-93 on account 1893-94 $4,075 00		
Unpaid 30th June, 1894 1,142 92		
		5,217 29
		109,394 18
Unexpended balance Civil-list appropriation		1,520 17
do do Geological Survey appropriation		0 65
	110,915 00	110,915 00

The correspondence of the department shows a total of 9,592 letters sent, and 7,650 received.

I have the honour to be, sir,

Your obedient servant.

GEORGE M. DAWSON,

Deputy Head and Director.