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

SUMMARY REPORT

ON THE

OPERATIONS OF THE GEOLOGICAL SURVEY

FOR THE YEAR 1890

BY

THE DIRECTOR

OTTAWA
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1893

SUMMARY REPORT

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OPERATIONS OF THE GEOLOGICAL SURVEY

FOR THE YEAR 1890.

GEOLOGICAL SURVEY DEPARTMENT,
OTTAWA, 21st December, 1890.

The Hon. EDGAR DEWDNEY, M.P.,
Minister of the Interior.

SIR,—In submitting the customary annual summary of the work accomplished by the Geological Corps during the calendar year, 1890, it seems desirable to commence by stating that during the last session of Parliament the "*Act relating to the Geological and Natural History Survey of Canada and the Museum in connection therewith*," 40 Victoria, Chap. 9, was repealed and a new Act, 53 Victoria, Chap. 11, was passed, and assented to 16th May. 1890. The provisions of this Act read as follows:—

HER Majesty, by and with the advice and consent of the Senate and House of Commons of Canada, enacts as follows:—

Interpretation.

1. In this Act the expression "Department" means the Department of the Geological Survey hereby constituted.

Department constituted. Minister of Interior to preside.

2. There shall be a Department of the Civil Service which shall be called "The Geological Survey," over which the Minister of the Interior shall preside; and the said Minister shall have the management and control of the Department.

Staff of Department. To be under "The Civil Service Act."

3. The Governor in Council may appoint an officer who shall be the Deputy-Head and Director of the Department and such other officers, clerks and servants as are required for the proper conduct of the business of the Department, all of whom shall hold office during pleasure, and shall be appointed and classified under Schedule A of

"*The Civil Service Act;*" and in accordance with and under the terms of section six of the said Act:

Technical officers.

2. Such officers of the Department as are continuously engaged in the prosecution of original scientific work or investigation shall be classified as technical officers, under class (*b*) of Schedule A of "*The Civil Service Act,*" and the Governor in Council may cause to be prepared a list of such officers of the Department as are considered to be entitled to be thus classified with any designations that may be deemed expedient to indicate the scientific work in which they may be engaged.

Governor in Council may confer designations.

Qualification requisite in certain cases.

4. No person shall, after the passing of this Act, be appointed to this Department under class (*b*) of Schedule A of "*The Civil Service Act,*" unless—

Graduates of certain institutions.

(*a.*) He is a Science Graduate of either a Canadian or foreign University or of the Mining School of London or the *Ecole des Mines* of Paris or of some other recognized science school of standing equal to that of the said universities and schools, or a graduate of the Royal Military College, and in each case only after having served a probation of not less than two years in the scientific work of the Department; or unless—

Service in Department.

(*b.*) He has served a probation of not less than five years in the scientific work of the Department; or unless—

Experience elsewhere.

(*c.*) He has had experience for the same number of years in similar work, official or otherwise, elsewhere.

Objects.

5. The duties, object and purposes of the Department shall be:—

Geology, mines, natural history.

(*a.*) To make a full and scientific examination and survey of the geological structure, mineralogy, mines and mining resources of Canada and of its fauna and flora;

Collections and arrangements thereof.

(*b.*) To maintain a museum of geological and natural history and to collect, classify and arrange for exhibition in the museum of the Department such specimens as are necessary to afford a complete and exact knowledge of the geology, mineralogy and mining resources of Canada; to collect, study and report on the fauna and flora of Canada; to carry on chemical and palæontological investigations, and to make such other researches as will best tend to ensure the carrying into effect the objects and purposes of this Act;

(*c.*) To prepare and publish such maps, plans, sections, diagrams and drawings as are necessary to illustrate and elucidate the reports of surveys and investigations ; Maps, &c.

(*d.*) To collect and to publish, as soon as may be after the close of the calendar year, full statistics of the mineral production and of the mining and metallurgical industry of Canada ; to study the facts relating to water supply, both for irrigation and for domestic purposes, and to collect and preserve all available records of artesian and other wells, and of mines and mining works of Canada. Statistics. Water supply.

6. The Deputy-Head and Director of the Department shall, as soon as may be after the close of each calendar year, make a summary report to the Minister, of the proceedings and work of the Department for the year, and shall also furnish final and detailed reports to be issued from time to time in such a manner and form as the Minister directs ; and the Minister shall cause the same to be laid before Parliament, with such remarks, explanations and recommendations as he thinks proper. Reports. To be submitted to Parliament.

7. The Department shall be furnished with such books, instruments and apparatus as are necessary for scientific reference and for the prosecution of the survey ; and the Governor in Council may, from time to time, cause the enlargement of the museum, and the distribution of duplicate specimens to scientific, literary and educational institutions in Canada and other countries, and also the distribution or sale of the publications, maps and other documents issued by the Department. Enlargement of museum. Distribution of specimens and publications.

8. The Minister may, for the purpose of obtaining a basis for the representation of the geological features of any part of Canada, cause such measurements and observations and physiographic, exploratory and reconnaissance surveys to be made as may be necessary for or in connection with the preparation of geological maps, sketches, plans, sections or diagrams. Surveys.

9. Persons employed in one section of the Department may be directed by the Minister to perform any duty in or with respect to any other section. Duties of employees.

10. No person employed in or under the Department shall— Employees not to deal with public lands.

(*a.*) Purchase any Dominion or Provincial lands except under authority of the Governor in Council ;

(*b.*) Locate military or bounty land warrants, or land scrip, or act as agent of any other person in such behalf;

Nor to disclose information obtained.

(*c.*) Disclose to any person, except his superior officer, any discovery made by him or by any other officer of the Department, or any other information in his possession in relation to matters under the control of the Department or to Dominion or Provincial lands, until such discovery or information has been reported to the Minister of the Interior, and his permission for such disclosure has been obtained;

Work for individuals Interest in mines, &c. Saving.

(*d.*) Make investigations or reports relating to the value of the property of individuals, nor hold any pecuniary interest, direct or indirect, in any mine, mineral lands, mining works or timber limits in Canada.

11. Nothing in this Act shall be construed to invalidate or interfere with the commissions, as assistant directors, heretofore issued under Orders in Council to certain members of the scientific staff.

R.S.C. c. 23, repealed.

12. This Act shall be substituted for chapter twenty-three of the Revised Statutes, respecting the Geological and Natural History Survey of Canada, which is hereby repealed.

Date of coming into force of Act.

13. The foregoing provisions of this Act shall come into force on the first day of July, one thousand eight hundred and ninety.

Hitherto the Geological Survey has been regarded as a branch, or sub-department of the Department of the Interior; by the present Act it has been made a separate Department, and while the official designation of the organization has been changed, no change has taken place in its functions or in the duties with which it is charged, as set forth in section 5, subsections *a*, *b*, *c* and *d*, and in section 8. By the provisions of section 4 it is hoped to maintain the efficiency and high scientific standing of the Department, but in order to ensure this desirable result a scale of remuneration should be established in the Department, more in accordance than it is at present with that which obtains elsewhere, and even in other departments of the public service and in the universities of Canada, for acquirements and experience such as is required of the technical officers of the Geological Survey, and in view of the risks, hardships and responsibilities they are often called upon to undertake. It should further be borne in mind in considering this matter that the officers of the Department are strictly prohibited from engaging in the private practice of their profession, for which there

are many opportunities, and by which their incomes could be often largely augmented. As professors in the universities, there are no such restrictions laid on them, while the salaries are larger and the vacations longer. The result is that our best and most capable men seek employment elsewhere. Since July, 1887, four such cases have occurred. Three of these are now university professors with considerably larger salaries than they would have received had they remained on the Geological Survey.

In this connection it may not be out of place to quote the words of a leading article which appeared in the Montreal *Herald* on the 24th of February, 1885, as follows :—

"The field of operations of the Canadian Geological Survey is so vast, the interests involved so great and so far-reaching, the staff provided for the work so weak numerically, that it is important to all the interests at stake that such officers as are called upon to bear the responsibility of the duties of the Survey, should be the best obtainable, and their salaries in keeping with their high attainments."

The truth and applicability of the above remarks cannot be refuted; they are as pertinent now as they were in 1885, and, therefore, I venture to express a hope that in the consideration of the estimates for the Department for the ensuing year, they will receive due consideration.

The early part of the year now closed was, as usual, occupied by the members of the staff in the preparation of maps and reports, in studying collections gathered during the summer, and in otherwise working out the results of the observations made in the field in 1889. Some of the reports relating to this work have already been published, and others are passing through the press. These will together constitute the Annual Report, Vol. IV., 1888-89, to be issued during the winter.

Those already issued since the 31st December, 1889, are :—

Part A.—Vol. IV.—1888–89. Summary Report of Operations.

" B.—Report on a portion of the West Kootanie District, British Columbia.—Dawson.

" E.—Report of Exploration of the Glacial Lake Agassiz, in Manitoba.—Upham.

" K.—Report on the Mineral Resources of the Province of Quebec.—Ells.

" S.—Report on the Mining and Mineral Statistics of Canada for 1888.—Brumell.

" S.—Report on the Mineral Statistics and Mines for 1889.—Ingall.

" T.—Annotated List of the Minerals occurring in Canada.—Hoffmann.

Early in April arrangements were made to send out fourteen field parties. Four of these parties worked in two divisions, thus making practically eighteen parties in the field, distributed as follows :—

British Columbia	2	Quebec	4
North-west Territories, Athabasca District	1	New Brunswick	1
Manitoba	2	Nova Scotia	3
Ontario	2	Labrador	1

A brief summary of the operations of these several parties is submitted herewith, as also of the work done in the several divisions of the Department as under :

1. Mineral Statistics and Mines.
2. Chemistry and Mineralogy.
3. Palæontology and Zoology.
4. Botany.
5. Entomology.
6. Topography and Mapping.
7. Library. Sale and Distribution of Publications.
8. Visitors.
9. Staff, Finances and Correspondence.

The general progress of the field work has been satisfactory, though the resignation of members of the staff, already referred to, and others having to take up their work, has occasioned considerable delay in completing maps and reports and in the publication of result.

On the 17th of June I left Ottawa for Shelburne, Nova Scotia, to visit the gold fields first opened in 1886 at and near Caledonia Corner, and to investigate the probability of the same leads continuing southward and westward, into the county of Shelburne, and also to ascertain what would be the best plan of operation in commencing a detailed examination and survey of these western parts of Nova Scotia in connection with the occurrence of gold, in quartz veins or in placer deposits, or in regard to other economic minerals. I had, in 1870, visited and cursorily examined the same part of the Nova Scotia coast, having then made detailed notes on a journey from Digby *viâ* Weymouth, Cape St. Mary and Salmon River to Yarmouth ; and thence to Tusket, Shelburne, Liverpool and Bridgewater to Lunenburg, the Ovens and Chester, returning to Bridgewater and Liverpool *viâ* New Ross and Dalhousie, and from Liverpool to Annapolis *viâ* Caledonia. The present trip has enabled me to do little more than refresh my memory and to confirm the general accuracy of the conclusions then arrived at respecting the distribution of the granitic and gneissic rocks and the gold-bearing series, as subsequently delineated on the geological map.

On the 23rd of June a trip was made 28 miles up the river from Shelburne to Indian Fields, where some pits have been sunk searching for gold. The country here is tolerably open, much of it flat and swampy and covered with drift and a fine granitic gravel or sand, with few exposures of the underlying rocks, though doubtless such would be

found by following up the beds of all the brooks and small streams in the district. On the 24th of June I examined the route from Shelburne to Lockeport, and thence *viâ* Sable River, Port Joli and Granite River to Liverpool. On the 25th I drove from Liverpool to Caledonia, 30 miles inland, and found the rocks to be alternations of the "whin" and black slates of the Atlantic coast Gold Series or Lower Cambrian, as indicated on the published geological map. The gold field of Whiteburn, six miles south-west of Caledonia, was visited on the 26th. It is of limited extent, on an oval shaped anticline outcrop of the lower "whin" rock, surrounded by the upper black slate. The veins are parallel with the stratification. They are not more than from six to nine inches thick, and therefore costly to work, as about four feet of hard barren rock has to be mined in driving or sinking on them. Consequently, though the quartz is of more than average richness the profits are not large. The beds dip about 45° to S.E. On the 27th I left Caledonia for Bear River, on the Annapolis Basin. As regards the extension or recurrence of anticlines like those in which the Malaga and Whiteburn leads occur, further to the south-west, no definite statement can be made. That some such areas should be found in the unsettled country where the boundaries of the counties of Digby, Yarmouth, Shelburne, Queen's and Annapolis meet, and especially along the flanks of the central granite mass, the limits of which have not yet been traced, but which certainly occupies a considerable area in this district and which is crossed with a width of ten or twelve miles on the road between Maitland and Bear River, is most probable.

On the 2nd of July I returned to Ottawa, and then made arrangements with Professor Bailey of Fredericton, to commence a detailed examination of the south-eastern coast of Nova Scotia. His summary report of the work done in pursuance of this arrangement is now presented.

On the 11th July, after attending to correspondence and other departmental work, I left Ottawa again for Manitoba, the North-west and British Columbia. Deloraine, Morden and the Lowe Farm were visited in connection with the water supply question. The Turtle Mountain coal field was also examined.

In the summary report for 1889, the well then boring at Deloraine was referred to, and I said: "There seems every probability, when a sufficient depth has been reached, a good supply of artesian water will be obtained." I was at Deloraine on the 22nd of September, 1889, and the boring, then 1,340 feet deep, was progressing, but the available funds were exhausted. On the 29th of October, on my arrival in Ottawa, I recommended that a further special grant should be made

to continue the boring to the required depth, and stated that water might be expected between 1,500 and 1,600 feet. The grant recommended was assented to and in December, 1889, a depth of 1,475 feet had been reached when the contractor reported that he could not go deeper without enlarging the hole. The work incidental to this occupied him several months and in July, 1890, when I again visited Deloraine, I found the hole had been re-bored to only 1,180 or 295 feet less than it was in the previous December. On the 21st of October, 1890, the expected water was struck at a depth of 1,570 feet. It is of fairly good quality and has since stood at about 8 feet from the surface. Unfortunately at this point, the soft mud began to run in and block the hole and no efforts of the contractor were successful in clearing it, or in going deeper. It was essential that this should be done to give free flow to the water and to ascertain whether it would not overflow at the surface when the obstructions referred to were removed. The work requisite to effect this has proved both difficult and tedious, but is now, the 31st December, 1890, progressing favourably and it is hoped will terminate satisfactorily early in the ensuing year.

The total expenditure to date on account of it has been $8,648.62. This has been derived and paid to the Deloraine Well Finance Committee, who had charge of the boring, as follows:—

Raised by municipal loan, grant from the Local Government and by subscription..	$4,482 78
From Geological Survey appropriation, 1889-90.....	500 00
From special appropriation of $2,000 voted by Parliament in 1890.....	1,997 54
From special appropriation of $10,000 voted by Parliament in 1891.....	1,668 30
	$8,648 62

The well is still incomplete and it is impossible to state what further amount will be required to complete it, but it is hoped the cost in 1891 will not exceed an additional sum of $2,000.

There seems little or no hope of finding any deep seated sources of fresh water in the Red River valley, east of the Pembina escarpment, or the first prairie-step. In places, however, a limited supply of fairly good water is obtained from shallow wells sunk in the superficial deposits of sand, clay and gravel with which the region is overspread. These deposits are very irregular in character and vary greatly in thickness, ranging from 0 feet to nearly 300. At the Lowe Farm, range 1, township 4, section 31, they were penetrated to a depth of 170 feet, leaving off in sand, with a supply of salt water which stands at 3 feet from the surface. Seven miles to south-west on range 2, town-

ship 4, section 17, a well was sunk 205 feet, the bottom being in similar sand with salt water which flows over slowly. Whether fresh water or salt water will be found in wells sunk in these deposits, within the area under consideration depends, in the first case, on the occurrence of permeable strata, that are not inclosed between others of an impermeable character, but communicate with the surface, and in the second case, on the character of the beds which immediately overlie the rocks from which the saline waters issue, with a strong upward pressure. If these beds are impermeable, then no salt water would be found in the wells above referred to that do not penetrate into the underlying salt water-bearing strata, as is the case at Rosenfeld, and at Morden, where, last year, a boring was made to a depth of 600 feet, and as had been predicted, salt water only was found. The upper strata of the superficial deposits in the Red River valley are largely impermeable dark clays sometimes reaching, as in the Lowe Farm wells, a thickness of 140 feet. These, of course, prevent any direct downward percolation and thus account both for the original swampy condition of large areas in the magnificent fertile belt of country which lies between the Red River and the base of the Pembina escarpment, and also for the general absence, or only very limited supply of fresh water in the wells of this district.

In the Turtle Mountain coal field, range 24, township 1, several pits and bore holes have been sunk and in all seams of lignite-coal of workable thickness have been struck. In one pit, now full of water, but said to be 50′ 6″ deep, strata are stated to have been passed through as follows :—

	Feet.	Inches.
Surface	3	0
Dark clay	4	0
Coal	5	6
Clay shale	10	0
Coal	3	6
Sandy brown shale	6	0
Soft whitey brown sandstone	2	0
Sandy clay	6	0
Coal	1	6
Friable whitey brown sandstone	12	0
Bored from bottom of shaft—sandstone	20	0
	73	6

In another pit, 150 yards south of the one above described and about 15 feet higher, the coal was struck at 40 feet 4′ 6″ thick, then 12 feet sandy shale and thin bands of iron ore; coal 1′ 6″, then bored 35 feet through sandy shale; total 78′ 6″. This is the only pit from which any coal has been raised. An engine with winding gear and

shaft house have been erected here and a few tons of coal raised. This section is probably the most reliable, and omitting the upper 5′ 6″ seam of coal given in the first section which is probably a mistake—the two sections are much alike. The coal or lignite like that of the Souris at Roche Percée slacks on exposure and would not bear distant transport. The seams probably underlie the whole of the Turtle Mountain except where deep ravines have been cut out and have been filled in again with the superficial drift deposits. They will probably be found in places in township 1 from range 19 to 24. They could be mined at small cost, and for use among the settlers in the treeless country to the north and north-west between the Souris River and the Mountain would prove a cheaper and more economical fuel than wood.

I examined this district in 1883, and in the summary report for that year, page 2, it was stated "the evidence obtained clearly shows that there is every likelihood of workable seams being found here, as on the south flank of the mountains, at the head of Willow Creek in Dakota a seam has already been found showing from 3 to 5 feet of lignite of fair average quality." The seams now opened are doubtless the extension of those above referred to on Willow Creek, and as soon as railways are constructed to the mines, the lignite could be very advantageously distributed over a wide extent of country in which wood is even now scarce and costly and yearly becoming more so.

Leaving Manitoba on the 3rd of July, the first week in August was spent examining the sections between Banff, Field and Ottertail. Several promising deposits of silver-lead ore and copper ore were opened in this district in 1885-87. Some of them have changed hands since, more than once, at high figures, but the attempts to work them have been intermittent and insignificant. The Monarch mine, three miles and a half east of Field Station, is the only one on which any work was being done. At the time of my visit it was temporarily suspended, and the door of the gallery and level which have been constructed around the perpendicular face of Tunnel Mountain at 800 feet above the rails of the Canadian Pacific railway, was locked, and I could not examine the mine. This portion of the mountains and the mines that have been opened in them are well described in the Annual Report of the Geological Survey, Vol. II., Part D, by Mr. McConnell, 1886, and in Vol. III., Part R, by Dr. Dawson, 1888, and my present cursory examination has only enabled me to verify and to appreciate the accuracy of the reports referred to. That so little actual development has been achieved on these promising deposits on the Bow and Kicking Horse rivers since their discovery in 1886 is certainly to be regretted. It may in a great measure be attributed to the high prices at which the claims are held, the low grade of the ore and the cost of transport

to the smelter. The latter difficulty will, however, now be obviated by the construction this year of a smelter at Golden, already nearly completed.

A fine smelting plant has also been erected on the bank of the Columbia at Revelstoke. It was completed in the spring of 1890, but has not yet been put in operation. Last spring and summer, however, there was no immediate prospect of a sufficient supply of ore being available to keep the smelter running, nor was there likely to be till the Sproat-Nelson railway was completed. This, it is expected, will be accomplished this spring, and a great stimulus will then be given to the development and *bonâ fide* working not only of the West Kootanie mines, Nelson, Toad Mountain, Hendryx, Hot Springs and others, but also to the many promising but more distant deposits already discovered in the Selkirk and Rocky Mountain ranges between Golden, on the Columbia, and Castle Mountain, on the Upper Bow River. Seven days, from the 9th of August to the 16th, were occupied in a trip to Victoria, including two days with Dr. G. M. Dawson at Kamloops.

At Victoria very satisfactory arrangements were made by which to secure statistical and other information respecting the progress of mining development in the several remote and scattered mining districts in British Columbia. To effect this object, the Honourable John Robson, Provincial Secretary, very kindly issued the following circular letter to each of the District Commissioners of Mines :—

"VICTORIA, 18th October, 1891.

"SIR,—The Director of the Geological Survey Department, Ottawa, being desirous of obtaining full and prompt information appertaining to the mining and quarrying industries of the province, has suggeste the appointment of 'local correspondents' as a medium by which his purpose can be accomplished.

"In response to the desire expressed by Mr. Selwyn, I have to request that you will act in the capacity of local correspondent in your respective district, your functions as such, to consist in collecting general information on matters relating to new discoveries, new operations undertaken, and the progress of industries already established, and embodying the results of your inquiries in a letter at the end of each month. And also to supply information asked for in the accompanying directory book, which has been forwarded by Mr. Elfric Drew Ingall, the Mining Engineer in charge of the Division of Mineral Statistics and Mines.

"It is further requested that you will commence to exercise your functions on the lines indicated without delay, it being clearly understood that your monthly letter to Ottawa, will not interfere with your Annual Report to the Minister of Mines.

"All communications should be addressed to the Geological Survey Department, Division of Mineral Statistics and Mines, Ottawa, and need not be stamped, as all mail matter addressed to the Government Departments in Ottawa, is carried free by the post office.

"I am, Sir, your obedient servant,

(Signed) "JOHN ROBSON,

"*Provincial Secretary.*"

In response, already some valuable and interesting information has been received, and the Mining Bureau of the Department may now expect to be fairly well posted on mineral production and mining development in British Columbia.

Returning eastward to Illecillewaet on the 16th of August, the next day was occupied in a visit to the Lanark and Maple Leaf mines situated 3,000 feet above the railway. Except driving a prospecting tunnel, then in progress, to cut the leads at a lower level, not much work has been done and no important developments appear to have been made since the date of my visit in 1886. On the 18th I visited the newly opened Gold Hill camp. A good pack trail to this camp has been made by the Provincial Government; it starts from the right bank of the Illecillewaet at about five miles above the village and ascends rapidly for three miles and a half in a northerly direction to about 2,800 or 3,000 feet above Illecillewaet. The country is quite open and well grassed with scattered groves of spruce and fir in sheltered places. The whole ridge was marked off in claims, and a number of small openings had been made, nearly all on bands of a rusty red weathering calcareo-magnesian rock associated with dark calcareous and brown shades or schists, very similar to those seen in the section on the railway in the vicinity of Illecillewaet; irregular and mostly thin bands of galena are seen in all the openings. What those veins may turn out when further developed it is impossible to predict. As regards most of them, however, my impression of their probable value was not favourable. The ridge on which they are situated is a triangular block of country about twelve miles long which lies between the Illecillewaet River and its north branch and in which also the Lanark Maple Leaf and other mines are situated. The dip is fairly regular to E.N.E. $<35°$-$85°$, the veins run with the strike; but in dip appear often to pass from one bed plane to another, and are probably more nearly coincident with the planes of schistosity or cleavage than with those of bedding. In my Summary Report for 1887 in reference to the Illecillewaet black slates it was suggested they might be of Silurian (Ordovician) age. It is now almost certain they are near the base of the Cambrian and probably represent nearly the horizon of the silver-bearing Animikie rocks of Lake Superior; beneath them there is a

great thickness of flaggy, brown and grey quartzites and gneissic schists becoming more granitoid and crystalline to the westward. Much more detailed examinations, however, are required in eastern and south-eastern British Columbia before the precise relations of the different groups of strata can be definitely determined.

At Albert Cañon, near the base of the Illecillewaet dark slaty series, is a bed of excellent crystalline grey limestone apparently about 25 to 40 feet thick, it crosses the rails at the look-out platform with a dip of about 30° to N.N.E. and is very favourably situated for the establishment of a lime-burning industry. The occurrence of limestone in this region was not known when I mentioned it to gentlemen in Revelstoke. All the lime hitherto used there, and for considerable distances both east and west, having been brought from the Pacific coast.

From the 21st to the 29th of August was devoted to a trip from Revelstoke to the Kootanie mining camps, Sproat, Nelson, Hendryx and Hot Springs. For description and map of the district, Part B. of the Annual Report, Vol. IV., '89-90, can be referred to and my brief visit does not enable me to add anything of importance to Dr. Dawson's report above referred to. I may, however, express an opinion from what I saw that the mines in this district will prove much richer and more permanent than those of the Illecillewaet district. My reason for so thinking being based on the fact that experience has shown that the association of granitoid and other crystalline rocks, porphyries, felsites, diabases, &c., generally exerts a favourable influence on the productiveness of metalliferous deposits, and that, while such rocks are abundant in the Kootanie district, they appear to be entirely wanting or of very exceptional occurrence, in the ranges at the sources of the Bow and the Kicking Horse or Wapta rivers. As, however, they often occur in narrow bands or dykes they easily escape the notice of prospectors; they should, therefore, be carefully looked for, as in the richest mining districts to the south, they almost invariably accompany and are indicative of the most productive ore bodies.

On the 29th of August, a short time was spent at Canmore to look at the coal mines newly opened there on the seams on the right bank of the river described, pages B–132 and 133, Annual Report, Geological Survey, Vol. I., 1885. The three-feet seam is now being worked by a slope which starts on a terrace about 200 feet above the river, where a small outcrop of the measures is exposed dipping 50° to 60° to westward. In a level being driven into the hill to cross-cut the seams, about 100 feet below the slope, the dark shales associated with the coal had been struck at about 30 feet in dipping 30° to north-east, so that there must be either a fault or a steep anticlinal fold along the face of the hill. The coal is much crushed and slicken-

sided. It is apparently a semi-anthracite, like that from Cascade River—see analysis, Part M., Annual Report, Geological Survey, Vol. I., 1885. There can be little doubt that the Canmore seams are the extension of those of Cascade River and Anthracite on the opposite side of the Bow River valley. The mine is already connected by a branch railway with the station at Canmore ; an incline tramway and shipping stages have been constructed at the mine and there is now every convenience for handling a large output.

On the 30th of August I left Calgary for Macleod, with the intention of visiting the Crow's Nest Pass petroleum discoveries, but being unfortunately prevented from doing so, returned *viâ* Lethbridge and Dunmore to Manitoba and after again visiting the Deloraine boring reached Ottawa on the 19th of September.

The greater part of October and up to the 5th of November, was occupied with matters relating to the formal invitation from the Canadian Government to the members of the Iron and Steel Institute of Great Britain and the Association of German Iron Masters, then assembled in New York, to visit Canada. Nearly 100 members accepted the invitation and on the 29th of October, they were received at Niagara by a committee on behalf of the Canadian Government and were accompanied thence *viâ* Hamilton, Toronto and Sudbury to Ottawa and Montreal.

Dr. G. M. Dawson left Ottawa for field work in the southern part of the province of British Columbia on the 5th of June, returning on the 28th of October. He was assisted as before by Mr. J. McEvoy, and for a portion of the season by Mr. A. T. Kirkpatrick. Dr. Dawson furnishes the following summary of the work carried out :—

" At the conclusion of field work in 1889, there still remained a part of the area comprised in the ' Kamloops sheet ' of the geological map which had not been examined, and for which both geological and topographical information was required. This portion of the area of the proposed map included a belt of mountainous country to the west of the Fraser River, together with several other smaller separated areas, and the work necessary for the completion of the sheet naturally first received attention. As in former years, the topographical work was carried out chiefly by Mr. McEvoy, while the concurrent geological examinations occupied the greater part of my own time. The size and boundaries of the Kamloops sheet having been noted in the last Summary Report (p. 7), need not here be further alluded to.

" After finishing the work above referred to, necessary for the completion of this sheet to the degree of accuracy and detail which appears to be at present practically requisite, some time was spent on the area

of the adjoining sheet to the east, which it is proposed to designate the 'Shuswap sheet,' and before returning, in the autumn, a preliminary examination was also made of the geological section found in the Selkirk Mountains in the vicinity of the line of the Canadian Pacific Railway. This examination was undertaken principally with the object of connecting our knowledge of the rocks of the Interior Plateau (in the area of which the Kamloops sheet and most of the Shuswap sheet are included) with that of the formations of the Rocky Mountains proper, where palæontological evidences of age are more abundant and in which one section has been carefully examined and described by Mr. McConnell. Part D, Annual Report, Geological Survey, Vol. II., 1886.

"The working up of the topographical and geological data obtained for the Kamloops sheet, the plotting of sections and study of specimens brought back, are now in progress in the office, and will fully occupy the entire winter. No detailed report can be prepared till this work shall have been completed, but some points connected with last summer's field operations may be mentioned.

"It was found impossible to examine in much detail the Alpine region to the west of the Fraser, constituting the eastern border of the great Cascade or Coast Range of British Columbia, without the expenditure of a large amount of time; and as the rocks were found to consist for the most part of gray granites, monotonous in character and apparently of no economic importance, it was considered sufficient to gain a general knowledge of this region. In 1889, several high summits opposite the eastern front of this range and to the east of the Fraser valley had been occupied as transit stations and observation points, but in consequence of stormy weather and the smoky state of the atmosphere, even the main features of the range had been very imperfectly seen or delineated. To fix the main peaks in the range, two additional summits, each about 6,000 feet in height, were first occupied one being to the north and the other to the south of Lytton, and both on the east side of the Fraser. The Fraser River was then crossed at Lytton and three summits in the eastern part of the Coast Range itself were successively occupied as transit stations and look-out points, the heights of these being 8,130, 8,960 and 7,430 feet respectively. Some excursions were also made in the range, and the entire belt of foot-hills between its base and the Fraser was examined. In the course of this work several zones of schistose rocks which traverse the granites were outlined and the border of the Cretaceous rocks was definitely located for the whole distance. These latter rocks occur in the form of a long narrow trough (very imperfectly shown on the general map of 1877), which is followed by the Fraser River. They are most-

ly of Earlier Cretaceous age, being equivalent to the Queen-Charlotte Islands and Kootanie series,* and to the Shasta group of California. A small collection of fossil plants obtained at one place appears, however, to show that strata as new as those of the Dakota series are also included. The occurrence of these plant remains, together with the presence of carbonaceous shales in several places, affords some reason to hope that coal may exist in some part of the area occupied by the Cretaceous rocks in this portion of the province, though none has so far been discovered.

"A good general idea of the character of that part of the Coast Range which lies between the Fraser and Harrison and Lillooet Lakes, to the west of the Kamloops sheet, was gained from the high peaks ascended. The culminating mountains are rough and wide in outline, and though none of them are specially dominant in altitude, several attain or somewhat exceed a height of 10,000 feet. They include very extensive snow-fields and numerous small glaciers, and will afford an interesting and not extremely difficult field for alpine climbing and exploration.

"Later in the summer a log-survey of Kuk-waus or Bonaparte Lake was made. This lake was seen by Mr. McEvoy in 1889, but has not appeared on any published map. It lies forty miles north of Kamloops and proved to be ten miles in length. The Bonaparte River issues as a small stream from its west end, and the rocks along its shores are entirely granitic, though Tertiary basalt caps many of the hills at no great distance from it. On the south from this lake the eroded edge of the basaltic rocks to the west of the North Thompson was traced in detail.

"While the volcanic rocks of the Tertiary, just alluded to, and which cover large parts of the Kamloops sheet, often rest directly on granites or other ancient rocks, they also in certain districts form the upper member of a Tertiary series of some thickness, of which the lower part consists of ordinary stratified rocks locally characterized by the occurrence of coal or lignite. One of the more important results of the work now done on this sheet, is the definition of the areas in which such fuels exist or in which they may be sought for with reasonable prospects of success.

"The best known occurrences of coal or lignite in the area of the Kamloops sheet or in its immediate vicinity are those on the Nicola and North Thompson rivers and Hat Creek with that near the town of Kamloops. These have already been described, and no new facts of importance concerning them can be obtained till further exploratory work has been carried out by boring or otherwise. A reported coal

* Am. Journ. Sci., Vol. XXXVIII, p. 120.

discovery on the Bonaparte, within a few miles of Ashcroft, was visited, but proved to be unimportant, because of the thinness of the seam, and the very small area of the Tertiary outlier in which it is contained. It is, however, of interest as showing the occurrence of coal in the base of the Tertiary rocks of this vicinity, and points to the desirability of testing the adjacent larger Tertiary areas by boring, for which a site might be chosen to the north of the road between Câche Creek and Eight-Mile Creek. The further investigation of the coal-bearing basin near the town of Kamloops, should be made by boring near the line of railway and west of the town, or on the opposite side of the lake near the point at which the main irrigation ditch leaves the Tranquille River. A boring near the mouth of the Nicola would also be desirable, in order to test the possible extension of coal westward from the known outcrops near the mouth of the Coldwater, to the Thompson; while a boring in the western edge of the Tertiary near the mouth of the Nicoamen River, below Spence's Bridge, would not be without importance in the same connection.

"The metalliferous deposits in the vicinity of Stump Lake, referred to in the Summary Report for 1888 (p. 8) and in the Mineral Wealth of British Columbia (p. 69 R.), notwithstanding the favourable conditions for their development and the high assay value of some of the ores, have not yet assumed a position of permanent importance. The Nicola Mining and Milling Company have now sunk in the 'Joshua' shaft to a depth of about 400 feet, and have done considerable drifting, for the purpose of exploration, but with this exception 'assessment work' only has been carried out on the various claims taken up in this vicinity. The general parallelism and the evident connection of the veins of this locality with the outline of the great granitic area to the west rendering it important that this should be done, the remaining part of the line of contact of this granite with the stratified rocks was traced in detail. The vicinity of this line of contact, like that of several other similar contact lines and numerous places not distinctly connected with granitic masses, is characterized by a great abundance of vein quartz. Many specimens of such veins have been collected for the purpose of assay, the results of which it is hoped will afford some definite information as to the habitus and mode of occurrence of the gold and silver ores.

"A point of some interest in connection with the stratigraphy of the Kamloops sheet, is the discovery of fossils representing the characteristic Alpine Trias fauna, which was made last summer in the hills north-east of Savona. The evidence heretofore obtained pointing to the existence of these rocks in this part of the Interior Plateau region had been rather imperfect.

"In the course of the preliminary work done on the Shuswap sheet, the Monashee Mine, situated on the watershed between Cherry Creek and Kettle River, in process of development by Mr. D. McIntyre, was visited. There are at this place several distinct veins of auriferous quartz in which specks of free gold are frequently visible. These veins, in which points of gold are often visible, traverse Monashee Mountain, composed of quartzite, diabase (?) and limestone strata, near to the margin of a wide granitic mass, which lies to the south. Several small tunnels and openings have been made on the veins, and a small mill has been erected with a view to commencing work on the ore in the spring. A number of small specimens selected from the ore at the mouth of the principal working drift at this place, have been proved on assay by Mr. Hoffmann, to contain, gold 0·583 oz, silver 2·683 oz. to the ton.

"The preliminary examination of the section across the Selkirk Range, near the line of railway, which has already been alluded to, shows that the western part of this portion of the range consists of gneissic rocks and other crystalline schists of the Shuswap series,* probably Archæan. Above these, and further to the east, is a mass of rocks composed principally of dark argillites, passing into micaceous schists, with a thickness of about 15,000 feet. These evidently represent the Nisconlith series of the Interior Plateau and correspond in a general way to the Bow River series of the Rocky Mountains. The argentiferous lead ores of the vicinity of Illecillewaet occur in these rocks, which are believed to be of Lower Cambrian age.

"Overlying the Nisconlith series and forming a great synclinal in the axial part of the range, is a series chiefly composed of schists and quartzites, with apparently a total thickness of about 25,000 feet. This is believed to correspond to the Adams Lake schists on the west, and to the Castle Mountain group, with a portion of the upper part of the Bow River group in the Rocky Mountains, and very probably includes beds ranging in age from the Lower Cambrian to the Cambro-Silurian. Still newer strata appear to be represented on the eastern flanks of the Selkirk Range, probably representing the Graptolitic shales and Halysites beds of the Rocky Mountain section. The partial correlation of the beds of the Rocky Mountains proper with those of the Interior Plateau which this section enables us to reach, is a point of some importance, but the Selkirk and Columbian ranges require to be studied in greater detail before the different parts of the Cordillera in British Columbia can be satisfactorily compared."

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* See Report on a Portion of West Kootanie District, 1889, p. 31B.

Mr. McConnell left Ottawa on the 2nd of May to continue the exploration of the Athabasca petroleum region, commenced in 1889. (See pp. 10 to 13 of the Summary Report for 1889.) On this season's work he reports as follows :—

"On the 19th of May I left Athabasca Landing, ninety miles north of Edmonton, with one canoe and two men. It was considered advisable to utilize the early part of the season in examining as many of the tributary streams as possible, as after July most of these become unnavigable, therefore little work was attempted in descending the river. Records of a number of interesting sections were, however, obtained at various points.

"We reached Fort Chipewyan, on Lake Athabasca, on the 3rd of June, and on the 15th left for the Birch Mountains. We ascended the Quatre Fourche Fork of Peace River, crossed Lake Mammawee and then by utilizing a number of old river channels and making a few short portages reached Lake Claire. This lake, together with Lake Mammawee and a large number of smaller water basins, occupies the delta-plain which stretches from the west end of Lake Athabasca far up the Athabasca and the Peace. They represent portions of Lake Athabasca separated from the main basin by accumulations of stream detritus. They are everywhere very shallow, and at ordinary stages of the water seldom exceed nine feet in depth even in their deepest parts. In seasons of exceptionally high water the low marshy plain separating them from the main lake and from each other is flooded, and they become united into one broad sheet of water. Lake Claire is the largest of the group, and has a width of from ten to fifteen miles and a length of from twenty-five to thirty miles. The northern part has not yet been surveyed. The shore line is irregular and is broken by a succession of long points and deep bays. At Pointe de Roche on the west side of the lake a greyish, granular limestone is exposed which holds *Atrypa reticularis* and is probably a continuation of the same Devonian limestone which is found along the Athabasca. This was the only exposure of the older rocks noticed on the part of the lake examined.

"The two principal streams flowing into Lake Claire are Cut-bank River and Birch River, both of which head in the Birch Mountains, the former draining the eastern and the latter the western slopes of the range. I ascended both these streams for some distance. Cut-bank River was followed for about thirty miles by the course of the stream, but probably not more than fifteen miles in a straight line, and then leaving the main stream I followed a tributary which led through a deep valley directly into the Birch Mountain plateau. In the lower part of Cut-bank River Devonian limestones cross the valley at several

points and form small rapids, but in the upper part only recent sands and clays are seen.

"The Birch Mountains were examined for the first time during the present season's exploration. They consist of an elevated plateau, runing in a north-and-south direction, or nearly parallel to the course of the Athabasca, from which they are separated by a flat, fifteen to twenty miles wide. The plateau is from fifteen to thirty miles wide. The surface is undulating and is broken by numerous lakes, most of which drain eastward into the Athabasca. Around the northern end the slopes are steep, and the highest points rise to an elevation of about 1,200 feet above Lake Claire, or about 2,000 feet above the sea. Further to the south the slopes become less abrupt and the relative elevation above the bordering plains is also somewhat less.

"Genetically the Birch Mountains are simply a denudation plateau and consist of almost horizontal Cretaceous strata. A band of yellowish and greyish sands and soft sandstones outcrops at various points around the northern end of the hills. These beds are destitute of fossils, but were referred on stratigraphical grounds to the horizon of the Niobrara. They contain small coaly seams, and some of the beds are blackened with bituminous matter, and resemble in this respect the Dakota tar-bearing sands found along the Athabasca. The sands exposed here have a thickness of 200 feet, but the base was not seen. They are overlaid by 150 feet of dark Pierre shales. The beds underlying the Niobrara and forming the base of the mountains were concealed at the point examined.

"Birch River and one of its tributaries, Swift-current Creek, were explored for some distance, but offered little geological information, as they have not cut through the alluvial mantle which covers in this region the older rocks.

"After returning from Birch River I coasted along the southern shore of Lake Athabasca as far as Point William, where I was stopped by the ice (June 25). This shore as a rule is low, and is bordered for long distances by low bluffs of stratified sands and clays. At Pointe de Roche, and at a couple of other places, the basement rocks come to the surface and were found to consist of a granular siliceous sandstone which, from its general character and position may be referred to the Cambrian, and probably belongs to one of the lower divisions of this system. For reference it may be called the 'Athabasca sandstone.' No fossils were found in it, nor was its contact with the overlying or underlying rocks observed. This sandstone is usually coarsely granular in texture, but occasionally passes into a fine-grained conglomerate. Its colour varies from white to dull red. Its bedding planes have been obliterated, but its general horizontal attitude is betrayed

by the textural differences. It is cut by two systems of jointage planes, and in weathering breaks up into huge blocks, some of which contain several hundred cubic yards of material. Numerous fragments, some of large size, of a mottled rather fine-grained sandstone, somewhat similar in appearance to that occurring at Sault Ste. Marie were noticed strewn along the beach, but were not found *in situ*. The Athabasca sandstone apparently extends all along the southern shore of Lake Athabasca, as specimens brought by Mr. Cochrane in 1882, from the east end of the lake cannot be distinguished in appearance from those collected at Pointe de Roche and neighbouring localities. Its extension southwards cannot be as yet approximately determined. On the north, its junction with the Archæan is concealed beneath the waters of Lake Athabasca.

"After leaving the lake, I ascended the Athabasca River, and on the way up examined portions of Muskeg River, Lower Steep-bank River, of Dr. Bell's map, Jackfish River, Steep-bank River, Red River and the North Pembina. A second trip was also made into the Birch Mountains, with Moose Lake situated on the summit of the range for its objective point. At the lake I was fortunate enough to obtain a couple of birch bark canoes, and on the return journey, Moose River, the outlet of Moose Lake, was followed in its headlong career down the mountain side and across the bordering plain to near its junction with the Athabasca. This river has a fall of 1,200 feet in about thirty miles, and in its course cuts through all the Cretaceous strata from the Pierre shales down to the Dakota sands.

"The valley of the Athabasca for a hundred miles above Lake Athabasca shows only alluvial sands, and the boulder-clays associated with stratified sands and gravels. Beds of rolled tar-sand pebbles occur in the latter in a number of places. A coarse gravel bed which immediately underlies the surface, and overlies the boulder clay was found to be completely saturated with soft tar. Ten miles below Calumet River the Devonian limestone rises to the surface of the valley from beneath the glacial beds and almost immediately afterwards is overlaid by the tar-bearing sands of the Cretaceous. From this point the Devonian limestones undulating at low angles, and accompanied by the tar-sands, are exposed at frequent intervals as far as Crooked Rapid, a distance of about eighty miles. At Crooked Rapid they become affected by a slight south-westerly dip and sink below the surface of the valley, and eight miles farther on, at Boiler Rapid, the tar-sands disappear, and are replaced by higher divisions of the Cretaceous.

"The tar-sands mentioned above belong to the Dakota formation and constitute in this region the basal member of the Cretaceous system. They rest uncomformably on the Devonian limestones. Litho-

logically they may be described as soft sandstone, the cementing material of which is a bitumen or inspissated petroleum derived from the underlying limestones. The sands are siliceous and usually rather fine-grained, but also grade occasionally into a coherent grit. The eastern boundary of the tar-sands was not precisely defined, but their outcrop was estimated to have a minimum distribution of fully 1,000 square miles. In thickness they vary from 150 to 225 feet. The tar is unequally distributed through the sands, in some places merely staining the grains, but in most of the sections examined it is present in sufficient quantity to render the whole mass more or less plastic. An analysis by Mr. Hoffmann of a specimen collected some years ago by Dr. Bell gave by weight:—

Bitumen	12·42
Water (mechanically mixed)	5·85
Siliceous sands	81·73

A cubic foot of the bituminous sand rock weighs, according to Mr. Hoffmann, 117·5 lbs. This figure multiplied by the percentage of bitumen, 12·42, gives 14·59 lbs. as the amount of bitumen present in a cubic foot, or $\frac{14\cdot59}{63\cdot7}=22\cdot9$ per cent in bulk. At the minimum thickness of 150 feet, and assuming the thickness as given above at 1,000 square miles, the bituminous sand rock in sight amounts to 28·40 cubic miles. Of this mass, if the preceding analysis is taken as an average, although this is probably rather high, 22·9 per cent in bulk or 6·50 cubic miles is bitumen. This calculation can, of course, only be regarded as an approximation, but will serve to give some idea of the enormous outpouring of bituminous substances which has taken place in this region. The amount of petroleum which must have issued from the underlying limestones required to produce 6·50 cubic miles of bitumen cannot be estimated, as the conditions of oxidation and the original composition of the oil are unknown. It must, however, have been much greater than the amount of bitumen.

"A few miles west of the Athabasca the sand rock, still saturated with tar, passes below the higher divisions of the Cretaceous, and its extension in this direction can only be ascertained by boring. It was not recognized on Peace River nor on the lower part of Red River, and must disappear somewhere in the intervening region.

"In ascending the Athabasca the tar-sands, after an exposure of over twenty miles, pass below the surface at Boiler Rapid and are not seen again. Above this the upper divisions of the Cretaceous, influenced by a light south-westerly dip, and also by the grade of the stream descend gradually in the banks of the valley and disappear in succession. The Cretaceous section is as follows in descending order:—

		Feet.
Cretaceous.	Pierre shales	700
	Niobrara sand and sandstone	35
	Niobrara shales	90
	Niobrara sand and sandstone	300
	Benton shales	275
	Dakota tar-sands	175
		1,575
	Devonian limestone	

"The commercial value of the tar-sands themselves, as exposed at the surface, is at present uncertain, but the abundance of the material and the high percentage of bitumen which it contains makes it probable that it might, in the future, be probably utilized for various purposes. It proves a flow of petroleum to the surface unequalled elsewhere in the world, but its more volatile constituents have long since disappeared, and the rocks from which it issued are probably exhausted. In their extension under cover, however, the case is different, and it is here that oils of economic value must be sought. Above Boiler Rapid the tar-sands are overlaid by a cover of shales sufficient to prevent the oil from rising to the surface, and as we ascend the river this cover gradually thickens. The geological attitude of the cover is not the most favourable, as the beds dip away from the outcrop at the rate of about six feet to the mile, and it is possible that part or even the whole of the oil may have flowed northwards and eastwards through the Dakota sands and escaped where these come to the surface. It is unlikely, however, that all the oil has escaped in this manner, as small anticlinals in the covering beds are almost certain to exist, and a differential hardening of the sands themselves may serve to inclose reservoirs or pools of large capacity. It is also possible that the sands at their outcrop may, by the deposition of tarry substances, be plugged tightly enough to prevent further egress.

"Favourable indications of the presence of oil are afforded by the existence of several natural gas springs in the valley of the Athabasca above Boiler Rapid. One of these occurs at the mouth of Little Buffalo River and is twenty miles distant in a straight line from the outcrop of the tar-sands. The gas here forces its way from the sands up through a covering of 250 feet of Benton shales and issues from the surface in numerous small jets distributed over an area fifty feet or more in diameter. Some of the jets when lighted burn steadily until extinguished by heavy rains or strong wind, and afford sufficient heat to cook a camp meal. A second spring was noticed thirteen miles below the mouth of Pelican River, or forty miles in a straight line from the outcrop of the tar-sands at Boiler Rapid. The volume

of gas escaping here is less than at the mouth of Little Buffalo River, and in order to reach the surface it is obliged to penetrate 570 feet of shales and sand. Escaping jets of gas were also noticed at several points further up the river, but these were mostly small and may possibly be due to decaying vegetable matter.

"The question of the continuity of the tar-sands, and their petroliferous character under cover, can only be settled in a decided manner by boring, and it is highly desirable that drilling operations should be undertaken for this purpose. The indications seem amply sufficient to warrant the small expenditure involved, and the advantages which would accrue from a successful issue of the search to this portion of the North-west are almost incalculable. The southern limit of the field cannot, with our present knowledge or without boring, be defined; it may possibly extend to the Saskatchewan or beyond, as, even as far as Manitoba, the rocks are more or less petroliferous.

"Two bore holes, one at the mouth of Lac la Biche River, and the other at the mouth of the Pelican, would add largely to our knowledge of the underground geology of this region, and would either settle positively the question as to the presence or absence of petroleum in paying quantities, or at least afford valuable data for future action. At the mouth of the Pelican River, a bore hole, in order to reach the tar-sands, would require to be sunk 700 feet, and at the mouth of Lac la Biche River about 1,200 feet. The former locality is 50 miles distant in a straight line from the outcrop of tar-sand at Boiler Rapid. The latter is 106 miles distant from the same point, and is only 110 miles from Edmonton."

Mr. J. B. Tyrrell spent the winter examining the large collection of rocks and fossils gathered in North-western Manitoba during the previous summer, and preparing for the publication of a report on that district.

A specimen of phosphatic shale collected by him from the Niobrara formation on Wilson River, on the Lake Dauphin Plain in Manitoba, was given for analysis to Mr. Hoffmann, who reports that it contains 17·27 per cent of phosphoric acid, equivalent to 37·7 per cent of tribasic phosphate of lime. A very small outcropping of this shale, which is largely composed of fragments of fish remains, was seen in the bank of the river, but if the bed proves to be an extensive one, it will furnish a very valuable source of supply of phosphate of lime for the benefit of Manitoba and the country further west, being very similar in character to the coprolite beds of England and France.

During the past summer Mr. J. B. Tyrrell, assisted by Mr. D. B. Dowling, continued the geological survey of the northern portion of the province of Manitoba. Mr. Tyrrell reports as follows:—

"Leaving Ottawa on the 2nd of June, I proceeded to Winnipeg, where preliminary arrangements were made for obtaining money and supplies for the year. From Winnipeg I instructed Mr. Dowling to proceed to Minnedosa *via* the Manitoba and North-western railway, and there obtain horses and men and drive north on the Lake Dauphin trail to the crossing of Ochre River, in order to complete the geology and topography of the south-eastern corner of the map of North-western Manitoba, shortly to be published. On his return from Minnedosa he was instructed to start from Selkirk with a boat and two men, and survey with compass and micrometer or floating boat log the many islands in the northern and western portions of the lake, to note their character, mark any rock exposures, and collect fossils whenever they were to be found.

"This partition of the party was considered advisable as a larger amount of work could thus be performed during the present season, and a reliable map obtained with which to carry on the geological exploration of Lake Winnipeg during the coming summer.

"At the same time I proceeded by rail to Russell, where I had the good fortune to find Mr. Donald Sinclair, who has formed one of my party since 1887. From Russell we drove northward to Fort Pelly at the elbow of the Assiniboine River, from which point I purposed descending the river to Portage la Prairie.

"On the 15th of June, accompanied by one man, I started down this stream in a little canvas canoe. The river is very narrow and tortuous, winding too and fro in a shallow secondary valley in the bottom of a basin-like trough west of the northern portion of the Duck Mountain. Proceeding a short distance, low banks of dark grey clay belonging to the Millwood subdivision of the Pierre shales begin to put in an appearance in little scarps on the outer banks of the river. Near the first of these lies a large boulder consisting of a spherical nodule of Dakota sandstone quite similar to the large nodules which form a conspicuous feature on Kettle Hill at the south end of Swan Lake. If this nodule has been carried by the Laurentide glacier from Kettle Hill, its occurrence here would determine the direction of flow of the ice for this locality at one time in the glacial period as S. 55° W. or directly up the wide valley of the Swan River, rising, in the seventy-three miles travelled, more than four hundred feet. In the same vicinity many rounded or lenticular nodules of calcareous ironstone are to be seen sliding down the face of the bank.

"Proceeding down the river the channel was found to be very tortuous, winding through the alluvial bottom land. The valley gradually becomes more sharply defined till, just below the mouth of Little Boggy Creek, its banks rise abruptly on either hand to a height

of more than two hundred feet. At some of its bends the river impinges on the outer bank of the valley, and either cuts a cliff of dark grey Millwood shale, holding occasional nodules of ironstone, or grey jointed till from which striated boulders of gneiss and limestone are falling. At the base of these cliffs the accumulation of boulders gives rise to miniature rapids, which break the usual quiet flow of the stream. It is a circumstance very worthy of remark that the river does not appear to carry boulders any considerable distance down its channel, as they are found for only but a very little way below the cliff from which they are falling.

"The sides of the valley are everywhere seen to be composed of Millwood shale, till, or alluvial deposits all the way down to the mouth of Bird Tail Creek. In this distance the banks are in places beautifully terraced, the terraces rising as regular grass-covered steps, one above another. They are well shown at the village of Shellmouth, which has a most charming situation on the open sandy terraces that rise from the east bank of the Assiniboine River till they abut against the side of the main valley.

"Near Fort Ellice the banks of the river in some places are composed of boulders beaten down to an even slope by the ice, showing excellent examples of boulder pavements formed by river ice. Their surfaces were, however, neither worn nor scratched like the glaciated pebbles seen in the till.

"Shortly below the mouth of Bird Tail Creek pebbles of Pierre shale, Odanah series, begin to appear in the till.

"A few miles above the mouth of Arrow River, the top of the bank of the valley is found for the first time to be composed of the light green grey hard fissile shales of the Odanah series. These shales form a prominent feature as far east as Oak Lake, often giving rise to bare rounded buttes on the sides of the valley, reminding one strongly of the bad lands of many of the arid regions of the west.

"At the Sioux Indian Reserve the valley becomes wider and more open, and at a point north of Alexander a gravel plain indicates the position of the ancient mouth of the Little Saskatchewan.

"From this gravel plain to near the mouth of Cypress Creek no Cretaceous rock is seen in place, but the banks are composed of till or alluvial deposits, while the channel is occasionally blocked by an accumulation of boulders.

"At the mouth of Cypress Creek a dark grey shale outcrops in low exposures near the edge of the water, possibly representing the bottom beds of the Millwood series of the Pierre. A short distance further down the river fragmental limestone and marl, typical of the Niobrara

formation, gradually rise above the water to a height of 15 feet. This rock is directly overlain by till and at the lowest exposure in S. 23, T. 9, R. 10 W., where the marlite rises highest above the water, its surface is beautifully and evenly striated, the striæ bearing S. 38° E. As the valley is here 120 feet deep it is possible that these striæ do not give the exact direction of flow of the ancient glacier, but they would indicate that it had an easterly rather than a westerly trend. From the lowest outcrops of the Niobrara marlite to Portage la Prairie, no cliffs of rock are seen on the river, but its bed appears to be composed of the dark grey shale of the Benton formation which usually weathers with a very lightly sloping surface.

"We arrived at Portage la Prairie on the 15th of July, having spent precisely a month on our journey down the river from Fort Pelly.

"I proceeded at once to Winnipeg and found that Mr. Dowling had completed the survey of the small area on the face of the Riding Mountain, south of Lake Dauphin, and had gone at once to Selkirk.

"On the 17th of July I went from Winnipeg to Morden, and there, through the kindness of Mr. Dunsford and other gentlemen, obtained the log of the well that had been drilled by the village for the purpose of obtaining a large and permanent supply of fresh water. A few specimens had been kept typical of the various strata passed through by the drill, and these were kindly handed over to me and are at present under investigation. A hurried examination made on the spot showed that the well had been begun in the Pierre shales, had passed through the Niobrara, Benton, and Dakota formations, and had penetrated a considerable distance into Palæozoic shales and limestones. A large flow of salt water had been obtained in the Dakota sandstone. The record of the Rosenfeld well shows that fresh water is not to be hoped for from the Palæozoic strata, so that I was obliged to advise the people of Morden that there was no probability of obtaining fresh water by sinking the well to a greater depth. The work of boring was therefore discontinued, having been carried to a depth of 600 feet.

"It is quite probable, however, that the village can readily obtain a large supply of water from the gravel bed that stretches eastward from the mouth of Horse Creek.

"The next day I returned to Winnipeg and thence went on to West Selkirk where I found that the boat built under my instructions by Wm. Watts & Co., of Collingwood, for coasting work, had already arrived. I was also met by Mr. L. M. Lambe, the artist of the Palæontological branch of the Geological Survey, who had come from Ottawa to join my party to assist in collecting fossils from the Cambro-Silurian rocks on the shores and islands of Lake Winnipeg.

"James Collins, who had already spent eight years on Lake Winnipeg, was hired as sailor, and supplies and any goods necessary to complete the outfit were obtained from Messrs. Robinson & Co.

"On the evening of the 22nd of July, we embarked on the steam barge *Red River*, bound for the Grand Rapids at the mouth of the Saskatchewan. On the way we left Mr. Lambe at Dog's Head to join Mr. Dowling.

"Shortly before noon on the 25th of July we arrived at the fish-packing station at Grand Rapids, and from there we took our goods and supplies in the small sailboat up to the Hudson Bay Company's warehouse at the lower end of the tramway, a mile further up the river. That evening, Abraham Scott, an Indian, who was thoroughly acquainted with the river as far up as Cedar Lake, was added to the party.

"The next morning we loaded the boat, with all necessary supplies for two weeks, on a flat car; to this car a horse was hitched and we rode to the other end of the tramway at the landing above the Grand Rapids. At this place we launched the boat and ascended the Saskatchewan River with oars, poles or tow line to Cedar Lake. A survey was made with compass and floating boat log of the south shore of Cedar Lake, and the river examined up to the Hudson Bay Company's Post at Chemahawin. Here an Indian showed me a piece of amber, and stated that he had found it in the vicinity. The next day I had the pleasure of meeting Mr. King, of the Hudson Bay Company, who kindly accompanied me to the place where the amber was found, on the west shore of Cedar Lake, near the mouth of the Saskatchewan River.

"It occurs mixed with sand and many fragments of partly decayed wood, on a low beach behind a gradually shelving shore and along the face of a deep, wet spruce swamp. The pieces were for the most part smaller than a pea, but could be readily seen glittering among the sand and vegetable débris. Some pieces were found as large as a robin's egg, and Mr. King informed me that he had collected pieces very much larger. It has evidently been washed up on the shore by the waves, but its exact age has not yet been positively determined.

"The first place at which it was seen was in a small bay behind a limestone point projecting towards the north, but the most extensive deposit is more than a mile south of this point, where a rounded beach stretches across the margin of a low swamp. This beach is about a mile in length, and from eighty to one hundred and twenty feet in breadth. The amber is found most plentifully along its ridge, where it constitutes between five and ten per cent by volume of the sand and

vegetable débris, and holes dug to a depth of two feet show no diminution in its quantity. Towards the edge of the lake, however, the sand is freer, both from fragments of wood and amber.

"It is difficult to make an accurate estimate of the quantity of amber on this mile of beach, but it may confidently be said to be found throughout the distance in a band thirty feet wide, with a minimum depth of two feet. This band has thus a total bulk of 316,800 cubic feet. A number of specimens collected from various parts of it showed an average of a little over ten per cent of amber, which, in natural fragments, weighed forty-six pounds to the cubic foot. The amount of amber on this strip of beach would, therefore, be about 31,680 cubic feet, or 1,457,280 pounds. At a minimum value of twenty-five cents a pound, this would represent a total of $364,320. This estimate refers merely to the material that is now washed up on the ridge of the beach, without considering the source from which it is originally derived.

"Returning down the river, the rocky islands at the western end of Cedar Lake, and the islands and the shore of the east end of the same lake were surveyed. Instead of again taking advantage of the tramway we ran our boat through the Grand Rapids, and for a few short moments enjoyed the exhilaration of being tossed about on the surging waters of the grandest part of one of the grandest rivers in the Canadian North-west. There is some error in the computation of the fall of this rapid made by Mr. John Fleming, when acting as Professor Hind's assistant. The fall is given by him at 43½ feet, whereas the actual fall from top to bottom of the rapid is in the vicinity of 100 feet.

"The rock outcropping on Cedar Lake was found to be the same as that on the north-east shore of Lake Winnipegosis. It was, however, here found to contain a much larger number of fossils, which clearly determine its age as about that of the Niagara formation of Iowa and Wisconsin. The rock through which the river has cut its gorge at the Grand Rapids also belongs to the same formation.

"On the tramway between the upper and lower ends of the rapids several well defined gravel ridges are crossed at altitudes from 100 to 120 feet above Lake Winnipeg. These probably represent the shore lines of Lake Agassiz when it stood at the Stonewall Stage described by Mr. Upham in Part E. Ann. Rep. Geol. Survey, Vol. IV., 1888-89.

"Leaving the mouth of the Saskatchewan we coasted northward down the shore of Lake Winnipeg to its extreme north-west angle in Limestone Bay. Wherever rock outcrops were observed they were found to be Cambro-Silurian limestones of about the age of the Trenton or Utica formations.

"Limestone Bay is cut off from the rest of the lake by a narrow spit of sand twelve miles in length projecting towards the south-west. From the base of this spit an even unbroken sand beach stretches eastward to near Mossy Point, while behind the beach is an almost vertical cliff, rising in some places to a height of forty feet, composed at the bottom of a stiff blue alluvial clay, and at the top of a mossy peat. Rounding Mossy Point we descended Nelson River through Playgreen Lake to Norway House, and on our return made a log survey through Little Playgreen Lake, by a channel not previously mapped, into Playgreen Lake and thence by Warren's Landing to Lake Winnipeg. Nelson River at the discharge of this lake flows over a bed of Laurentian gneiss which it has not worn sufficiently even to obliterate the well defined glacial striæ that may be seen on almost any of the rocks along its shore. It is, however, enlarging and deepening its channel by cutting away the alluvial point lying to the west of it, on which the store-house of the Hudson Bay Company is at present situated. This point, which stretches as a long narrow arm between Winnipeg and Playgreen Lakes is also being rapidly worn away by the waves of both these lakes, and the time is not very remote when the site of the present narrow arm of alluvial clay and peat will be at the bottom of the united lakes.

"A deposit of clay similar to that on Mossy Point extends all along the east shore of Lake Winnipeg, and the waves washing against the soft cliffs become charged with the mud from which the lake derives its name.

"This clay is also of great economic interest, for instead of the east shore of the lake being an uninhabitable rocky wilderness, as is generally supposed, it is largely covered with a rich blue alluvial soil, and the area of rock surface is relatively small. Much of this land is covered with forests of poplar and spruce, while on account of the retentive impervious nature of the clay soil much of it is also boggy and wet, but when it is cleared and drained it will form rich agricultural land. At Bad Throat River, Mr. Wood, the local Inspector of Fisheries, had cleared a beautiful farm out of the midst of the poplar-forest, and he informs me that he grows successfully all the crops ordinarily raised in Ontario. Mr. McKay, the Indian Agent at Berens River, has also a clearing situated on the south side of the river in the midst of what was a dense forest of small spruce. He has under cultivation a nice garden, and this year the potatoes were not cut down by frost till the middle of September.

"On the evening of the 1st of September, we pitched our tents near Warren's Landing, beside that of the Mounted Police lake-patrol, under my old college friend, Mr. H. E. Morphy. He was travelling

in an excellent yacht built by Matthew Watts, of West Selkirk, who was employed on it at the time in the capacity of skipper.

"On the following morning we rowed to the east shore of the lake and travelled along it without interruption until Wednesday evening, when we camped in the mouth of a small creek south of Spider Island Point. The same evening we saw the police yacht sail into the harbour of Spider Islands. On Thursday a heavy storm set in from the north-west and we were unable to move from the mouth of the little creek till about sunset, when taking advantage of a lull in the tempest we sailed across to Spider Islands and again camped beside the police detachment. On Friday the gale continued with redoubled fury, and the day was spent in closely examining the small island of gneiss on which we were forced to remain, and photographs were taken of the camp and of the surrounding rocks. About sunset the wind fell and we at once furled our tents and ran to the mouth of Little Black River, three miles distant, where we remained for the night.

"On Saturday morning the weather was beautifully clear with a light air blowing from the north-west, and as I walked along the sandy beach I saw the ill-fated police yacht sail out from Spider Islands and disappear in the distance towards the south-west. That afternoon a very heavy storm of rain and north-west wind set in and continued throughout the night, and before morning the police yacht had struck on a reef off Pigeon Point and gone over on her side. The two policemen were drowned, but Matthew Watts, the skipper, lashed himself to the side of the boat and, twelve days later, was taken off by some passing Indians.

"Sunday was still dark and rainy, with a high wind from the north-west, but on Monday, the 8th of September, we continued southward along the shore, and on Friday, the 12th, reached Berens River, where we camped beside the Hudson Bay Co.'s trading post. For most of the distance from Nelson River I had travelled on foot along the beach, while the boat followed as near the shore as the many reefs would allow. The rock was everywhere found to be Laurentian gneiss without any constant dip or strike. It was also found to be strongly glaciated, and in several places two sets of striæ could be clearly recognized. It was generally covered by the soft blue imperfectly stratified alluvial clay mentioned above.

"At Berens River inclement weather detained us for several days, and during this time we were indebted to Mr. Angus McKay, Indian Agent, for continued hospitality. On Tuesday evening, the 16th of September, the Rev. Mr. Butler, Methodist Missionary, informed me

that a skiff had been found by an Indian on the shore, but it was not till the following evening that we ascertained that this was the tender of the police yacht, and that a boot and last had also been found on which was written the name of one of the unfortunate policemen.

"The next morning, the 18th of September, we started before daybreak, and ran out to Pigeon Point, followed by Mr. Angus McKay, and examined the shore closely from Pigeon Point southward to the mouth of Catfish River, but a heavy gale striking us, we were unable to take our boats more than four miles south of Pigeon Point. About three miles south of this point the first wreckage was found, and from this place southward for three-quarters of a mile to a prominent point, which might be called Police Point, light wreckage, such as pine boxes, etc., was scattered on the beach, much of it several feet above the level of the water. On the south side of Police Point, no wreckage was found, but from the bottom of the next bay to Catfish Point, heavier pieces of wood, such as oars, etc., were discovered, often half buried in the sand, having evidently been thrown on the beach by a heavy northwest wind.

"The next day was beautifully calm, and Mr. McKay proceeded along the shore in his canoe to Flower Point, while we examined the reefs and islands between Swampy Island and the main land. We also left a letter with Mr. Plunkett at the lighthouse, near Swampy Island, to be forwarded as soon as possible to Hon. John Schultz, Lieut.-Governor of Manitoba, informing him of the probable wreck of the police yacht 'Keewatin.' No trace of a wreck was to be seen on any of the reefs or islands, but Mr. McKay found further signs of wreck on the shore, but up to that time we had not found the boat itself.

"Friday night was spent at Flathead Point, and on Saturday a heavy wind blew from the south, so that we were unable to proceed. On that evening, however, several Indians arrived from the south, and informed us that they had found a large sail boat, with an old man lashed to its side, lying on the beach between Flower and Rabbit Points; that the old man had been taken care of, and brought to a house on Rabbit Point, and that the boat had been righted and taken into a harbour. Also that the old man, Matthew Watts, had told him that his two companions had fallen off the side of the boat several days before.

"Nothing further could be done, therefore, for the ill-fated policemen, and as the stormy weather presented every appearance of continuing for some time, I decided to leave the great northern expansion of the lake, and to run at once to Dog's Head, and work southward in the less open water south of the narrows.

"From the point east of Dog's Head the east shore was closely followed most of the way on foot, to the mouth of the southern Black River, and at the same time Black Island and many of the adjoining smaller islands were also examined. This proved to be much the most interesting part of the lake, as the shore from Dog's Head to Loon Strait was found to consist of altered gneisses and quartzites with a regular and long continued strike down the shore, having quite a distinct field appearance from the Laurentian gneiss further north. These rocks continue along the shore for a short distance south of Loon Strait and are then gradually replaced or overlaid by green quartz porphyries possibly of the Keewatin series. In a group of islands lying off Delay Point and north-east from Big Grindstone Point this quartz porphyry island is well seen in the eastern members of the group, while the most south-westerly island is conspicuously high and wooded and was found to be composed of massive green soft serpentinous rock, through which are running many veins of magnetic iron ore.

"Black Island was found to be composed of dark green schistose or massive chloritic rock which in the bottom of Hole Bay was found to present a sharp line of contact with the quartz porphyries. Overlying these schists is a considerable thickness of Palæozoic sandstones, apparently of the age of the Chazy ('St. Peter's Sandstone') of Minnesota, which at the south-west end of the island are found to run up conformably into the Trenton limestone.

"This sandstone evidently extends northward as the basal formation of the Palæozoic and the basin of Lake Winnipeg has been largely eroded out of its soft and easily disintegrated beds.

"From Black Island the supposed Keewatin rocks were followed round the bottom of Hole Bay, to near the mouth of Bad Throat River, where they suddenly end, and the shore is found to be composed of dark gray micaceous schists and light reddish gray granites, which are thence found to continue at least as far south as Black River.

'From Black River we crossed to the south of Red River and reached Selkirk just as the first heavy snow storm of the season set in. Here I learned that Mr. Dowling had arrived in from the lake a few days earlier. The following is his account of the work done by him during the summer:—

'I left Winnipeg on the 10th of June, and proceeded to Minnedosa, stopping at Westbourne to ship the large boat and camp outfit, stored here last year, to Selkirk. At Minnedosa a team was hired, and we proceeded northward on the trail known as the "Dauphin Road." For twenty miles we passed through a well settled country, and the road was well beaten, but from Scandinavia north it runs through

bush, following a meridian township line in to the settlement at Lake Dauphin. From Minnedosa, 1,670 feet above the sea level, the mountain rises gradually to 2,300 feet above sea, the trail then descending the northern slope into the valley of the Ochre River, 1,000 feet below. The top of the mountain is covered by a series of morainic hills, and the trail following a meridian line is forced over hills that otherwise might have been avoided.

'Having completed our observations in this district, I returned to Minnedosa and thence to Selkirk, where supplies and men were obtained for the summer work on the islands of Lake Winnipeg.

'Leaving Selkirk on the 28th of June, we proceeded north to Punk Island, were our work commenced. This island and Deer Island were traversed along their shores, the measurements being made with a patent floating log, and the position of the islands fixed by bearings taken from known points on the main shore.

'North of Dog Head, in Fisher Bay, are several large islands, which were surveyed, and the rock exposures examined, and a collection of fossils made.

'On the 25th of July, Mr. Lambe, of the Palæontological branch, joined our party for a month, and aided materially in making our collection of fossils more comprehensive.

'Berens Island and the bars and islands south of it were all traversed, and the month of September was spent among the islands on the west side of the lake between the mouth of the Little Saskatchewan and Long Point. Reindeer Island which has not been shown on any map, was found to be twenty miles long and five miles wide.

'Soundings were taken whenever practicable and noted, more particularly in the shoaler parts.

'Observations for latitude were taken at the following places: Cat Head, mouth of Little Saskatchewan, north end of Reindeer Island, south-east side of Reindeer Island, Fishing Station, Berens Island and at Berens River Post. Owing to the delay occasioned by the many storms during the season, the northern part of the lake was not visited, and we returned to Selkirk on the 8th of October.'

"At Selkirk the goods and smaller boat were stored in the warehouse of the North-west Navigation Company, and the larger boat was left in charge of Messrs. Wright and Howell, and on the 16th of October we left for the east.

"During the season eighty-three photographs were taken of points of especial geological and economical interest."

Cost of season's exploration, $1,976.59.

Mr. McInnes left Ottawa on the 5th of June for the purpose of continuing the work previously carried on by Dr. A. C. Lawson, in the districts of Rainy Lake and Thunder Bay. He was joined at Toronto by Mr. Smith, with his assistant, Mr. Lawson, and by Mr. Thos. Wiggins, of Napanee, who was appointed assistant for the season's field work.

A summary of Mr. Smith's work is appended.

Mr. McInnes reports as follows :—

"The party arrived at Port Arthur on the 9th of June. Some difficulty was experienced there in obtaining canoemen, who were in great demand on account of the activity of prospecting and surveying work in the district. Very good men were, however, eventually obtained from Rat Portage, through the kindness of Mr. Alex. Matheson, of the Hudson Bay Co., and were sent to Wabigoon Tank, on the Canadian Pacific railway, whence a start was made, on the 17th of June, southward on the Manitou route. This route follows a chain of lakes and waterways to Manitou Lake, and, still southerly, through this long, narrow lake to Rainy Lake. The valley occupied by this chain of lakes lies altogether in Huronian (Keewatin) strata. The long, narrow shapes assumed by the lakes being determined by the trend of the schists whose strike is followed in a remarkable way by the contours of the lakes. This feature which Dr. Lawson speaks of (p. 17, Part F, An. Rep. Geol. Survey, Vol. III.) is a very striking one, and characterises not alone this route but all the great water routes of the region. It seems to be due to the greater readiness with which the calcareous beds of the Huronian give way under denuding agencies. The valleys on these routes, generally narrow, are often of great depth ; narrow lakes, less than one mile in width, will frequently show a depth of more than 200 feet. Some of those belonging to a chain running north from the Seine River were found by Mr. Smith to be very remarkable in this respect, and soundings in Dog Lake gave a very uniform depth of from 180 to 220 feet.

" Rainy Lake was followed southerly to its south-westerly corner at Fort Francis, and thence easterly to the north of Seine River. This traverse led through the centre of the Rainy Lake sheet already published, and afforded an opportunity of proving the immense advantage to one travelling through the district of so carefully compiled a map as the one here referred to.

" From Rainy Lake the Seine River was followed upwards to Lac des Mille Lacs. From this lake the Kaministiquia River was reached by way of Lakes Kashabowie Shebandowan and the Matawin River

" The Kaministiqua River was followed to Port Arthur and the re-

mainder of the season devoted to an examination of the Dog Lake region and to a micrometer survey of Greenwater Lake—a large lake hitherto unsurveyed, which lies south of Shebandowan and which flows into that lake.

"In general character the region is a rolling country of low hills, generally well rounded and glaciated, and often with a surface almost bare of soil. It is exceedingly well watered—a district of lakes and watercourses which afford ingress to it, and by means of which intercourse is carried on through it in every direction.

"The rocks of the region under consideration may be divided into the two great divisions of Laurentian and Huronian. The former, chiefly gneisses and granitoid gneisses, occur in detached areas and bands, which are surrounded on all sides by Huronian (Keewatin) rocks. Only in the south-western part of the Aticokan sheet were rocks noticed which seem referable to Lawson's Coutchiching series. Everywhere else the Huronian is represented by the so-called Keewatin series, consisting largely of trappean material, sometimes massive, but often with a schistosity developed by pressure. There is, however, in addition to the trappean beds mentioned, a considerable amount of clastic strata—of conglomerates, altered argillites and quartzites, generally calcareous. The quartzites, alternating with thin bands of limestone, are in places shattered, and re-cemented by calcite.

"Considerable activity was shown in prospecting in the district during the past summer, and the iron-bearing area of the Aticokan River is already largely taken up.

"The reports from many of the mines in the silver-bearing Animikie series to the south were very encouraging and the completion of the Port Arthur and Duluth railway through the silver districts will afford the outlet so long needed by these mines, and will enable them to carry on their work to much greater advantage.

"Although the district as a whole cannot be called a good agricultural one, there are in it numerous areas of good lands suitable for cultivation. Some good red pine was noticed at different points, though for the most part it is scattered and poor. That seen around some of the lakes connected with the Seine River could be driven down that river to Rainy Lake and thence to Rat Portage.

"During the season about 400 miles of lakes and streams were surveyed by prismatic compass and boat-log, and by estimated distances, and 40 miles by micrometer telescope. In addition to the above, traverses were made during the summer for the purpose of examining the region geologically, where no surveys were necessary."

Mr. Smith left Ottawa for the field on the 3rd of June and was joined in Toronto by Mr. William Lawson, his assistant. On their arrival at Port Arthur, a few days were occupied in procuring supplies and equipment, and some delay was caused in securing suitable men.

The party with Mr. Smith left Savanne on the 14th of June, and the first seven weeks were occupied in making micrometer and compass surveys of a chain of lakes, which extends from Clearwater Lake, on the Seine River, to Little Wabigoon River; of the Eye River route, connecting the latter with Seine River; in a partial survey of a chain of lakes hitherto unknown, which extends from Clear Lake, on the Wabigoon route above mentioned, to the Big Turtle River; and in a partial survey of the upper lacustrine expansions of the Seine River.

The second trip, of three weeks' duration, was occupied in making a micrometer and compass survey of the upper part of the Seine River from its junction with the Fire Steel River to the entrance of Partridge River; of the Brush Creek route to English River on the Canadian Pacific railway, and partially of the Partridge Lake route to Lac des Mille Lacs.

At Savanne four days were lost through bad weather and delay in securing men to replace those who had left, and on the 30th of August the party left Savanne, travelled down the Dawson route to Windigonstigwan Lake, thence through Crooked Pine Lake and down the Aticokan River, finishing surveys of some short routes running northward which afforded sections across the Keewatin belt of rocks here traversed; thence down the Seine River, completing the surveys of the last season, to within eight miles of Sturgeon Falls. Here the party was divided, Mr. Lawson returned up the Seine River, and completed all the unfinished topography on this route to the eastern boundary of the sheet, while Mr. Smith, with one man and a light canoe, passed by a winter route across the headwaters of the Little Turtle River, and thus gained another section across the northern limit of the Seine River Band of Keewatin rocks; passing by this route into the chain of lakes explored in the earlier part of the season, he finished the surveys west to the Turtle River and east to Clearwater Lake. Thence he descended the Seine River to the next lake south, and then passed through a chain of small lakes running easterly to the old Indian Reserve No. 23 on the first expansion down the Seine River. He then proceeded to Savanne, *viâ* the Partridge Lake route, and arrived there on the 4th of October, the day after Mr. Lawson.

The band of Keewatin rocks shown on the "Rainy Lake sheet" as following up the Seine River, as far as the eastern limit of the map, has been traced all the way up the river in somewhat broader development as far as Steep Rock Lake. Here the band bifurcates the

northern portion, strikes N.N.E. and skirts the N.W. side of Clearwater Lake, with a width of three miles. Thence it curves to the N.E. and E., crosses the Brush Creek route, with its southern boundary on First Lake and its northern boundary on Pyramid Lake, and is again seen at the first falls up the Fire Steel River, where its strike is a little south of east.

The other band, varying in width from four to seven miles, passes in a general easterly direction up the Aticokan River, encompasses Crooked Pine Lake, and the north-western and north-eastern arms of Elbow Lake, and it is again seen on Baril Bay of Lac des Mille Lacs. The iron ores of the Aticokan and Whiskey Jack rivers are found in this band, and iron ores have also been found below the bifurcation of the band on the Seine River. The "Star Island" gold location is in a spur from this band which outcrops on Partridge Lake.

Between the bands and to the northward the country is entirely occupied by Laurentian gneisses and granites.

The broad band of Coutchiching mica schists so extensively developed on Rainy Lake, extends into the country shown on the south-western part of this sheet, but a few miles from its western boundary they are replaced by and interbanded with gneiss, which, as we proceed eastward, becomes the predominant rock, holding narrow bands of mica schists, which become less frequent further to the east. But this characteristic of the rocks is fairly constant throughout the whole of the gneissic area embraced in the southern portion of the Seine River sheet.

The work of the season was somewhat scattered and isolated, and an unusual amount of time was lost through wet weather.

The topography of the Seine River sheet has, however, now been completed, and all the accessible lakes in an area of about 1,600 square miles accurately outlined. About 300 miles of compass and micrometer lines, 250 miles of log and compass lines, and 50 miles of time traverses were run, serving as base lines for the compass triangulation of islands and intermediate points.

In addition careful notes were taken of all rock exposures, on the lake shores and on the rivers, from which the geographical distribution of the several bands can be accurately mapped.

Mr. McInnes returned to Ottawa on the 30th of September, and Mr. Smith on the 30th of October.

The cost of the season's work and pay of assistants was $2,556.13.

Dr. Bell was again engaged in the vicinity of Sudbury, working out the details of the structure, and studying the affinities, mode of occurrence and associations of the very interesting rocks with which the nickel, copper and other economic minerals of this district are associated. The subdivisions and their geographical distribution will now be shown on a map, scale four miles to one inch, covering an area of 3,456 square miles around Sudbury. This map is now nearly ready for the engraver. It will be sheet No. 130 of the projected series of the geological maps of Ontario, and will accompany and illustrate Dr. Bell's detailed report of his investigations in the great Sudbury Huronian belt during the seasons of 1887-88-89.

Mr. A. E. Barlow, as during the seasons of 1887, 1888 and 1889, assisted Dr. Bell in both the geological examinations and in the topographical measurements.

Mr. Barlow left Ottawa for the field on the 8th of July and returned on the 27th of September. Dr. Bell left on the 15th of July and returned on the 30th of October.

Three students, Messrs. A. M. Campbell, H. H. Walker of McGill College and T. L. Walker of Queen's, were attached to the party, and H. Skill and D. McLaren were engaged as canoe men and general assistants.

Dr. Bell reports on the work as follows :—

"Most of my time was occupied in the northern, central and western portions of the district represented on the map, while Mr. Barlow worked principally on the south-eastern half of the Huronian belt which traverses it. The work of both consisted largely in tracing out more closely the limits of the lithological divisions of the Huronian system and in ascertaining more details respecting the Laurentian. Special study was given to the geological relations of the nickel and copper deposits. Incidentally to these investigations, a good deal of topographical surveying required to be done.

"For the purpose of delineating more accurately the outlines of Lake Wahnapitæ and connecting it with the towns to the westward, I re-surveyed its western side, and the lakes and portages thence to the Vermilion River, and also made a micrometer survey of this river from the point reached by Mr. Barlow last year to a position beyond Proudfoot's east and west line. In connection with this survey, fourteen traverses, each occupying one or two days, were made to the right and left of the Vermilion River as a base. Other explorations were also undertaken in the Laurentian country between the Onaping and Vermilion rivers, in the townships of Morgan, Levack and Lumsden, and between these and Proudfoot's base line. Besides

these a track survey was made of seven lakes lying eastward of Wahnapitæ Lake, the largest of which (Koo-ka-ga-ming) is nine miles long. Some additional geological work was done in the Geneva Lake Huronian outlier, which is first entered upon by the Canadian Pacific railway at a distance of thirty-three miles north-west of Sudbury. Mr. Barlow re-surveyed Ramsay Lake and some smaller bodies of water in the townships of McKim, Garson, Blezard and Snider. Surveys were likewise made of the roads which have been lately opened in the townships of McKim and Snider, Sudbury district, and also of the Emery Lumber Company's railway north-westward from Wahnapitæ station, in the township of Dryden.

"The following are among the geological results of the season's operations: The numerous exposures of gneiss and red quartz-syenite between the Wahnapitæ road and the township of Denison have been traced out and connected together, showing that they all belong to a continuous range of these rocks lying in the centre of this part of the Sudbury trough. It was found impossible to separate on the map the gneiss and quartz-syenite of this range or of the main body of these rocks on the northern west side of the trough. An area of fine-grained, dark gray varieties of imperfect gneiss and quartz-syenite occurs around Wia-shai-gaming (or 'Fairbank') Lake, which connects this central range of the ordinary gneiss and quartz-syenite with the great area of these rocks on the north-west.

"A long and rather narrow mass of coarsely crystalline gray diabase was traced from Whitson Lake south-westward into the township of Denison, a distance of twenty-four miles. This cuts off a narrow belt all along the south-eastern side of the central range of gneiss and quartz-syenite. It is about a mile wide in the middle and runs to a point in either direction. The ore deposits of the following properties are situated along the south-eastern side of this mass or in the continuation of its course: Waddle's, the Dominion mine, Russell's, Stobie's, Murray mine, McConnell mine (in Snider), Lockerby and McIntyre's, lot 10, range I., Snider; the Crean or McConnell mine and the "Mineral Range," in Denison. The ores of the Stobie, Copper Cliff, Evans, lot 12, range 3, Graham, and the Vermilion mine, are associated with diorite, mostly brecciated, along the south-eastern or opposite side of the belt of gneiss and quartz-syenite which is cut off by this mass. Its confused character and the great number of angular fragments and masses of other rocks which it contains would indicate that we have here another line of ancient volcanic disturbance.

"A second mass of crystalline, gray diabase, similar to that of the first one which has been described, was traced from the north-eastern

part of the township of Levack south-westward for a distance of eighteen miles. This one is also about one mile wide in the centre and has the same form and course as the other. Several deposits of the nickeliferous pyrrhotite have been found on its course. Numerous masses of green crystalline diorite occur within the area chiefly occupied by the quartzite and greywacke series, and at the contact of these with the adjacent rocks several promising deposits of similar ores have been discovered.

"In regard to the stratigraphy of the district, the Sudbury Huronian trough, where it is traversed by the line of the Canadian Pacific railway, has a width of twenty-four miles. The Geneva Lake outlier has a breadth of seven and that of Onaping Lake of three miles. In the main or Sudbury trough the rocks on either side dip at high angles towards the centre. The lowest member is the quartzite and quartzose greywacke series, which prevails all along the south-eastern side from the southern border of the sheet at Lake Panache as far as the Wahnapitæ River, beyond which it becomes rapidly more argillaceous and spreads out over a wider geographical area.

"The green diorite masses in the midst of the quartzite and grey-wacke series vary in length from half a mile to ten miles, and as a rule, their longer diameters conform approximately with the prevailing strike of the surrounding rocks. On the north-west side of the trough this series is represented by a band of gray quartzite containing scattered pebbles of white quartz. This quartzite is overlaid by the remarkable black breccia referred to in last year's summary report. It appears to be several thousand feet thick, and was traced from Vermilion Lake north-eastward to a point on the upper Vermilion River beyond the latitude of Lake Wahnapitæ. Professor G. H. Williams, to whom specimens of the Sudbury series of rocks were sent for microscopical examination, has found that the irregular white spots with which this rock is flecked were originally fragments of pumice, but that they have been entirely replaced by silica.

"The highest member of the Huronian series in the district consists of thick gray argillaceous sandstones or greywackes, interstratified with more argillaceous bands. These rocks occupy a large tract of country between Vermilion Lake, in the township of Fairbank, and Lake Wahnapitæ, and generally dip at moderate angles."

The cost of the season's operations was $1,746.64.

The strata above referred to by Dr. Bell as the highest member of the Huronian resemble very closely the rocks known as the whin series in Nova Scotia, as they do also the Lower Cambrian (Harlech and Llanberris grits of North Wales).

Mr. A. S. Cochrane was again engaged in topographical work in the Ontario peninsula. He left Ottawa on the 23rd of July and returned on the 18th of October. His work was similar to that of previous years, and consisted in mapping the streams, hill features, etc., more correctly than they had been hitherto represented on the township plans. These plans are from the original surveys, which were made when the country was all under the primitive forest, and at that time the contours of the smaller hills could not be seen and the streams could only be noted where they intersected the concession and side-lines. As stated last year, the swamps, which existed while the country was in a state of nature, have been drained and have to a great extent dried up since the land has been cleared, so that in this respect the original maps do not correctly represent the country. In 1889, Mr. Cochrane had finished sheet number 115 and the past season he commenced on sheet 107, which is the next one to the south. He completed the topographical details in the townships of Kincardine, Huron, Kinloss and part of Greenock, which lie in the north-western corner of this sheet. In sketching in the above features Mr. Cochrane was guided by the lot lines, which are marked by boundary fences or by odometer measurements. The heights were determined by aneroid barometer.

Except near the shore of Lake Huron, where sand and gravel prevail and the surface is level, the townships examined are underlaid by a great depth of bluish-gray stone clay, with brown clay sometimes resting upon it; the surface being undulating and usually overspread by a rich loamy soil.

The fundamental rock was found in only one place, namely, about three miles east of the town of Kincardine, where a flat layer of gray limestone was exposed for several hundred feet in the bed of a branch of the Penetangore River. Some fossils were collected here which Mr. Whiteaves states belong to the Corniferous formation which had been already represented as occurring at this locality upon the geological map of the province.

Cost of this field-work, $350.

During the past summer Dr. Ells, assisted by Mr. Giroux, was occupied in continuing and extending the work of the previous season within the limits of the south-west quarter sheet of the Eastern Townships map. His own attention was devoted to a more careful and detailed examination of the area between the Grand Trunk railway and the Vermont boundary and between Memphremagog Lake and the Richelieu River, while the northern or St. Francis River area was

studied by Mr. Giroux, whose work included a careful examination of the section exposed down that river and up the Yamaska to St. Hyacinthe. Respecting these examinations, Dr. Ells states as follows :—

"Large collections of fossils from a number of points were obtained, in which work I was ably assisted by Mr. W. E. Deeks, B.A. Toward the latter part of the season, a few days were spent with Mr. C. D. Walcott, of the United States Geological Survey, in the study of the rocks about Philipsburg, Mystic and Highgate, in order to determine more accurately the exact horizon of the Philipsburg and Stanbridge series. Upon the setting in of bad weather in October, the rest of the season was devoted to the examination of the copper and asbestus mines of Sherbrooke, Thetford and Black Lake.

"While the surveys of the past season have not yet been fully plotted out, sufficient has been done to determine, with the aid of the fossils collected, the stratigraphical sequence and boundaries of the several formations east of the great St. Lawrence and Champlain fault. The black limestones of Farnham, which were supposed in 1863 to underlie the Levis formation, were found, as was pointed out in 1877 to be of Trenton age, as indeed the list of fossils, see pp. 239, 240 Geology of Canada, 1863, very clearly indicates. The stratigraphical sequence embraces, from the Cambrian through the Calciferous and Chazy to the Farnham limestones, which certainly represent a portion of the Trenton formation, the underlying Chazy being seen both to the east and west. Thus the Farnham rocks occupy the centre of a synclinal instead of the crest of an anticlinal, as supposed in 1863.

"The lowest rocks of the series, west of the Sutton Mountain pre-Cambrian and Cambrian strata, are the red and green slates and sandstones which constitute the prominent ridge of Granby, and which extend south-westerly almost to the line of the Canadian Pacific railway east of Farnham station, and also occupy the country between Granby and Abbotsford up to the great St. Lawrence and Champlain fault, which passes immediately to the west of Yamaska Mountain.

"The black Trenton limestones of Farnham centre do not appear to reach the Vermont boundary, the underlying Chazy limestone and dolomitic shales coming to the surface in this direction in a basin-shaped synclinal whose depression is to the north-east; but northward they can be traced continuously east of Granby and Roxton to and across the St. Francis to the Danville and Arthabasca areas.

"The country west of the St. Lawrence and Champlain fault is generally level, broken only by the intrusive masses of Rougemont, St. Hilaire, Mount Johnson, Monnoir, and kindred mountains. There

are very few rock exposures in this level country. Some outcrops which occur at Chambly, St. Jean Baptiste and St. Hyacinthe have yielded a numerous list of fossils; they have not yet been determined, but appear to indicate that the rock over the greater part of the area belongs to the Utica and Lorraine formations, as they are described in the Geology of Canada, 1863.

"The slaty belts on either side of the Central Anticlinal axis of Sutton Mountain, referred to in the Summary Report last year (1889) were traced for seventy-five miles, and the complicated relations of the rocks between these slaty belts and Lake Memphremagog were carefully examined. A complete micrometer survey of the lake on the Canadian side was made, and the intricate mixture of Silurian and Cambro-Silurian fossiliferous rocks, cut in places by very peculiar, often sheared dykes, clearly mapped out.

"The mining interests of the townships, though for the most part within the area adjoining that contained in the field of work just described, are on the increase. Two new copper mines in the Sherbrooke belt of schists, the Moulton Hill and the Howard, have been opened, and are now shipping ore to a considerable extent. The ore is very similar to that found at the Capelton mines, and, like that, is used for the manufacture of sulphuric acid. The copper contents of the lode apparently increase as the veins or lodes are opened downward. Further development, on properties abandoned some years ago in the district near Sherbrooke, are about to be undertaken; and the Huntington mine, lately acquired by Messrs. G. H. Nichols & Co., has been pumped out and mining operations resumed.

"The asbestus industry shows also a great increase, both in the amount of the output and in the prices obtained for the raw material, and probably not less than 8,000 tons have been shipped during 1890, though the complete returns are not yet in. The price of No. 1 has risen rapidly from $100 to $125 to $200, and even $250 per ton, with a further tendency upward. Several new mines have been opened and the work at the old mines has been pushed with greater vigour. The increase in the output is largely due to the fact that improved machinery is now employed in all the pits, in some of which compressed air for the purposes of drilling and hoisting is used; others use steam direct, the former being considered the more advantageous, owing to the ease with which the drill holes can be kept clean. Preparations are now being made for removing the dumps from their present sites to the barren ground near the Thetford River, and it is estimated that the crushing and cribbing of these will amply repay the cost of removal. The necessity of employing machinery for the purposes of crushing and

cobbing for the smaller veins at least is now recognized, and is being put in operation at the American and Anglo-Canadian mines at Black Lake. In addition to the mines already described in former reports, several new areas have been opened on the west side of the Quebec Central railway. While the veins at all these occasionally show good fibre, it is evident, upon examination, that the rock nearer the river and on the low ground does not yield such fine asbestus as in the mound where the mines were first opened. In Coleraine, also, several of the new companies which began operations last year at Black Lake have abandoned their locations, owing, probably, to an unfortunate choice of ground, while some of the Thetford companies—notably King Bros., A. S. Johnston and A. H. Murphy—have opened new areas here and found good veins. Among others, Dr. James Reed, on lots 27, 28, 29, has erected a first-class mining plant, with air compressors, for carrying on work on his areas, on which considerable work has been done during the past season, mostly by the contract system.

"On the west side of the upper part of Black Lake, near the inland line, Messrs. Grundy, Steel & Co., of the Beaver Mining Company, have begun work in Range B, Coleraine, but the work so far has been mostly exploratory. Numerous small veins and some of fair size have been found, but their value cannot yet be definitely pronounced upon.

"Great activity on the part of prospectors is manifested throughout the whole of the Serpentine belt of Thetford, Coleraine, Broughton and Wolfestown. Several finds of valuable areas are reported, none of which, however, in so far as careful inquiry could determine, are of very great importance.

"An interesting point discovered during the past year is the fact that the walls of so-called barren rocks encountered in nearly all the mines, owing to the presence of faults, and formerly supposed to be worthless, are now in good ground, the barren portions extending but a short distance. This is what might have been expected in such areas, the fault being only local and merely displacing masses of presumably equally rich serpentine.

"The serpentine areas of the south-western portions of the province have not yet disclosed the presence of workable veins of asbestus in quantity, with the exception of the mine at Danville, owned by Mr. Jeffrey, where some fine veins have lately been discovered. The Brompton Lake mine, which is the most southerly, worked to any extent, has been opened to a very considerable depth, and a large amount of money has been spent; but the prospects for workable veins in the lower workings are no better than at the surface, and no returns have yet been made. About Orford Pond on the south side of Orford Mountain,

and near Long Lake, at the northern extremity of the same ridge, excavations have been made in thin and irregular seams a fourth of an inch, and in the road west from Knowlton Landing to Bolton Pass, in the serpentine band to the east of the Missisquoi River, some exploratory work has been done without finding asbestus of any economic value, and in so far as yet ascertained this portion of the province does not present favourable indications for profitable asbestus mining.

"Of the work of the assistants in the field, Mr. N. J. Giroux, C.E., and W. E. Deeks, B.A., I can speak in the highest terms."

The party left Ottawa on the 11th of June and returned on the 11th of October.

Expenditure for the season, $1,490.

During the months of July and August the Rev. Abbé Laflamme, at my request, made some geological investigations in the county of Charlevoix, on which he furnishes the following report :—

"Attention has been more especially directed to the study of the Cambro-Silurian deposits on the north shore of the St. Lawrence, in the county of Charlevoix. The valleys of the Rivière du Goufre and of the Malbaie River are almost entirely occupied by limestones, extending in the first of these, to about ten miles from the St. Lawrence, and forming a band of nearly uniform width all through that distance, except at Cape Martin, where the outcrop of the calcareous strata, measured transversely to its direction, is notably narrower.

"In the Malbaie River valley the limestones disappear at a point nearer to the St. Lawrence, or at most seven or eight miles from it, but the area they occupy is considerably wider than on the River Goufre. Other limestone areas occur in the valleys of the Petit Lac and Lake Nairnes.

"Except in a very few places, it has been found totally impossible to trace with certainty the limits of the calcareous beds, the drift deposits which fill those valleys being so thick as to utterly prevent any such determinations, especially along the upper parts of the above-mentioned rivers.

"There are no Cambro-Silurian beds in the narrow valleys of the other streams of Charlevoix county, such as the Little Malbaie River and the numerous creeks falling into the St. Lawrence between St. Irénée and Baie St. Paul.

"The calcareous strata in both the large valleys referred to are only slightly disturbed. They generally take the shape of a broad synclinal, with only a few secondary folds.

"Other conditions obtain in the Cambro-Silurian band along the shore of the St. Lawrence, between Gros Ruisseau and Point Pères, and from Cape Martin to one mile above the wharf at Eboulements. This band is narrow from one end to the other, its maximum width being little more than a mile. It is not continuous, as shown on the map sent me from Ottawa last spring, but is interrupted for a long distance between Cape Martin and Point Pères, the only trace of it to be found in this distance being some unimportant and isolated knolls on the shore of Apple Cove (Anse aux Pommes).

"All the beds dip at a very high angle, mostly towards the St. Lawrence River. At points where they have not been too much disturbed there appear, both above and below, and lying conformably with them, beds of quartzite, frequently cut by large felspathic veins, of a pink colour, and apparently of Archæan age.

"Fossils are scarce in the basins of the Goufre and Malbaie Rivers, but they are plentiful at the mouth of the latter stream, especially along the line of contact of the limestone and sandstone beds which, with a thickness of a hundred feet, here constitute the base of the Trenton series.

"This great deposit of sandstone forms a building stone of excellent quality. The rock is cream-coloured in the upper part and becomes light green at the base of the series ; it can be quarried in blocks of any dimension. The material in the top beds is hard, fine-grained and is but slightly affected by exposure, being in consequence very well adapted for pavements. In fact, a large quantity is extracted every year for this purpose.

"There are but few economic minerals in Charlevoix county. In addition to the limestones and sandstones above referred to there may be found here rocks holding a large quantity of garnets, notably at St. Iréné and Malbaie. At the first mentioned place these garnets are very large, being frequently over six inches in diameter, but all are fissured and of no value. At Malbaie on the shore one mile above the wharf, the crystals are smaller, but their colour is better and their brightness greater than at St. Iréné.

"I have also visited the deposit of titanic iron ore at St. Urbain, but notwithstanding a careful examination of the place, its actual limits could not be defined, on account of the thickness of the drift there. One thing, however, is certain and that is that the quantity of titanic iron ore in the deposit is practically unlimited. The part already opened is immense, and many other similar deposits may be seen in various places.

"The iron works, formerly erected by an English company which, it is said, spent half a million of dollars on the spot, are totally ruined, there being only left to mark their site a few piles of old bricks, and the same must be said of the tramway which connected the mine with the village of Baie St. Paul, on the shore of the St. Lawrence.

"The silver mine which it is was alleged had been worked by the French and had been re-discovered recently never had any existence, except in the fancy of those interested in the selling of the property; and the galena veins on the west side of Baie St. Paul are so small and carry so little of the mineral that they are totally worthless. The alleged phosphate mines of St. Iréné are nothing but veinlets of sandstone imbedded in Archæan rocks and carrying fluorspar.

"It has been reported that asbestus and mica had been found at a point a few leagues distant, north-west of the St. Lawrence, but the truth of the report has not been ascertained and it should not be lightly credited."

The first description of these limestone areas was given in the Geology of Canada, 1863, Chap. IX., pp. 160-163.

Cost of exploration, $400.

Mr. A. P. Low was engaged during the past season on an exploration of the region around Lake St. John, in continuation of the work previously undertaken there by Mr. F. D. Adams and the Rev. Professor Laflamme. Respecting this work Mr. Low states :—

"The party left Ottawa on the 28th of May, and after spending ten days in Quebec copying plans of surveys in the district the work was commenced at Lake Edward. A complete geological examination was made of its shores and of the Jeannotte and Batiscan rivers, flowing out of it, to Laurentides Station on the line of the Quebec and Lake St. John railway.

"Along the southern shores of Lake Edward and on the upper part of the Jeannotte River a dark greenish, basic, dioritic gneiss occurs; this rock is highly impregnated with iron ore, usually occurring in the form of small grains, but frequently in masses several inches in diameter, and probably may be found in larger quantities and be of economic value. These dark basic rocks are also seen along the shores of Lake Batiscan and its outlet, also on the line of the Quebec and Lake St. John railway, to the north of Lake Edward.

"Having completed the exploration of the Batiscan valley, a canoe route from the headwaters of the Rat River was followed through Lake Najalouyand, on the Bostonnais branch of the St. Maurice, thence

across the height of land through Lakes Doré, Ecarté, Ouaquagamasis, Commissaires and Bouchette to the mouth of the Ouiatchouan River at Lake St. John.

"No economic minerals in quantity were found on this route, but on Lake Commissaires veins of pink pegmatite were seen carrying detached masses of hematite up to three inches in diameter, but generally smaller; some of these veins also hold large crystals of black mica, but these are considerably crumpled. A small detached area of anorthosite was found on the Ouiatchouan River similar to the great mass of that rock east of Lake St. John.

"Following this a close examination of all the rock cuttings along the Quebec and Lake St. John railway was made from Black River to the northern terminus. These cuttings afford admirable sections of the Archæan rocks in the area north of the St. Lawrence, which will be of great value in correlating the similar rocks found elsewhere in that region.

"A gray hornblendic granitite gneiss is found in the cuttings from Rivière à Pierre to Meguick. It is being quarried near the latter place for building stone. It is very valuable for heavy foundations and for exposed walls. About Lake Ouaquagamasis a red variety of the same rock would answer for building material quite as well as the gray, and would also likely prove valuable as a material for all purposes in which polished or worked granite in large blocks is required.

"Besides these building stones, the only other mineral of economic value observed was a small vein of mixed iron and copper pyrites, seen in the first cut south of Stadacona station; this vein in itself is insignificant, but indicates the possibility of finding these minerals in veins of larger dimensions.

"On the completion of this examination a trip was made up the Montmorency River to beyond the beaver meadows, and the country explored eastward from there to the Sault à la Puce River, in order to trace out the northern boundary of the mass of anorthosite which occurs behind Chateau Richer, and which holds lenticular masses of titaniferous iron ore scattered through it.*

"Two weeks were then spent in Charlevoix county, where, in conjunction with Prof. Laflamme, the outliers of Trenton limestone along the coast were traced out, as well as the southern boundary of the large anorthosite area are seen on either side of the Goufre River, near St. Urbain. This area is particularly rich in titaniferous iron ore, which often occurs in immense masses. One of these is on the hillside

* Geology of Canada 1863, pp. 34, 46 and 589.

west of St. Urbain,† where thousands of tons of ore are in sight. This deposit was worked some years ago, but owing to the high percentage of titanic oxide present and the high cost of fuel profitable reduction was impossible and an extensive plant was abandoned.

"In the valley of the Goufre River a bed of peat, eighteen inches thick, was found, apparently overlaid by marine clays; this peat would form excellent fuel.

"In a coarse garnetiferous gneiss on the land of Edward Martin, St. Jérôme road, two veins of pegmatite hold considerable quantities of graphite in disseminated scales.

"At the conclusion of the work in Charlevoix county the party returned to Lake St. John, where Mr. Smaill, B. Ap. Sc., had been engaged carefully tracing out the junction between the Archæan and Cambro-Silurian rocks on the west and south sides of the lake. The indications of petroleum at Point aux Trembles were investigated; the Utica shales were there found to be highly impregnated with oil, but as the shale and limestone appear to form a synclinal basin in the Archæan valley, with only a few low, narrow anticlinal ridges, the possibility of a large collecting area for oil under the shales is doubtful.

"The Cambro-Silurian rocks of Lake St. John are also, as in the west, the source of mineral springs. Several of them occur around the margin of the lake, one comes out on the shore between Chambord and the mouth of the Matabetchouan River. The water of this spring is at present under analysis here, and it may prove of medicinal value.

"During September an exploration was made in the country north of Lake St. John on the Wassiemeska, Rat and Ours rivers, branches of the Mistassini River. On the first named only Archæan gneisses were seen to the limit of the explorations some forty miles north from the lake; but here numerous boulders of jasper conglomerate, felsite and diorite, closely resembling the rocks of the Huronian north of Lake Huron, were found, indicating that a Huronian area will be found farther to the northward.

"At the sixth and seventh portages of the Mistassini River a large band of crystalline limestone was noted. This band is irregular in thickness, and appears to thin out at the upper portage; an extension of the same or a similar band is exposed for several miles along the course of Rat River, from which it crosses into the Rivière aux Ours, where it is seen below the first fall, but is there only five feet wide, and apparently near its eastern limit. This limestone or marble is occasionally found free from impurities, but having a coarse granular texture is unfit for building or ornamental purposes. The greater

† Geology of Canada 1863, p. 35.

part of the mass holds a varying quantity of light brown mica in small scales, while veins and detached masses of white orthoclase and pink and green scapolite are also common. In some of the bands rounded grains of green hornblende or pyroxene are found, chiefly near the junction with the enclosing gneiss.

"The Rat River was followed thirty-two miles along its course, the upper five being through an anorthosite area, probably an extension of the large area seen on the Peribonka River."

The Rivière aux Ours was ascended only ten miles, as the river there becomes unnavigable for a considerable distance. The rocks seen on this stream were orthoclase gneisses, with the exception of the limestone noted above.

"On the completion of this trip the party disbanded and Mr. Low returned to Ottawa, on the 27th of September. Cost of the explorations, $1,208.

Mr. Chalmers left Ottawa on the 5th of June to continue the survey and mapping of the surface geology of New Brunswick, his field work being the area included in the quarter-sheet map No. 2, S.E. This sheet embraces the county of Kent with adjacent portions of the counties of Westmoreland and Northumberland. His assistants were Mr. John H. McDonald, of Brockville, Ont., from the date of his leaving Ottawa till the 4th of October, and Mr. W. J. Wilson, of St. John, N.B., from the 30th June till the 15th of August.

The following is Mr. Chalmers's report on the season's work :—

"In the district to which this report relates the surface features are, generally speaking, uninteresting and monotonous, presenting the aspect of a low, level plain, which, however, rises gently towards the north-west margin. Between river valleys this flat Middle Carboniferous area is comparatively undrained, and hence much wet, barren land exists upon it, and shallow peat bogs are common.

"Making Weldford station our headquarters in the first part of the season we examined the country along the Intercolonial railway to the north and south. Numerous cuttings exposed good sections of the superficial deposits, and the rock surfaces exhibited striæ in many places. Two well-defined sets of these were observed. The first set occurs along the railway to the north of Richibucto River, the striæ trending about due east, and this course was found also near the coast in the Buctouche and Cocagne districts, varying in some places to points between east and north-east. The second set was seen along the Intercolonial railway to the south of Richibucto River, the striæ

having a nearly north to south course. Good examples of the latter were discovered just south of Welford station where the rock surfaces were exposed during the construction of the railway exhibiting finely preserved striæ with a course of S. 5° W. This is upon the water-shed between the Richibucto, which flows easterly into the Straits of Northumberland, and the Salmon River, flowing southwesterly into the St. John, or rather into Grand Lake, the elevation of this water-shed not being more than 200 to 250 feet above the sea. These two sets have only been produced by two different bodies of ice, both of which, to all appearances, have been local, the east and west striæ by ice which moved towards the straits mentioned, and the north and south by ice which flowed either northwardly into the valley of the Richibucto, or southwardly towards that of the St. John River.

"Boulder clay is sparingly found in many places on the higher grounds, but the chief covering of the rocks is a coat of their own debris, in the form of gravels, sands, &c., intermixed with boulders, chiefly local, with which, however, transported ones occur in greater or less numbers. The local debris referred to is usually masked by stratified materials, the relations of the two being seen in river banks, especially below the 200 feet contour line. The whole superficial covering of the Carboniferous rocks, indeed, appears more or less stratified in the upper part, and is, generally speaking, deeper than that resting upon the other geological systems or formations of the province. It conceals the rocks from view everywhere, except along river valleys. The millstone-grit, in its decay, seems, however, to have crumbled down largely into arenaceous materials. Sandy loam is met with along river courses, and clay beds constitute the basal member of the stratified series in certain places, but are not common; hence the conditions necessary for the preservation of the shells of marine animals in the post-Tertiary deposits of this district are rare, and consequently very few of these are found in the fossil state.

"A noteworthy feature of the surface beds upon the area referred to is the presence of boulders of granite, felsite, diorite, etc., scattered broadcast over them and often embedded therein. The boulders are obviously derived from the Cambro-Silurian, Cambrian and pre-Cambrian rocks to the north-west. Near the coast and below the 200 feet contour line, however, they are sparingly intermingled, in some localities, at least, with others which are not so easily accounted for, and which appear to have been borne thither by floating ice. The direction in which the boulders on the higher parts of the district have been transported is exemplified by their greater or less abundance in the different localities as we recede from the parent beds. For example,

along the south-west Miramichi those of granite and other crystalline rocks are unusually large and abundant, and in many cases angular, being near the parent rocks; but as we proceed eastwards across the Carboniferous basin they become smaller and more scattered. These transported boulders are, however, merely the residual specimens of the vast numbers which have been borne thither. Remains of others which have crumbled to pieces are seen in the coarser gravels and sands in numerous places.

"The other superficial deposits of the district presented no new features worthy of consideration.

"The evidence regarding the Pleistocene subsidence indicates that it may have been slightly less here than in the Bay of Fundy and the Baie des Chaleurs basins. An old shore line, quite distinct, was observed at Galloway, near Kingston, at a height of 150 to 160 feet above sea level. A similar ancient shore line, at about the same elevation, occurs in the Miramichi valley.

"After Mr. Wilson joined our party on the 30th of June, he and Mr. McDonald examined the southern part of the district, following all the roads and streams. While they were thus engaged, I first visited the ship railway now under construction across the Isthmus of Chignecto, for the purpose of re-examining the formations disclosed in an excavation for docks which is now being made at its western end. This excavation is opened in the margin of the Amherst salt marsh, between the mouths of the La Planche and Missaguash rivers. The section exhibits in descending order—(1) marsh mud, (2) blue clay holding shells of *Mya arenaria*, *Macoma grœnlandica*, and the young of *Buccinum undatum?*, (3) peat or humus, (4) red clay, and (5) boulder-clay, with local boulders. The bottom of the boulder-clay is not reached, although the excavation is upwards of 60 feet in depth. Afterwards I proceeded to Grand Manan, to examine one or two doubtful points there. Striation by ice, apparently from the mainland, and a few boulders evidently belonging to rocks other than those on the island, were observed on the higher parts, 350 to 400 feet above the sea. Returning to Kent county, I then made a canoe trip along the coast and around the lagoons inside of the sand dunes, which here form barriers along the shallow shores. Many interesting facts were noted regarding the formation of the sand beaches, lagoons, peat beds, salt marshes, etc.

"On the 3rd of October I visited St. John, with the view of re-examining the boulder-clay beds at Negrotown Point and the Fern Ledges. In company with Mr. Wilson, I measured a section of them at the latter place, to enable me to make a diagram exhibiting a deposit

of stratified clay intercalated therein. From St. John I went to St. Andrews to make some further observations on the glaciation of that section, more especially of Chamcook Mountain, etc. It was found that ice had ground completely over that hill, and that the summit, 637 feet above sea level, was scored and polished in a remarkable manner.

"Regarding the soil of the district examined during the past season, it may be remarked that it is, on the whole, good, especially along the coast and river banks, and also on some of the higher grounds between the streams. But large tracts are swampy, or covered with boggy material, constituting the so-called barrens. Wherever the natural drainage is sufficient to carry off the surplus waters due to precipitation, the land is fit for cultivation. It is, however, deficient in lime, and requires frequent applications of that material to bring it up to its highest yielding capacity. Good farming districts are found along the Richibucto valley, more especially on Nicholas River and Coal Branch, also in the Kouchibouguacis valley, and in the Buctouche and Cocagne districts.

"The forests of this part of the province, formerly so dense, and consisting of a mixed growth of trees, such as pine, spruce, birch, hemlock, cedar, poplar, hacmatac, etc., are now becoming greatly depleted. Large areas have been overrun by fires, and present little else but bare trunks and a scanty second growth. The destruction of timber from this cause alone is enormous. During the summer of 1888 the fires which swept over a large portion of the area under review destroyed valuable tracts of the forest.

"The materials of economic value met with in the district are few and unimportant.

"Peat is found in extensive bogs along the coast, especially near the Kouchibouguac, the Kouchibouguacis, Aldouane, Richibucto, and in many other places. These bogs are often deep, and produce abundant crops of cranberries. In the interior, large bogs often occur upon the flat, undrained portions of the district, but they are usually shallow, and in many cases support a scrubby growth of hacmatac and black spruce. No use has yet been made of peat in this part of the country.

"Gravel and sand, suitable for ballasting, road-making, etc., were observed in nearly every locality, and clay, available for brick-making, occurs in many of the river valleys. Fine blown-sands are abundant everywhere along the coast, forming the dunes or barriers already referred to.

"In the latter part of the season I visited the deposit of so-called magnetite, near the head of Millstream, Gloucester county, specimens

of which, analysed by Prof. Donald, chemist and assayer, Montreal, are reported to have yielded upwards of 60 per cent. of metallic iron, with 10 per cent of silica, etc. Considerable portions of the ore appear to be highly pyritous. About two miles distant from this deposit there occurs a vein of pyrites and galena, the former containing traces of gold and the latter of silver, according to an assay made by Mr. Hoffmann, chemist and mineralogist to the Geological Survey Department.

"Field work closed on the 4th of November and on the 6th I reached Ottawa. Mr. W. J. Wilson rendered me good service, and has now acquired such a knowledge of surface geology as to make him an efficient and valuable coadjutor in the work."

Cost of season's explorations, $1,005.41.

Early in July, Professor Bailey was occupied in completing the work taken in previous seasons in the counties of Rimouski and Temiscouata, in the province of Quebec, and in obtaining the additional data required to complete the sections of the map illustrating this region. Respecting the work, he reports as follows :—

"Careful examinations were made of the rocks exposed along the lines of the Intercolonial and Temiscouata railways, with reference both to the succession of strata and the possible occurrence of fossils, while similar observations were extended to portions of the intervening district, between Little Métis and Rivière du Loup. The general result was to show that the greater part, if not the whole, of this district is occupied by the Sillery formation, supposed to represent an upper portion of the Cambrian system. A detailed report, with accompanying maps, is being prepared, and will be published during the year.

"About the 25th of July I proceeded, in accordance with your instructions, to the province of Nova Scotia, and entered upon the study of the geology of Queen's and Shelburne counties. Having been desired by you to give my first attention to the coast, operations upon the latter were begun at the town of Liverpool, and were continuously carried on until the entire coast, from Port Medway harbour, forming the eastern boundary of Queen's county, to Pubnico harbour, forming the western limit of Shelburne, had been examined. This work was found to be unexpectedly easy, owing to the circumstance that almost the entire shore is occupied by fishermen, and bordered by roads which give easy access to any desired point. The comparative uniformity of the rock formations, consisting chiefly of fine grained gneisses, quartzites and mica schists, together with irregular masses of granite, further facilitated their study. The general result of these observations was

to show the crystalline rocks in question, which occupy a belt along the coast of from two to fifteen miles in width, are only a more highly altered condition of the gold-bearing slates and sandstones of the interior.

"Having completed the study of the coast, attention was next given to the more accessible portions of the inland districts. Every road in the two counties was traversed and observations were made on the character and relations of their rock formation, particular attention being paid to the country embracing the gold districts of Molega Lake and Whiteburne. The several members of the gold-bearing series were clearly distinguished, and numerous facts ascertained bearing upon their succession and the plications by which they have been affected, facts of the first importance in connection with the development of the gold industries of the district. A report embodying the results of these observations is now in course of preparation, but cannot well be completed until examinations are made of the numerous lakes and streams by which the country is intersected, and for the traversing of which there was not sufficient time during the past season. One of the streams, the Port Medway, affords admirable opportunities for this purpose, forming an almost continuous rock section from the border of Annapolis county to the coast, and its careful study will supply a key to the structure of the entire region."

Mr. Fletcher left Ottawa for Nova Scotia on the 8th of July, 1890, and continued fieldwork until the second week in December, being engaged during the greater part of that time in an examination of the district lying west of that surveyed in 1889, including a portion of the counties of Colchester and Hants.

His assistants were M. H. McLeod for six months, B. A. L. Huntsman for two months and a half, and D. I. V. Eaton, who is still employed. The cost of the season's explorations, including salaries of assistants, will be $1,300.

Within the area examined, Triassic, Carboniferous limestone and Devonian rocks are well exposed.

Between the Intercolonial railway along the Salmon River and the valley of the Stewiacke River, the country is occupied chiefly by the rocks of Union and Riversdale, described in previous reports as Devonian. These, at Brookfield, are referred by Sir Wm. Dawson to the Devonian, but south of Truro, to the lowest part of the Carboniferous. Dr. Ells, who considers them Devonian, traced them in 1884 nearly to the Shubenacadie River where they are succeeded by Carboniferous limestone; but beyond this river quartzites and

slates also occupy a considerable portion of the shore of Minas Basin at Walton, Split Rock, Somerville Landing and Avonport, and are seen in most of the brooks from Maitland as far as the mouth of the Gaspereaux River. Although at a few points west of Clifton the Carboniferous limestone comes between them, they are as a rule capped on the north by Triassic strata. These occupy, in nearly horizontal attitude, a basin which extends westward from near Valley Station, one rim fringing the south side of Minas Basin, the other reaching much further inland on the north side.

South of the Devonian slates, Carboniferous limestone occupies the basin of the Stewiacke River from Eastville to its confluence with the Shubenacadie, whence it stretches from Brookfield to Gay's River; thence up Shubenacadie River to Enfield, where it rests on Cambrian rocks of the Atlantic coast gold-bearing series and down stream to Maitland and Blackrock. Outliers are also found on Minas Basin, and a broad belt lies, as already stated, along the Kennetcook River.

Between the gold-bearing rocks and the Carboniferous of Stewiacke lies a great mass of drift sand, gravel and boulders.

Good sections across the country are given by the road from Walton to Brooklyn and Newport station, by that from Noel through Kennetcook Corner to the Gore, and from the Gore to Shubenacadie station. The first crosses principally Carboniferous limestone to the contact of the gold-bearing rocks, a short distance east of Newport station. The second shows first Devonian, then Carboniferous limestone, with the small coal seams of Kennetcook, then the great band of soft micaceous and chloritic slates of various colours, which enclose the cross-leads of quartz, from which are derived the stibnite of the West Gore antimony mine and the gold of Central Rawdon. From the last named locality come the forms found at the gold mines last summer by Professor Hind, supposed by him to be *stromatopora*, but which, on examination by Mr. T. C. Weston, of the Geological Survey, proved to be only concretions of dolomite. From Shubenacadie and Elmsdale to the slates of the Gore—once quarried for roofing slate—the rocks are chiefly Carboniferous limestone.

A careful survey of the Devonian rocks and Carboniferous limestone of the East Mountain of Onslow and Penny's Mountain, in Clifford's and Farnham's brooks, has shown that the latter rest, in small patches, on the former, with the most complete and satisfactory evidence of unconformity, and unconformity scarcely less evident is seen also at Walton and Cheverie.

The Trias seems to yield no minerals of economic value, its sandstones being too crumbly for building, and its concretionary beds too impure for limestone. In the Lower Carboniferous, on the other hand, limestone quarries abound, some of which at Brookfield, Stewiacke, Shubenacadie and elsewhere, are extensively worked. The red hematite of Newton Mills is a deposit at the junction of the Carboniferous limestone, and conglomerate with the Cambrian gold-bearing series, and similar ores may be expected at other points along the line of contact. The limonite of the Brookfield iron mine is also at or near the base of the Carboniferous. It is now being vigorously worked by the New Glasgow Coal, Iron and Railway Company, who are also working their East River of Pictou iron areas, near which they are erecting a large blast furnace (see "Canadian Mining Review" for August, page 113.) At the same horizon, probably, are the manganese mines of Tenny Cape, Walton, Cheverie and East Onslow. That of Tenny Cape has continued for many years to supply a large quantity of the purest manganese di-oxide (pyrolusite).

From quarries near Windsor, Cheverie and Walton large quantities of gypsum are exported to the United States, and plaster is also worked on a smaller scale at Beaver Brook, Shubenacadie, Stewiacke and other places within the area.

In the East Brook, which flows into Stewiacke River from the south, about eight miles above the station, a seam of coal, apparently not exceeding eighteen inches in thickness, of mixed coal and carbonaceous shale, was lately opened. A boring sunk about 80 feet at Johnston Brook, not far distant, is said to have cut black gypsum, and the coal is probably about the same horizon as that of Kennetcook. The celebrated scythestone of Birch Hill, a fine gray sandstone, with sharp grains of silica, is found in the same neighbourhood. Coal was also reported to occur at Selma, but the report seems to have arisen from the presence of thin bands of dark gray shale, marked with fossil plants, among thick beds of gray flinty sandstone, which forms barrens in the neighbourhood. At the request of Mr. Robert H. Fraser, Superintendent of the Nova Scotia Central railway, a visit was paid on the 20th of October to borings made in search of coal at Spa Springs, Annapolis County. One hole had been sunk 100 feet, but nowhere in the neighbourhood were rocks seen in which coal could reasonably be expected to occur. Beneath what appears to be an overflow of coarse dolerite near the top of a steep slope lies a layer of bright greenish clay rock, underlaid by dark graphitic argillite, from a few inches to several feet thick, succeeded below by bright red rocks, presumably of Triassic age.

Great excitement was caused last summer by the reported discovery of gold in a whitish-gray flinty conglomerate consisting almost wholly of pebbles and grains of white quartz, beds of which underlie the Carboniferous limestone from the neighbourhood of Brookfield, far up the Stewiacke River on the north side. The region was proclaimed a gold district, and rights of search taken out covering many miles. The attention of prospectors was, moreover, directed to all the conglomerates in the province. That the conglomerate on Gay's River is auriferous has long been well known, and Professor Hind has proved the existence of gold, silver and copper in certain beds of that nature near Baddeck. The Brookfield conglomerate was said to have given rich returns by milling, although a somewhat close examination by panning the dirt in the beds of the streams flowing over it failed to indicate the presence of gold in appreciable quantity. Two samples were sent to Mr. Hoffmann, one from the neighbourhood of the barytes mine, the other from the brook three hundred yards above the Glenbervie mills; but neither of them yielded, on assay, a trace of either silver or gold. Tests subsequently made on a large scale at the mill of one of the gold mines emphatically confirmed the accuracy of Mr. Hoffmann's assays.

It has been shown that the rocks of the Londonderry iron mines, formerly supposed to be Devonian, and subsequently Silurian or Cambro-Silurian, everywhere contain Devonian plants; and as similar slates were stated by Mr. Scott Barlow to be largely developed in the west branch of Economy River, it was deemed advisable to re-examine these latter for comparison, and to collect specimens of the fossils with which they are crowded. In 1876, from dark shales in situ in a little brook at Farmington, in Cumberland county, a locality of slaty rocks to which also attention was directed by Mr. Barlow, and at which he obtained trilobites in 1876, several species of graptolites and other Silurian fossils were collected. In Bulmer Brook and other brooks of this vicinity, pre-Carboniferous argillites were seen in contact with traps, agglomerates, felsites and other rocks of similar origin.

The conclusion arrived at, that large areas hitherto mapped as Cambro-Silurian are no older than Devonian, led to a short re-examination of the Cambro-Silurian strata of the iron mines of the East River of Pictou. These, however, appear to be older than the rocks of Londonderry.

Mr. E. R. Faribault left Ottawa on the 11th of June, with instructions to continue the detailed surveys of previous years and study the

stratigraphical structure of the gold-bearing series of rocks of the Atlantic coast of Nova Scotia.

The district surveyed lies westward of that surveyed in 1888, and southward of that surveyed in 1889, extending along the sea shore in Halifax county from Tangier to Lawrencetown and some twenty miles inland, an area of about 375 square miles.

The auriferous Lower Cambrian rocks of the country are cut by an uninterrupted belt of granite, two to four miles wide, extending westward to within two miles of Waverly. The folds of the gold-bearing series, and more especially the anticlinal axes, were carefully examined and traced out, on account of their close relation to the richest auriferous belts.

The gold mining districts of Tangier, Lake Catcha and Head of Chezzetcook are situated in the region examined. These districts were carefully studied as to their geological structure, and found to be on the axes of anticlinals, and are the auriferous leads of Murphy's Cove and Black Point of Ship harbour, Clam Bay and English Point of Jeddore, and those on the south side of Conrod and Thomson lakes are similarly situated.

Three miles up the Musquodoboit road a few tons of loose argentiferous galena ore were taken out, along four levels tunnelled in granite debris on the face of a hill. An assay of the ore is said to have given a good showing of silver, but so far the developments made have not reached the bed rock.

Some fossil forms, taken from the gold-bearing slates at the Northup gold mines at Rawdon, and believed to be of organic origin, were found on microscopic examination by Mr. T. C. Weston to be merely concretions.

Mr. Ed. Gilpin, Inspector of Mines in Nova Scotia, has found markings on Lower Cambrian rocks near Bedford which may prove of some importance in determining more definitely the age of this series.

Mr. Faribault was assisted, as in previous years, by Messrs. A. Cameron, J. McG. Cruickshanks and P. A. Faribault.

The season's work extended until the first of November; cost $1,106.54.

MINERAL STATISTICS AND MINES.

Mr. E. D. Ingall, Mining Engineer in charge of the division of Statistics and Mines, makes the following report on the work done during the past year :—

"The early part of the year was occupied with the ordinary routine connected with preparation of statistics of mineral production, etc., during 1889. A summary of this was printed and distributed in April, and the full report was issued in November. Considerable attention has also been given to devising more complete and efficient methods for attaining the objects sought in establishing the Mining division of the Department. To this end, efforts have been made to revise and complete the Directory of producers of economic minerals and of the localities where the various minerals are worked, or occur in the Dominion: these latter are being geographically represented on maps by means of a complete system of conventional signs. In the compilation of this schedule of signs those already in use by the Survey have been taken as a basis, others invented, where necessary for the completion of the list, and the whole elaborated so as to show not only the metallic ore dealt with, but also the particular ore yielded by the deposit.

"Preliminary steps have also been taken towards the more systematic arrangement of the mining records, such as of borings, mining plans, reports, etc., and the cataloguing of the same, while effort has also been directed towards the more continuous and regular acquirement by the office of general mining information at frequent regular intervals during the year from the several mining districts.

"During the summer investigations were made by myself and by Mr. Brumell, regarding the progress and condition of the mineral industries in a number of mining districts in Ontario, Quebec and New Brunswick.

"As last summer was the first opportunity I have had to visit most of the mining districts referred to, the investigations made were more or less of a preliminary and general character, and were undertaken to familiarize myself with the aspect and leading features of the several districts, and to become better acquainted with the mine owners and managers, and thus be able to deal more intelligently with the returns and the reports sent by them to the Department.

"With this object in view the iron, mica and phosphate districts of the eastern part of the province of Ontario were visited, as also were the Madoc gold and iron centres, likewise the Sault Ste. Marie and the Sudbury mining districts. Attention was also directed to the salt, gypsum, petroleum and natural gas industries, the two latter receiving special attention from Mr. Brumell.

"In Quebec visits were made to the gold, asbestus and copper mining, and slate quarrying districts of the Eastern Townships, as well as the newly started asbestus mines and phosphate mines of Ottawa

county. In New Brunswick the coal and manganese mines were visited, and also the gypsum and granite quarries, etc.

"During the summer Mr. Brumell visited several points in Ontario where boring operations were being carried on. Notes on these were made and information relating to old borings and the occurrence of gas and oil was obtained. Mr. Brumell states:—

"In Essex county extensive drilling operations were in progress at various points, more especially in the district between Essex Centre, Harrow and Leamington. At Essex Centre the Central Gas and Oil Company of that place have finished a well 1,200 feet in depth without, however, any economic result, as neither gas nor oil were obtained. At Walker's Marsh, the Messrs. Walker and Sons, of Windsor, have finished three wells from which a very considerable flow of oil was obtained. They have also been actively carrying on operations in other parts of the county and in the adjoining county of Kent. The Citizens Gas, Oil and Piping Company, of Kingsville, during the year drilled on the road allowance, west of the well known as 'Coste No. 1,' where a daily flow of gas amounting to over 7,000,000 cubic feet per day was obtained; this gas is now being utilized in lighting the streets of Kingsville, to which town it has been piped. The drilling of this well was the cause of considerable litigation between the owners and the Ontario Natural Gas and Fuel Company, the owners of 'Coste No. 1,' the result of the suit was, however, in favour of the former company the injunction given at the instance of the latter company not being sustained. The Ontario Natural Gas and Fuel Company have, it is understood, again undertaken operations in the county, in that part between 'The Marsh' and Essex Centre, with what result, however, we are unacquainted. Various other operators have been working throughout the country, but owing to lack of time I was not enabled to ascertain the result nor the extent of their operations.

"In Kent county, in addition to the work done by Messrs. Walker & Sons, mentioned above, a certain amount of work has been carried on, notably the well sunk by the Citizen's Gas Company of Blenheim, where in a boring 900 feet deep small flows of gas were obtained at 700 and 800 feet.

"At Stratford, Perth county, a boring was undertaken by the Stratford Natural Gas Company, which at the time of my visit, on the 12th of August, had reached 900 feet without encountering gas or oil.

"In Welland county the Provincial Natural Gas and Fuel Company, have finished their series of wells to the number of fourteen, all of which are situated in the townships of Bertie and Humberstone, in the vicinity of Sherks Station on the Grand Trunk railway. Other

operators have been busy throughout the county, notably Messrs. Conmiller & White, who drilled for and obtained gas in the town of Port Colborne. John Rube struck gas a few miles west of that town, this gas is being utilized in the firing of lime-kilns owned and operated by Mr. Rube. Another lime producer, Mr. Carroll, drilled in the south-west part of Bertie township, and in the northern part of Port Colborne, Mr. Edward Wear struck a well from which a daily flow of gas of over 400,000 cubic feet is recorded.

"In Wentworth county considerable activity has been evinced in the search for gas and oil, several wells having been sunk in the vicinity of Hamilton, though with what result was not ascertained.

"Outside of the counties above mentioned, but little has been done except in the county of Lambton, where, in the oil territory of Enniskillen township, the usual amount of boring has been carried on and many new wells brought in with the usual average daily flow of oil."

A detailed report of the gas oil and salt wells in Ontario is now being prepared by Mr. Brumell.

In reference to the development of the gas and oil industry of which particulars are given above as regards Ontario, I desire to again call attention to a district in the province of Quebec, viz.: The valley of Richelieu River, north of St. Hyacinthe, on the Grand Trunk railway, as one in which there are strong probabilities of remunerative gas or oil wells being struck at depths probably not exceeding 1,500 or 2,000 feet. The whole area is underlaid by the Trenton limestone and already, further north-east, near Lake St. Peter, a considerable flow of gas was struck, but which, so far, as I can learn, has never been utilized in any way. This well was described in the Summary Report for 1887. That the discovery at St. Grégoire should not have been more energetically followed up, is probably accounted for, if, as I am informed, one company has acquired by charter an exclusive right to seek and use natural gas in and over the whole province of Quebec.

"Mr. Jas. White's time was occupied in completing surveys of the south-west corner of the map illustrating the River du Lièvre, and Templeton phosphate districts, and in making surveys of mines and workings in the Eastern Ontario phosphate, mica and iron districts, comprising the workings and pits of some 22 mines.

"Since returning from the field in the fall, the time has been occupied in the ordinary routine work of the division; collecting and preparing the material for the annual report; answering inquiries, etc., together with a continuation of the work of preparation of the Directory, and maps of mineral occurrences, etc. It is hoped, that some of these maps will be published during the coming year.

"The number of circulars sent out, together with the reminders found necessary, amounts to about 5,500, besides about 650 letters sent, and some 500 received."

Chemistry and Mineralogy.

With reference to the work carried out in this connection, Mr. Hoffmann reports as follows:—

Agreeably with the practice of former years, the work carried out in the chemical laboratory has been of an almost purely practical character; but few examinations or analyses having been made other than material which it was deemed might, not improbably prove of some importance. The work embraced:

I. Analyses of fuels.

II. Analyses of limestone and dolomites.

III. Analyses of mineral waters and brines.

IV. Analyses of iron ores.

V. Gold and silver assays.

VI. Miscellaneous examinations—under which heading are included clays, marls, saline deposits, etc., etc.

The number of mineral specimens received, brought or sent, for examination amounted to five hundred and fifty-eight. The greater number of these were brought by visitors, to whom the required information in regard to their economic value was communicated at the time of their visit. In other instances, those where a more detailed examination appeared called for, or when the specimens had been sent from a distance, the results were sent by letter. The number of letters written, the majority of which were of the nature of reports, amounted to two hundred and forty-six. The number of letters received, one hundred and forty-eight.

Mr. F. G. Wait has, as a principal work, been engaged in the analyses of some twelve samples of brine from Lake Winnipegosis, collected by Mr. J. B. Tyrrell; the inquiry having for its object the ascertaining if these brines would be suitable for the manufacture of salt.

Mr. R. A. A. Johnston has, in addition to a great variety of miscellaneous work, conducted a series of analyses of limestones and dolomites, with the view of ascertaining their relative merits, in so far as chemical composition is concerned, for structural and other purposes. He has also examined numerous samples of ore in regard to their nickel content.

In the work in connection with the minerological section of the Museum, I have been most ably and faithfully assisted by Mr. R. L. Broadbent. In addition to the work of labelling, readjusting specimens and maintaining the collection generally in an orderly condition, he has completed the rough draft of a catalogue of the economic collection of minerals, so that the manuscript of the whole catalogue for this section of the Museum will now very shortly be ready to place in the hands of the printer.

A great many of the mineral specimens have been replaced by more characteristic ones, and the collection augmented by the addition of some three hundred others. Of these the following were collected by members of the staff:—

1. Dr. G. M. Dawson:—

   Ninety specimens of gold and silver ores from British Columbia.

2. Mr. A. E. Barlow:—

   Thirty specimens of copper and nickel ore from Sudbury and vicinity.

And the undermentioned constituted presentations:—

1. Allan, W. A., Ottawa, O.:—

   Magnetite, from lot 1, range I., of the township of Torbolton, in Carleton county, O.

2. Baker, Lieut-Colonel James, M.P.P., Cranbrook, Kootanie, B.C.:—

   A sample of crude petroleum, from Sage Creek, Flathead River, East Kootanie, B.C.

3. Byrne, W. E.:—

   Galena, from mine on Mill Stream, township of Beresford, Gloucester county, N.B.

4. Campbell, A. M., Perth, O., per A. E. Barlow:—

   Martite, from the Dalhousie mine, Dalhousie township, Lancaster county, O.

5. Canadian Copper Company, Sudbury, O., per Wm. Evans, Manager:

   (*a.*) Pyrrhotite (nickeliferous), and

   (*b.*) Chalcopyrite and pyrrhotite (nickeliferous), from the Copper Cliff mine, lot 12, range II. of the township of McKim, district of Nipissing, O.

   (*c.*) Sample of foregoing ore, after roasting.

   (*d.*) Sample of matte containing 17 per cent nickel and 23 per cent copper.

(*e.*) Nickeliferous pyrrhotite and chalcopyrite, from Evans's mine, lot 1, range I. of the township of Snider, district of Algoma, O.

6. Dickson, Wm., Pakenham, O. :—
Silicified wood, from Long Lake, N.W.T.

7. Donald, J. T., Montreal, Q. :—
Scolecite, from Black Lake, township of Coleraine, Megantic county, Q.

8. Ferguson, J., Newcastle, N.B. :—
Iron ochre, from the North-west branch of the Miramichi, Northumberland county, N.B.

9. Gordon, W. H. Lockart, Toronto, O. :—
(*a.*) Apatite, from lots 13, 14, 15 and 17, range XI. of the township of Monmouth, Peterborough county, O.
(*b.*) Apatite, from lot 4, range III. of the township of Dudley, Peterborough county, O.
(*c.*) Apatite, from lot 11, range V. of the township of Dysart, Peterborough county, O.
(*d.*) Apatite, from lot 21, range XI. of the township of Harcourt, Peterborough county, O.

10. Grace, P., Gracefield, Q. :—
Mica, from lot 38, range I. of the township of Bouchette, Ottawa county, Q.

11. James, Joseph, Bridgewater, O. :—
(*a.*) Asbestus, from lot 7, range XI. of the township of Elzevir, Hastings county, O.
(*b.*) A sample of the ground asbestus.
(*c.*) Roofing cement prepared from the same.

12. McKindsey, Hon. G. C., Milton, O. :—
Seven specimens of terra-cotta ware.

13. Matthis, Bro., Ottawa, O. :—
Clay nodules, from Green's Creek, Gloucester township, Carleton county, O.

14. Murray, John, Spence's Bridge, B.C. :—
Gypsum, from vicinity of Spence's Bridge, B.C.

15. Northup, Gould, per Hugh Fletcher :—
Native gold in quartz, from the Central Rawdon gold mine, Hants county, N.S.

16. Payne, W. R., Bathurst, N.B. :—
Magnetite, from head of Mill Stream, township of Beresford, Gloucester county, N.B.

17. Poole, H. S., Stellarton, N.S. :—
Stalagmite, from the Acadia coal mine, Pictou county, N.S.

18. Robotham, Capt. J. G. C., Victoria, B.C. :—
Infusorial earth, from Quamichan, Vancouver Island, B.C.

19. Scott, J. G., Quebec, Q. :—
A six-inch cube of dressed limestone, River Mistassini, about thirty miles from Lake St. John, Q.

20. Soues, —, Clinton, B.C. :—
A nugget of native copper, from Eleven-Mile Creek, Fraser River, B.C.

21. Sperry, Francis L., Sudbury, O. :—
Sperrylite, from the Vermilion mine, lot 6, range IV. of the township of Denison, district of Algoma, O.

22. Willimott & Co., Ottawa, O. :—
(*a.*) A collection consisting of 119 specimens of Canadian cut-stones.
(*b.*) Strontianite, from Carleton county, O.

Mr. C. W. Willimott reports that during the early part of the year, he was engaged making up collections of minerals and rocks, for the following institutions :—

High School, Beamsville, Ont	113
do St. Johns, Que	113
Commercial Academy, Quebec, Que.—(Supplementary	20
Mechanics Institute, Wingham, Que	121
High School, Paris, Ont	113
Shefford Academy, Shefford, Que	113
Royal Military College, Kingston, Ont.—Supplementary	54
Collège St. Rémi, county of Napierville, Que.	106
High School, Essex Centre, Ont	109
do Parkhill, Ont	109
Separate School, Freelton, Ont	109
Collège Set. Anne de la Pocatière, Que	109
St. Francis College, Richmond, Que	109
Presqu'Ile Park Museum, Presqu'lle, Ont	109
High School, Guelph, Ont	115
Superior School, Petit Rocher, Gloucester county, N.B	13
Collegiate Institute, Hamilton, Ont	103
Total	1,648

A collection of 400 specimens of minerals and rocks was sent in for identification by the Collège St. Laurent, Montreal, these were named and returned. That during the summer, between the 11th of August and the 16th of September, several mineral localities in the townships of Hull and Wakefield were visited to obtain specimens, required for making up collections. Only those localities were examined, which it was thought would afford the best specimens. In some instances poor success was met with, either from the running out of the mineral, or from being unable to find the exact locality, owing to the dense growth of underbrush. Nevertheless ten boxes of suitable specimens were collected, including some fine examples of crystals. Considerable delay was caused by the extremely wet weather, making the search through the thick woods unpleasant and difficult.

Mr. W. F. Ferrier has been chiefly occupied in the study of collections of rocks brought from various parts of the Dominion by the field geologists and explorers of the staff.

A considerable portion of his time has also necessarily been devoted to superintending the preparation of thin sections of these and other rocks requiring identification, the arrangement of a large number of specimens collected by Dr. Lawson, Mr. Adams and others, and other routine work.

Good progress has also been made in the determination, naming and labelling of the rocks in the general stratigraphical collection exhibited in the Museum, which, when properly classified and arranged, will be invaluable as a reference collection. Numerous specimens have been handed to him from time to time, and identified by their microscopical characters and simple blowpipe tests.

A few of the building stones from British Columbia have been studied microscopically to determine their true character and durability, and further work is purposed in this direction.

The series of Archæan rocks collected by Mr. Tyrrell from Lake Winnipeg, and by Dr. Bell and Mr. Barlow from the Sudbury region, which show many striking points of resemblance are now being investigated. 121 of the specimens of rocks brought in by the field parties, have been studied in thin sections, with the microscope and reported on during the past six months.

Palæontology and Zoology.

In addition to museum work and his other official duties, Mr. Whiteaves has been engaged, during the past year, in a critical study of the fossils of the Devonian rocks of the Mackenzie River district and of

Northern Manitoba. The manuscript of the third part of the 'Contributions to Canadian Palæontology,' which consists of a report upon the collections of fossils made by Mr. McConnell in 1887-89, from the Devonian rocks of the Hay, Mackenzie and Peace rivers, was finished in September, and the four plates required for its illustration were printed. Before sending the MS. of this report to the printer, however, the receipt of an additional and important collection of fossils, made by Mr. McConnell during the summer season of 1890 from the Devonian rocks of the Athabasca River and its tributaries, induced the writer to enlarge its scope, so as to make it include not only all the raw material obtained by Mr. McConnell, but also three small collections of fossils made by Prof. Macoun, Mr. A. S. Cochrane and Dr. Bell, in 1876, 1881 and 1882, from the Devonian limestone of the Athabasca and the Clearwater. The report as thus enlarged has been rewritten, an additional plate has been prepared to illustrate it, and the whole is now ready for publication.

Considerable progress has been made in the study of the unusually extensive collections of fossils made by Mr. Tyrrell, in 1888-89, from the Devonian and Silurian rocks of lakes Manitoba and Winnipegosis. The generic and specific relations of nearly all the sponges, brachiopoda and cephalopoda, and those of most of the pelecypoda, gasteropoda, crustacea and fishes in these collections have been ascertained and a preliminary list of them prepared for publication in Mr. Tyrrell's forthcoming report on the geology of this region. Some of the more critical of the mollusca and most of the corals and polyzoa have, however, yet to be studied. At an early date it is intended to publish an illustrated report upon the whole of these fossils in the fourth and concluding part of the 'Contributions to Canadian Palæontology.' In the meantime a paper descriptive of fifteen of the most striking species of brachiopoda and mollusca in these collections has been prepared and published in the 'Transactions of the Royal Society of Canada' for 1890. It consists of eighteen pages quarto and is illustrated by seven full page plates.

In August a fortnight was spent with Dr. Ells in an examination of the fossiliferous exposures near Philipsburgh, St. Dominique and Mystic, P.Q., and several species of fossils new to that district were obtained. In September a short visit was made to Hamilton, Hagersville and Cayuga, Ont. At the first named place a number of local collections were examined and several specimens of interest secured for the museum, especially a series of jaws, vertebræ and other bones, of snakes, small rodents and insectivora from the upper part of the sand and gravel ridge at Burlington Heights. From the Corniferous lime-

stone of the neighbourhood of Hagersville a small collection of fossils was made which includes specimens of a few species not previously represented in the Museum.

The MS. of the first part of a descriptive monograph of the Vertebrata of the Tertiary and Cretaceous rocks of the North-west Territory, by Prof. E. D. Cope, has been received during the year and is now in type. It contains a description of the species from the White River beds (Older Miocene) of the Swift Current Creek region of the Cypress Hills and will consist of twenty-seven pages quarto, illustrated by fourteen full page plates.

The MS. of the third part of the 'Contributions to Canadian Micro-Palæontology,' by Prof. T. Rupert Jones, F.R.S., has also been received and is now in the printer's hands. It consists of a description of a number of Ostracoda from the Cambro-Silurian, Silurian and Devonian rocks of Canada, and will be illustrated with two full page large octavo plates.

In the Department of Zoology another large collection of the mammalia, birds, reptiles, etc., of British Columbia, has been received from Prof. Macoun. Fifteen specimens of mammals, ninety-five of birds and two of turtles have been skilfully mounted by Mr. Herring during the past year, and twenty-four bird skins have been put up by him. Among the most striking of the additions to this branch of the museum are a remarkably fine specimen of the Musk Ox (*Ovibos moschatus*), from Fort Rae, on Great Slave Lake, recently presented by Julian Camsell, Esq., Chief Factor of the Hudson Bay Company in the Mackenzie River district, and an adult male of the Woodland Caribou (*Rangifer Caribou*), from the Selkirk Ranges of British Columbia, obtained by Dr. G. M. Dawson.

For two months and seven days during the past summer the duties of Acting Director have been performed by Mr. Whiteaves, and in addition to the correspondence thereby occasioned, 220 official letters have been received during the year, and 220 written.

From the 6th of January to the 26th of June, Mr. T. C. Weston was confined to his house by severe illness. He subsequently obtained leave of absence until the first of August, and during that time and up to the 8th of September he was occupied in the examination of the rocks in the neighbourhood of Quebec city, from which he was successful in obtaining a remarkable and in some respects u nique set of fossils, which throw considerable light on the age of these rocks, which is still under discussion. From the 10th of September until the close of the year, Mr. Weston's time has been spent in museum work, in the palæontological and archæological sections, in arranging several hundreds of

new specimens in the cases, in preparing descriptive labels for them, and the like.

Mr. L. M. Lambe was engaged in the early part of the year in the study of collections of fossils from Lake Winnipegosis and the Hay River, collected by Messrs. Tyrrell, Dowling and McConnell, in assisting in their determination and preparing drawings for their illustration.

During the latter part of July and in August Mr. Lambe, with Mr. Dowling, made a collection of fossils from the Cambro-Silurian rocks of Lake Winnipeg, from Dog Head on the south to the Little Saskatchewan on the north, and then east to Beren's or Swampy Island, including all the islands off that part of the western shore of the lake. He also visited East Selkirk, Manitoba, and made a collection of fossils at that place.

After his return, Mr. Lambe assisted Mr. Whiteaves in an examination and study of some Devonian fossils from Lake Winnipegosis, and prepared plates for their illustration in the transactions of the Royal Society of Canada for 1890, and has since been engaged in the study of some fossils collected by Mr. McConnell on the Athabasca River during the summer of 1890.

During the past year Mr. H. M. Ami's time has been occupied at intervals in sorting, identifying and labelling large collections of fossils which have not been unpacked since they left Montreal. About 20,000 specimens were examined with this end in view, and all of these are now accessible and available for reference or as duplicates. In March he made a selection of about 100 specimens of fossils and Indian remains belonging to the estate of the late Sheriff Dickson, for the Museum. He also assisted in a preliminary examination of fossils recently received from the North-west Territories, and spent some time in rearranging the palæontological part of the library, with a view to making a catalogue thereof. In April Mr. Ami identified and labelled some 250 fossils for the St. Laurent College, Montreal, and some other specimens for a private collector at Hamilton in return for donations to the Museum. He also prepared systematic lists of species from various localities in Ontario, Quebec, Nova Scotia and New Brunswick, and selected several especially among the graptolidæ, monticuliporidæ and ostracoda, which require further study. With Mr. Herdt's assistance and during Mr. Weston's illness, he attended to the reception, registration and arrangement of the archæological specimens brought in by officers of the Survey or presented by them. During the month of May he arranged, classified and labelled the vertebrate remains of the Lower Miocene of the Cypress Hills upon which Professor Cope has recently reported. A collection of fossils, consist-

ing of 61 species and 184 specimens, has been prepared by Mr. Ami and sent to the Museum of Queen's College, Kingston, in July, and another, consisting of 365 specimens, was sent to the Redpath Museum, Montreal, in October. Small sets of fossils have been loaned or sent, for scientific purposes, to various specialists, especially to Professor Hall at Albany, Mr. C. D. Walcott at Washington, Professor E. D. Cope at Philadelphia, and Dr. J. G. Hinde of Croydon, England. At the end of October he visited Quebec city and collected a series of fossils from the neighbourhood and named several hundred specimens of fossils for the Laval University. In November he prepared systematic lists of fossils for Mr. Low's report on the geology of the counties of Portneuf, Quebec, Montmorency and Champlain, P.Q., and identified a few fossils from the black shales of Mr. Wissick, Lake Temiscouata, for Professor Bailey. He has also made a preliminary examination of the collections of fossils from Quebec city, made by Mr. Weston during the past summer, and of those made by Dr. Ells, Mr. Giroux and Mr. Deeks in the Eastern Townships. He has also prepared labels for a number of species of Cambrian and Carboniferous fossils which were previously unlabelled. From the 3rd May to the 1st September he was assisted by Mr. H. D. Herdt, a science student of McGill University.

The following collections have been received during the year from members of the staff:—

Dr. G. M. Dawson:—

174 specimens of fossil plants, shells, etc., from the southern interior of British Columbia. Six specimens of the fresh-water pearl mussel (*Margaritana margaritifera*) from the headwaters of the Bonaparte River, B.C. One fine specimen of the Woodland Caribou (*Rangifer Caribou*). About 200 specimens of arrowheads, jade implements, etc., from British Columbia.

J. F. Whiteaves:—

Fifty specimens of fossils from the Corniferous of Hagersville, Ont.

Dr. R. W. Ells:—

About 1,200 specimens of fossils from the Cambrian, Cambro-Silurian and Silurian rocks at numerous localities in the province of Quebec. Hairy-tailed Mole (*Scapanus Breweri*) from base of Orford Mountain, P.Q.

Hugh Fletcher:—

Fifty-four specimens of Silurian and other fossils from Economy River and River Philip, N.S. About sixty specimens of Carboniferous plants from the Pictou and Springhill coal mines of

Nova Scotia, through Messrs. H. S. Poole and William Madden.

R. G. McConnell :—

About 300 specimens of fossils from the Devonian and Cretaceous strata of the Athabasca River and its tributaries.

J. B. Tyrrell :—

500 fossils from the Assiniboine and Saskatchewan rivers and Lake Winnipeg region of Manitoba.

T. C. Weston :—

284 specimens of Cambro-Silurian fossils from the Montcalm market and Cove Field rocks of Quebec city, Que. One spear head from Hog's Back, Nepean, Ont.

H. M. Ami and H. D. Herdt :—

A number of fossils from the post-Tertiary deposits of Moose Creek, the post-Tertiary and Cambro-Silurian formations of the city of Quebec and vicinity of Ottawa. Eleven archæological specimens from Old Indian Settlement, Casselman, Ont., and an Ermine (*Putorius ermineus*) from Russell, Ont.

D. B. Dowling and L. M. Lambe :—

750 specimens from the Cambro-Silurian rocks of Lake Winnipeg, Man.

L. M. Lambe :—

Fifty specimens of fossils from East Selkirk, and a large "head" of *Cleiocrinus* from Hull, P.Q.

A. P. Low :—

One fossil from Chambord, Lake St. John, Que. One chipped quartz implement, Quebec.

N. J. Giroux :—

About 100 specimens of fossils from the Cambro-Silurian rocks of Quebec.

The additions to the palæontological, ethnological and zoological departments of the museum, by presentation, exchange or purchase, are as follows :—

By Presentation.

Julian Camsell, Chief Factor, Hudson Bay Co., Mackenzie River district :—

Fine specimen of the Musk Ox (*Ovibos moschatus*) from Fort Rae, Great Slave Lake.

James Fletcher, Ottawa :—

Male Mole Shrew (*Blarina brevicauda)* in the flesh. Six Snow-flakes (*Plectrophenix nivalis*) in the flesh. One Lapland Long-spur (*Calcarius Lapponicus*).

Dr. C. A. White, U.S. Geological Survey, Washington :—

Two specimens of an undermentioned species of *Rhynchonella* found associated with *Aucellæ* at Paskanta, California.

John C. McRae, Port Colborne, Ont. :—

Twenty-five specimens of fossils from the Corniferous Limestone near Port Colborne, two fragments of *Eurypterus* from the Water-lime group at Stonebridge, Ont., eleven specimens of fossils from the St. Louis limestone, and a *Spirifera* from the sub-Carboniferous limestone of Alabama.

Max Klotz, Preston, Ont. :—

Four specimens of *Megalomus Canadensis* from the Guelph limestone, below Preston, on the Grand River.

Donald McKay, Indian Head, N.W.T. :—

Skin of Silver-haired Bat (*Scotophilus noctivagans*) from Indian Head.

W. F. Ganong, Cambridge, Mass. :—

One Starfish (*Asterias Forbesi*) from Oak Bay, Charlotte Co., N.B., and four species of marine Mollusca from the oyster beds of Prince Edward Island.

G. R. White, Ottawa :—

Skin of Grey Gopher (*Spermophilus Richardsoni*).

Prof. H. Alleyne Nicholson, University of Aberdeen, Scotland :—

Named specimens of twenty-one species of Polyzoa from the Trenton, Corniferous and Hamilton formations of Ontario, described or identified by the donor.

H. G. Stanton :—

Specimen of *Miya truncata*, with both valves, from the post-Pliocene of River Beaudette, P.Q.

J. Deans, Victoria, V.I. :—

One specimen of *Monotis subcircularis*, two of *Arniotites Vancouverensis*, from the Trias of Vancouver Island, and phragmocone of a large Belemnite from the Cretaceous rocks of Maud Island, Q.C.I.

S. Robbins, Nanaimo, V.I. :—

Two cores from boring in the Cretaceous rocks (Nanaimo series) of Vancouver Island ; one containing specimens of *Anomia*

Vancouverensis, *Inoceramus mytilopsis*, *Entalis Cooperi* and *Haminea Hornii*.

Captain Josiah Jacques, Victoria, V.I. :—

Burrows of *Teredo* in fossil wood; four species of fossil Pelecypoda and two of Gasteropoda, from near Carmanah Point, V.I.; also one *Conchocele disjuncta* and one *Pachypoma gibberosum*, from post-Pliocene deposits, three miles E. S.-E. of Bonilla Point, V.I.

W. E. Saunders, London, Ont. ;—

One small Turtle (*Nanemys guttata*) alive, caught near London, Ont., and one fine living example of Blanding's Box Turtle (*Emys meleagris*, Shaw), from Rondeau, near Chatham.

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

Specimen of *Orthis circulus*, Hall, from the Niagara group at Hamilton.

D. Herring, Toronto ;—

Female Stilt Sandpiper (*Micropalama himantopus*), from Toronto Island; female Bartramian Sandpiper (*Bartramia longicauda*), shot on the Humber, near Toronto.

S. Herring, Ottawa :—

Four specimens of the Evening Grosbeak (*Coccothraustes vespertina*), shot near Toronto. In the flesh.

Col. Irvine, per Dr. G. M. Dawson :—

One large spear head from the Cypress Hills, Assiniboia.

W. Dickson, per Dr. G. M. Dawson, from the estate of the late sheriff Dickson, Pakenham, Ont. :—

Three adzes from the vicinity of Pakenham, Ont., from his own collection; one fragment of pottery from Long Lake, N.W.T.

R. Têtu, per W. McInnes :—

Two arrow heads from near the mouth of the Cabano River, Lake Temiscouata, Têtu P.O., Que.

D. J. Wing, per D. G. M. Dawson ;—

Chisel of jade, from Kamloops, B.C.

George Possie :—

An iron axe.

J. W. Mackay :—

Three black flint arrow heads, from Lillooët, B.C.; one stone scraper, from Spence's Bridge, B.C.; one skin scraper, from Kamloops, B.C.; fragments of shells, teeth and flint from Lytton, B.C.

Walter Odell, Ottawa :—

Eight specimens of sponges and Polyzoa, from the post-Pliocene clays of Odell's brick yard, Ottawa, Ont.

Walter R. Billings, Billings Bridge, Ottawa :—

Eight specimens of *Zygospira deflecta*, Hall, from the Trenton limestone of Division St., Ottawa.

Charles Giramaire, Ottawa :—

One female Short Eared owl (*Asio accipitrinus*) in the flesh.

John Vicars, Cannington, Ont. :—

Skin of a Hoary Bat (*Atalapha cinerea*) from Manitoba.

Dr. Lorenzo G. Yates, Santa Barbara, California :—

Two specimens of the rare *Cyprœa spadicea* from the Santa Barbara Channel; three specimens of *Gonostoma Yatesii* from Calaveras Co., Cal., three of *Melania Surati*, from near Cordova, Mexico, and one *Pinna Venturensis*, from the Cretaceous rocks in Ventura Co., Cal.

J. A. Doyon, Ottawa :—

Female Long tailed Duck (*Clangula hyemalis*) in fall plumage.

G. Everett, Ottawa :—

Specimen of the Deer Mouse (*Hesperomys leucopus*) in the flesh.

Dr. H. G. Griffith, Burlington, Iowa :—

Four species of corals and two of Stromatoporoids from the Hamilton shales at Rockford, Iowa.

G. P. Jones :—

Specimen of *Macoma nasuta*, Conrad, brought up on the point of a pile driven fifty feet into the bottom of the Nicomekyl River, B. C.

A. E. Walker, Hamilton, Ont. :—

Petrified specimen of *Mesodon albilabris* from cavities in the Niagara limestone of the mountain at Hamilton.

Dr. P. Jones, Hagersville, Ont. :—

Two otoliths of sheepshead (*Haploidonotus grunniens*) dug up in an Indian ossuary at Hagersville.

Isaac Moore, Ottawa :—

Young Night Heron (*Nycticroax nycticorax nœvius*) in the flesh.

By Exchange :

W. Turnbull, Hamilton, Ont. :—

Shells of three species of turtles, nine fossils from the neighbourhood of Hamilton, and one specimen of *Palœotrochus Kearneyi* from the Corniferous limestone of Hagarsville.

G. M. Leslie, Hamilton, Ont. :—

Six species of land shells from the vicinity of Hamilton. A series of vertebræ, ribs, jaws and portions of skulls of snakes, small rodents and insectivora from the upper portion of the gravel ridge at Burlington Heights.

S. W. Howard, J.P., Hagersville, Ont. :—

Seven specimens of fossils from the Corniferous limestone at Hagersville.

S. A. Morgan, B.A., Hagarsville, Ont. :—

One head of *Dalmanites anchiops*, one specimen of *Platystoma lineatum*, two specimens of *Chonetes hemisphærica* from the Corniferous limestone at Hagarsville, and two arrow heads from the same place.

By Purchase :

From John Stewart, Ottawa :—

Two hundred choice and selected specimens of fossils from the Trenton limestone, mostly from the neighbourhood of Ottawa, and from the post-Pliocene of Green's Creek, Gloucester, Ont. Among the former are about seventy remarkably fine, and in many cases unique crinoids, and two specimens representing a new genus of Blastoidea. Among the latter is the most perfect specimen known of the rare fish known as *Cottus uncinatus*, Reinhardt, and several plants not heretofore represented in the museum collection.

Henry Sproule, Ottawa :—

120 fossils from the post-Pliocene nodules of Green's Creek, Gloucester, Ont.

E. Effingham, Cooksville, Ont :—

Specimen of the Turkey Vulture (*Carthartes aura*), shot at Cooksville, Ont. In the flesh, and since mounted.

G. Hogle, Philipsburg :—

Seven specimens of fossils from the neighbourhood of Philipsburg.

Prof. Henry Ward, Rochester, N.Y. :—

A small series of exotic shells, mostly terrestrial species from the Phillipine Islands.

The entomological collections in the Department are under the care of Mr. James Fletcher. They are contained in nine cabinets, and number about 9,000 specimens. Mr. Fletcher reports :

"The cabinets have been regularly examined, and the collections therein contained are in a good state of preservation, no losses having occurred from insects, mould or accident. Several valuable additions have been made during the year. These are chiefly from the collections made by the officers of the Survey, and by donations. Valuable and extensive collections were brought in by Dr. G. M. Dawson, from the Kamloops district in British Columbia, of Coleoptera and Lepidoptera; by Prof. Macoun, from the Kootanie District in British Columbia, of Lepidoptera and Coleoptera; by Mr. W. McInnes, from the Lake Superior region, of various orders. There are in all these collections many specimens which are interesting additions for the cabinets as well as duplicates for exchange.

"Donations have been received from the following:—

Rev. C. J. S. Bethune, Port Hope, Ont., Coleoptera.

Mr. W. H. Harrington, Ottawa, Coleoptera and Hymenoptera.

Mr. W. H. Darley, Victoria, B.C., Lepidoptera.

Rev. G. W. Taylor, Victoria, B.C., various orders.

Mr. A. L. Poudrier, Victoria, B.C., Lepidoptera from the Rocky Mountains.

Mr. T. E. Bean, Laggan, N.W.T., specimens of rare Lepidoptera.

"Most of these are insects not represented in the collection, and were kindly given in response to an application by the Curator.

"Special cases have been prepared for the exhibition of a collection of native insects in the hall of the Museum, which, it is believed, will be of interest to the many visitors who frequent the Museum."

Botany, &c.

Early in the year Professor Macoun was engaged on Part V. of the Catalogue of Canadian Plants, and was also attending to Mr. Pearson's list of Canadian Hepaticæ, then passing through the press; both have since been printed and distributed. Part V. included the ferns and their allies, and an addendum that brought the whole work up to date. One hundred and fifty-five species have been added to the Canadian Flora since the addendum, printed with Part III., was issued.

As the investigation of the fauna and flora of British Columbia had hitherto extended only from the Pacific coast to the Gold Range, Professor Macoun was authorized last spring to make examinations of the Columbia and the Kootanie river valleys and lake districts, and later to make collections amongst the higher summits of the Selkirk and Rocky Mountain ranges. He reports: "This work was successfully carried out. By the first week in April a competent collector was

stationed at Revelstoke on the Columbia river. He worked there for two months, and procured 259 fine skins of rare birds. I joined him early in May and collected in the vicinity of Revelstoke for four weeks, or up to the first of June. My assistant, Jas. M. Macoun, who had remained in Ottawa reading proof and attending to arrears of office work, joined me on that date, and we then went down the Columbia to Deer Park and Sproat, where careful enumerations and collections of the fauna and flora were made. Early in July we crossed the portage from Sproat to Nelson, and spent the next three weeks at various points on Kootanie Lake. We then returned to Revelstoke, and on the 28th of July went to Roger's Pass in the Selkirk Mountains, where some of the highest surrounding peaks were ascended and a number of rare and interesting specimens were secured. Ten days were then spent at Hector, in the Rocky Mountains, and large collections were made on the higher summits around that station. We left Hector for Ottawa on the 20th of August.

To secure data to complete the enumeration of the mosses in Part VI. a three weeks' trip was made in September to the western part of Ontario. The species of that region which had not hitherto been noticed, were collected and recorded. Owen Sound, Windsor, Chatham, Sandwich, Port Dover, Leamington, Port Colborne and the vicinity of Niagara Falls were visited.

The results of the season's work were the addition of over twenty species of birds to the British Columbia Avi-fauna and the addition of many species of flowering plants, part new to science and all new to the Canadian flora. The discoveries in cryptogams, especially mosses, have been so numerous that Dr. Carl Muller, of Halle, says in a letter to Dr. Kindberg, that they constitute a new epoch in American Bryology. Up to the present writing these two gentlemen have named 200 species new to science, collected chiefly by Prof. Macoun during the last three years. About 400 specimens of birds and mammals and 20,000 specimens of plants were collected during the past season.

Since our return from the field my assistant had been engaged in examining and naming the year's collections of flowering plants, getting out the species to mount and doing the general work of the office, while I have been occupied on Part VI. of the Catalogue of Plants and on the Catalogue of Canadian Birds, which is approaching completion. All work in connection with the Herbarium has been done as in the previous year, 1889, by Mr. Jas. M. Macoun. During 1890, 3,807 sheets of specimens have been mounted and placed in the herbarium. Of these 2,316 were flowering plants and 1,491 cryptogams, principally mosses. Of the flowering plants 1,699 were Canadian, 260 from the United States, and 457 from Europe.

4,211 sheets of specimens were sent from the herbarium to private individuals and to public institutions in exchange for desiderata; of these 1,871 were cryptogams and 2,340 flowering plants. Specimens were sent to

The British Museum	200
Central Experimental Farm, Ottawa	200
Mechanics Institute, Wingham	100
St. John's College, Winnipeg	100
Department of Public Instruction, Quebec	100
McGill College, Montreal	100
National Museum, Washington	200
University of Nebraska	124
Harvard University	164
California Academy of Science	100
Shaw School of Botany, St. Louis, Missouri	170
Columbia College, New York	218
The University of Copenhagen, 100 flowers, 400 cryptogams	500
Professor Kindberg, Linkoping, Sweden	884

Since the 31st of December, 1889, in connection with the work of this division, 447 letters of sufficient importance to copy were written, and about the same number were received.

Since returning from the field the herbarium of St. Laurent College, Quebec, has been examined, and the specimens, over 2,100, named; also the herbarium of Mr. Morten, of Wingham, and Dr. White, of Toronto, besides many small collections from various parts of the Dominion.

The survey herbarium is arranged in eight large cases, but these are now so full that specimens are frequently injured by being crushed; another case will shortly be available and a better arrangement of the specimens will then be effected, and they will be much better preserved.

Considerable inconvenience is now caused by the crowded state of the small room devoted to the work of this division. It arises from the accumulation of the large collections annually brought in, and it is hoped that the alterations that have been suggested, whereby this serious inconvenience would be in a measure obviated, will be speedily carried out.

The following notices from foreign journals indicate the estimation and appreciation of the botanical work of the division under Professor Macoun:

From "Zoe," (Vol. 1-9) a biographical journal published at San Francisco—

"Catalogue of Canadian Plants, Part V. This part contains the ferns and fern allies and additions and corrections to Vol. I–IV., which are rather extensive, embracing a hundred pages and conforming to recent revisions. * * * The work in general has been carefully done and reflects credit upon the Government of Canada and the botanists concerned in its production."

From "Botanical Gazette," Vol. XVI. :—

"With the appearance of Part V., devoted to Pteridophytes, Prof. John Macoun's Catalogue of vascular Canadian Plants has been completed. It has been very handsomely done, and the painstaking care so evident through it all has made it a mine of information concerning the Canadian Flora. A large appendix brings together additions and corrections to Parts I–IV., the results of all monographic work done since the beginning of the catalogue being included. * * * The part is rounded out by a complete index to all the parts, and the five will make a very complete and compact volume."

MAPS.

Maps in course of Preparation and Published during 1890.

North-west Territory, 9 sheets, 20 to 26 inches long by 16 inches broad, showing waters followed by the members of the Yukon Expedition, 1887–88, and reaching from longitude 111° to 144° and latitude 59° to 68°, to accompany report by Mr. McConnell, will be ready for engraver in two months.....	8 miles=1 inch.	
Index map of the above now in the lithographer's hands.....	48 miles=1 inch.	
British Columbia, part of southern interior (Dr. Dawson), in draughtsman's hands, will be ready for engraver in April....	4 miles=1 inch.	6,400
British Columbia, Kootanie district (Dr. Dawson), published 1890.....	8 miles=1 inch.	11,000
British Columbia, Shuswap district (Dr. Dawson), in draughtsman's hands.....	4 miles=1 inch.	6,400
Manitoba, map taking in the whole of Lake Winnipeg (Mr. Tyrrell) in the draughtsman's hands.....	do	48,600
Northern Manitoba, in manuscript (Mr. Tyrrell).....	2 miles=1 inch.	5,000

Northern Manitoba, in engraver's hands (Mr. Tyrrell)	8 miles=1 inch.	20,000
Western Ontario, Lake of the Woods, sheet No. 2, in the engraver's hands	2 miles=1 inch.	2,000
Western Ontario, Hunters Island, sheet No. 7, (Dr. Lawson) in the engraver's hands	4 miles=1 inch.	1,450
Western Ontario, north of Hunters Island, sheet No. 6, in draughtsman's hands	do	3,456
Ontario, sheet No. 130, Sudbury Mining district (Dr. Bell), in hands of draughtsman; will be ready for engraver in a few weeks	do	3,456
Ontario, sheet No. 115, ready for draughtsman	do	3,456
Ontario, general map in progress	do	
Quebec, N.E. ¼ sheet (Eastern Townships map) in hands of engraver	do	4,500
Quebec, S.W. ¼ sheet (Eastern Townships map) in draughtsman's hands	do	4,500
Quebec, N.W. ¼ sheet (Eastern Townships map) in progress	do	4,500
Quebec, Quebec and Lake St. John district, 2¼ sheets in progress	do	6,912
Quebec, ¼ sheet, 18 S.E. and 18 N.E. (Messrs. Bailey & McInnes) in draughtsman's hands	do	3,950
Quebec, Lièvre River and Templeton Phosphate region, Ottawa county, 2 sheets (Mr. Ingall), will be ready for engraver in two months	40 chains=1 inch.	220
New Brunswick, surface geology, ¼ sheet 1 S.W., 1 S.E. and 1 N.E., 3 sheets (Mr. Chalmers), ready for engraver in a month	4 miles=1 inch.	6,650
Nova Scotia, ¼ sheet, 11 N.W. and 11 S. W. in the engraver's hands	do	
Nova Scotia, ¼ sheet, 4 N.E. and 4 S.E., (Messrs. Fletcher and Faribault) in manuscript, most part of them drawn	1 inch=1 mile.	

LIBRARY, SALES AND DISTRIBUTION OF PUBLICATIONS.

Dr. Thorburn reports that the distribution of the various publications of the Geological Survey Department with which he is charged has now attained large dimensions and is likely to increase year by year. Last year there was sent from the office, including Annual Reports, special Reports and maps, 8,936. This is exclusive of the annual Report Vol. III., 1887–88 in French, the printing of which has unfortunately been delayed. There have been distributed in Canada 6,527, the remainder, 2,409, were sent to foreign countries, to scientific and literary institutions and individuals in the various countries of Europe, India, China, Japan, Australia, the United States, etc.

There have been received as exchanges during 1890, 2,375 publications, including reports, transactions, proceedings, memoirs, periodicals, pamphlets and maps.

The books purchased during the year were 116, and 41 periodicals have been subscribed for.

The number of books bound during the same period has been 152. Now that the work of binding has been taken over by the Government, it is hoped that it will, in future, be done as promptly as is desirable, and indeed essential that it should be, to make the volumes accessible to the members of the staff who are constantly requiring them for consultation and reference.

As an evidence of the amount of work connected with matters relating to the library, and to the distribution of the Geological Survey publications, it may be stated that during the past year 1,644 letters were sent by the Librarian and 2,476 were received by him, as compared with 1,511 and 1,256 in 1889.

The number of volumes in the library is now about 8,500, and of pamphlets, 3,300.

In the Report for 1886, it was stated that a card catalogue of the library had been introduced. It has been in operation ever since and has been found to be of great service in assisting members of the staff in finding, more readily than formerly, information on the various subjects under investigation.

For several years past, the space allotted to the library has been found to be altogether insufficient, and consequently a large number of books are not readily available for reference, except at a great inconvenience of those wishing to consult them. It is to be hoped that this will be soon remedied so that a full and exhaustive classification may be made.

Sales of Survey publications for year ending 31st December, 1890, amounted to $2,366.42.

Visitors.

The number of visitors to the Museum during the year, from 1st January to the 31st December, was 17,760.

STAFF, APPROPRIATION, EXPENDITURE AND CORRESPONDENCE.

The staff at present employed is 52, viz.: professional, 34; ordinary, 18.

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

Dr. A. C. Lawson, field geologist, resigned.
Mr. Amos Bowman do do
Mr. F. G. Wait, appointed assistant chemist.
Mr. L. N. Richard, appointed draughtsman.
Mr. J. B. Tyrrell, promoted from 2nd to the 1st class.
Mr. R. L. Broadbent do 3rd do 2nd do
Mr. H. M. Ami do 3rd do 2nd do

The amount available for the fiscal year ended 30th June, 1890, was:

——	Grant.	Expenditure.
	$ cts.	$ cts.
Civil list appropriation	45,750 00	
General purpose appropriation	62,100 00	
Civil list salaries		40,768 78
Wages of temporary employees		17,051 85
Exploration and survey		22,528 01
Printing and lithography		13,520 83
Boring operations, Deloraine		2,497 54
Purchase and binding of books, etc., and purchase of instruments		1,232 80
Purchase of specimens		814 57
Laboratory apparatus and chemicals		238 34
Stationery, mapping materials, and Queen's Printer		1,216 45
Incidental and other expenses		2,488 09
		102,357 26
Less—Paid in 1889		6,026 93
		96,330 33
Add—Advances to field explorers		6,534 66
		102,864 99
Unexpended balance, civil list appropriation		4,981 22
do general purpose appropriation		3 79
	107,850 00	107,850 00

The correspondence of the Department shows a total of 11,159 letters sent and 6,016 received.

I have the honour to be sir,

Your obedient servant,

ALFRED R. C. SELWYN,

Deputy-Head and Director.